BRITISH STANDARD

BS 5839 :
Part 1 : 1988

Incorporating Amendment Nos. 1, 2 and 3

Fire detection and alarm systems for buildings

Part 1. Code of practice for system design, installation and servicing

Foreword

This Part of BS 5839 has been prepared under the direction of the Fire Standards Committee. It is a revision of BS 5839 : Part 1 : 1980, which is withdrawn.

In addition to the existing BS 5839 : Parts 2, 3, 4 and 5, a specification for line-type heat detectors is in preparation. Parts of EN 54 'Components of automatic fire detection systems' (in preparation by Technical Committee CEN/TC 72, Automatic fire detection systems, of the European Committee for Standardisation) will be published as Parts of BS 5445. Standards prepared by subcommittee ISO/TC 21/SC 3, Fire detection and alarm systems, (of Technical Committee TC 21, Equipment for fire protection and fire fighting, of the International Organization for Standardization) that are accepted as British Standards will be included in BS 5445 if adopted by CEN, and in BS 5839 if not.

As far as possible, this Part of BS 5839 takes account of the work of CEN/TC 72 and ISO/TC 21/SC 3.

The major part of this revision was updating the recommendations and important changes made are as follows.

(a) Classifications have been introduced to allow the specification of system type by principal purpose (i.e. life or property protection) and extent of protection provided (i.e. entire premises, areas of special risk only, or escape routes only).

(b) Recommendations have been included to cover systems utilizing recent advances in technology, e.g. the use of microprocessors, analogue detector signalling, multi-function indicators and radio-linked systems.

(c) Advances in technology have led to systems in which circuits serve more than a single zone: recommendations have been incorporated to restrict the effect of faults in such circuits.

(d) Recommendations on self-contained smoke alarms for domestic use are no longer included in the body of this Part of BS 5839.

(e) Consideration has been given to problems which might arise from the combination into one system of components from several manufacturers.

(f) Monitoring of circuits connecting detectors, sounders, call points, power supplies and control and indicating equipment is recommended.

(g) With the exception of control equipment for small manual systems, (see appendix G), all recommendations relating to the specification of control equipment have been transferred to BS 5839 : Part 4.

(h) The maximum delay in the response to the operation of manual call points has been altered to 8 s, and is further reduced to 3 s from 1 January 1990.

(i) Following recent research, the provision of detectors in rooms adjoining escape routes is now recommended, particularly for sleeping accommodation.

(j) More detailed recommendations on the avoidance of false alarms are included.

(k) The effect on manual call points of the removal of detectors from their bases is included.

Current legislation requires that an effective means of giving warning in case of fire be provided in certain premises. The fire authority and the Health and Safety Executive will advise on legislation that applies to any building. Consultation with the appropriate authority is advisable and may be obligatory.

The protection of property with a fire detection and alarm system may permit an insurance company to offer a reduced premium provided that the system is acceptable. Early consultation with the insurer is advisable.

Fire protection should not be confused with fire precautions, and the provision of a fire detection and alarm system should never be regarded as giving complete protection against fire. In particular, it should not be used as an excuse for reducing measures intended to prevent the occurrence of fire. For detailed recommendations on fire precautions in buildings, reference should be made to the relevant Parts of BS 5588

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.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

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Summary of pages

The following table identifies the current issue of each page. Issue 1 indicates that a page has been introduced for the first time by amendment. Subsequent issue numbers indicate an updated page. Double sidelining on replacement pages indicates the most recent changes (amendment, addition, deletion).

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Section one. General

1 Scope

This Part of BS 5839 provides recommendations for the planning, design, installation and servicing of fire detection and alarm systems in and around buildings. It does not recommend whether or not a fire alarm system should be installed in any given premises.

The systems covered in this Part of BS 5839 are referred to as fire alarm systems. This Part of BS 5839 covers systems ranging from simple installations with one or two manual call points, up to complex installations with automatic detectors, manual call points, control and indicating equipment, connection to the public fire service, etc. It also covers systems capable of providing signals to initiate, in the event of a fire, the operation of ancillary services (such as fixed fire extinguishing systems) and other precautions and actions, but it does not cover the ancillary services themselves.

This Part of BS 5839 does not cover systems combining fire alarm functions with other non-fire related functions, although some guidance on such integrated systems is given in appendix F.

Although recommendations on the installation of self-contained smoke alarms are not included in this Part of BS 5839, advice from the Home Departments* is reproduced in appendix H.

This Part of BS 5839 does not cover street fire alarms, the 999 emergency call system, or manually or mechanically operated sounders.

This Part of BS 5839 does not cover systems whose primary function is to extinguish or control the fire, such as sprinkler or automatic extinguishing systems, even though they might have a secondary alarm function; it does, however, cover the use of a signal from an automatic extinguishing system as one initiating element of a fire alarm system.

This Part of BS 5839 applies only to fire alarm systems in a temperate climate such as that of the United Kingdom.

Recommendations for fire detection systems in electronic data processing installations are given in BS 6266.

NOTE. The titles of the publications referred to in this standard are listed on the inside back cover.

2 Definitions

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

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

NOTE. Hybrid systems are possible in which groups of devices on a circuit can be separately identified, but not individual devices within the group.

2.2 aspirating detector. A detector system in which a sample of the atmosphere in the protected space is sucked by a fan or pump into a detector which may be remote from the protected space.

2.3 automatic system. A system in which an alarm of fire can be initiated automatically.

2.4 competent person. A person competent to perform a defined task.

NOTE. Normally a competent person will be an employee of a manufacturer, supplier, installer or servicing contractor, or a member of the user's staff who has received suitable training from a manufacturer or supplier.

2.5 detector. A part of an automatic fire detection system that contains at least one sensor which constantly or at frequent intervals monitors at least one suitable physical and/or chemical phenomenon associated with fire, and that provides at least one corresponding signal to the control and indicating equipment. The decision to give the alarm of fire or to operate automatic fire protection equipment may be made at the detector or at another part of the system, for example at the control and indicating equipment.

Detectors may be classified by the form of their output as follows:

(a) **analogue detector.** a detector which gives an output signal representing the value of the sensed phenomenon. This may be a truly analogue signal or a digitally coded equivalent of the sensed value. This detector does not itself make a decision of fire;

(b) **multi-state detector.** a detector which gives one of a limited number (greater than two) of output states relating to 'normal' or 'fire alarm' and other abnormal conditions;

(c) **two-state detector.** a detector which gives one of two output states relating to either 'normal' or 'fire alarm' conditions.

2.6 final voltage of a battery. The voltage at which the cell manufacturer considers the cells to be fully discharged at the specified discharge current.

2.7 lantern-light. A construction standing above the surface of a roof and intended to admit light to the space below.

2.8 manual system. A system containing no automatic detectors and in which an alarm of fire may only be initiated manually.

2.9 mimic diagram. A topographic representation of the protected premises and their subdivisions, carrying indicating devices for each subdivision such that the indications of the fire alarm system can be rapidly related to the layout of the premises.

2.10 monitored wiring. Wiring in which a failure, whether to open circuit or to short circuit, will result in a fault warning and not an alarm of fire.

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

2.11 normal supply. The supply from which the fire alarm system is expected to obtain its power. The normal supply is usually derived from the public electricity supply system.

2.12 protection

(1) The presence of one or more detector(s) able to initiate actions needed for the safety of life or property in the event of a fire.

(2) The provision of mechanical protection to prevent damage to system components from impact, abrasion, rodent attack, etc.

(3) The provision of fire resistance to prevent damage to system components from fire in their vicinity.

(4) The provision of electrical protection to prevent temporary or permanent disruption to the system due to overvoltage, excessive current, high transient or radio-frequency interference, etc.

2.13 responsible person. The person having control of the premises, whether as occupier or otherwise, or any person delegated by the person having control of the premises to be responsible for the fire alarm system and the fire procedures.

2.14 search distance. The distance which has to be travelled by a searcher within a zone in order to determine visually the position of a fire.

2.15 sector. A subdivision of the protected premises normally containing several zones. A sector may cover more than one building.

2.16 smoke. Particulate and aerosol products of combustion generated by a fire, whether this be of the smouldering or open flame type.

NOTE. In general the particle diameters range from 1 nm (invisible smoke) to 10 μm (visible smoke).

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

2.18 standby supply. An electricity supply, commonly from a rechargeable battery, which is automatically connected to the fire alarm system when the normal supply fails.

2.19 two-stage alarm system. A fire alarm system in which the initial alarm is given only in a restricted part of the premises, with an alert signal being given in the remainder of the premises.

2.20 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 an indication of fire in any other subdivision.

NOTE. A zone will usually consist of an area protected by several manual call points and/or detectors, and is separately indicated to assist in location of the fire, evacuation of the building and fire-fighting.

1 **2.21 condition.** The condition of a control equipment.

NOTE. For example, the control equipment may be in the normal condition, the fault condition, the alarm condition, etc.

2.22 phased evacuation. A system of evacuation in which different parts of the premises are evacuated in a controlled sequence of phases, those parts of the premises expected to be at greatest risk being evacuated first. (See appendix K.)

NOTE. A phased evacuation will normally require at least a two-stage

1 **2.23 staged alarm system.** An alarm system in which two or more stages of alarm can be given within a given area. (See appendix K.)

NOTE 1. Examples of staged alarm systems are a two-stage system capable of giving 'alert' or 'evacuate' signals, or a three-stage alarm system capable of giving 'staff alarm', 'alert' or 'evacuate' signals.

NOTE 2. The normal condition, under which no alarm is given, is not counted as a stage of alarm.

NOTE 3. In this standard, in order to avoid confusion:

(a) the term 'stage' is used to describe the different stages of alarm in one area of the premises;

(b) the term 'phase' is used in describing the sequence of phases of evacuation of different areas of the premises.

2.24 state. The outputs of a detector.

3 Types of system

3.1 General

Fire alarm systems may be installed in buildings in order to satisfy several different needs. They may be installed for the protection of property; they may be installed for the protection of life; in some applications they may be installed to meet a mixture of purposes, either simultaneously or differing in time or place.

Because of the great variety of systems covered by this Part of BS 5839, the systems have been divided into a number of different types, each identified by a letter.

Type P systems are automatic detection systems intended for the protection of property. They are further subdivided into:

type P1: systems installed throughout the protected building;

type P2: systems installed only in defined parts of the protected building.

Type L systems are automatic detection systems intended for the protection of life. They are further subdivided into:

type L1: systems installed throughout the protected building;

type L2: systems installed only in defined parts of the protected building; a type L2 system should normally include the coverage required of a type L3 system;

type L3: systems installed only for the protection of escape routes.

Type M systems are manual alarm systems, and have no further subdivision.

In some buildings control of various parts of the building may lie with several different occupants or even external authorities. The requirements for fire alarm systems in such buildings may differ from those in which control lies with a single occupant because of the need for liaison between occupants and possibly interconnection or overlap of the alarm systems. Systems intended for use in multi-occupancy buildings are given the suffix letter X.

Premises protected by automatic detection systems, both of types L and P, should normally also be provided with manual call points.

Some of the recommendations of this Part of BS 5839 apply to all systems, while other recommendations apply only to a limited number of system types. In order to clarify the application of the recommendations, those clauses having limited application are shown with the applicable system type designation in parentheses following the clause title. Clauses without system designations should be taken as having general application. Appendix J lists the clauses (general or specific) applying to each type of system.

If a system is intended to fulfil the purposes of more than one type of system, and the recommendations for the types differ, then the system should comply with the recommendations for each of the types. For example, a system whose sole purpose is to provide full coverage property protection (type P1) need only have a small number of sounders; but if it is also used to provide coverage of the escape routes for life safety, the number of sounders used will have to be sufficient to give warning throughout the building.

3.2 Systems for the protection of property (type P)

The longest delay in detection of fire is likely to occur when no person is present to detect the fire either at ignition or while it is in its early stages of growth. For the reduction of property loss, therefore, automatic detection is likely to be more successful than a simple manual system; however, manual call points should always be provided since people may be able to give an earlier alarm of fire if they are present.

A fire can start virtually anywhere on the premises and, if undetected, may grow until extinction becomes difficult or impossible. The highest level of property protection obtainable from a fire alarm system will therefore be given by a type P1 system, giving full coverage of all parts of the premises. Such a system will generally be the only type acceptable to fire insurers.

A lower level of protection, still giving a useful reduction in fire hazard, may often be obtained by the installation of fire detectors in only those parts of the building having a high fire risk. The areas where detectors are required can frequently be identified from the presence of ignition sources and easily ignitable materials, the potential for rapid fire spread, the absence of supervision, or the serious consequences of loss. Areas where detectors are less necessary might be those containing few combustibles or ignition sources, having continuous supervision and having good structural fire separation from the remainder of the building. Such a partial cover system is a type P2 system.

3.3 Systems for the protection of life (types L and M)

In some buildings the hazard to life from fire may be considered so small that no fire alarm is needed. In others, the only need may be for a device by which the alarm may be manually sounded. But in the majority of larger buildings there will be a need for a system by which the alarm can be sounded throughout the building, and, particularly where a wakeful watch cannot be guaranteed, the alarm sounders may need to be initiated by automatic detectors.

As with property protection, the greatest benefit will be given by a full coverage system (type L1). Such a system should give the earliest practicable warning of fire, wherever ignition may occur, and will then raise the alarm throughout the premises. However, a reduced but still useful level of protection may be obtained from a type L2 system, in which detection is only provided at points where the presence of a fire (or of the products of a fire) would lead to a significantly high life hazard. A type L2 system might, for instance, give detector coverage only in those areas where a fire might hazard people sleeping without supervision; other areas of low fire risk remote from the sleeping accommodation might be left without detector coverage although alarm sounders and manual call points should be provided. The areas protected by a type L2 system should normally include escape routes, i.e. those areas that would be protected by a type L3 system.

A type L3 system is intended only to protect escape routes, by giving warning of a fire in time for the escape routes to be used before they become blocked by heat or smoke. A type L3 system should not be expected to protect people who might be involved with the fire at ignition or in its early stages; it is intended only to ensure escape for those not immediately involved. It should be noted that protection of escape routes may also involve the installation of detectors in adjacent rooms (see **13.5**).

Type M systems provide only for manual initiation of the alarm. In many small buildings this may be all that is required, but it should be remembered that the efficiency of a type M system depends critically on the presence of people to detect the fire, and on the training they are given in the procedures to be followed if a fire occurs.

3.4 Single-family dwellings

In large private dwellings, for example a country mansion, the protection will usually need to be of types L and/or P, depending on purpose, and advice should be obtained from competent advisors. The use of self-contained smoke alarms, even if interconnected, is not considered to be a suitable method of protection.

However, in smaller, single-family, dwellings the installation of self-contained smoke alarms can give a significant improvement in the level of fire safety. For the improvement to be achieved, though, it is essential that the smoke alarms are correctly installed, used and serviced. Advice on this is contained in the booklet 'Smoke alarms in the home', produced for the Home Departments by the Central Office of Information; the contents of this booklet are reproduced as appendix H. In single-family dwellings smoke alarms will usually be installed by the occupier, who will probably have no training in installation techniques and will probably not seek advice from any competent authority. It is realised that the occupier is also unlikely to consult this Part of BS 5839, and hence it is important that smoke alarms intended for installation by the occupier should be accompanied by installation instructions generally following the relevant recommendations of this Part of BS 5839 and of the HMSO booklet referred to above. Occupiers should also be advised to keep a record of their installation, particularly where some parts such as wiring might be concealed once the system is installed.

3.5 Buildings in multiple occupation (X)

Buildings in multiple occupation may be buildings occupied by more than one commercial undertaking, or may be large family houses adapted to provide accommodation for several households in separate self-contained units. In some

cases they may include a combination of uses, such as a ground floor shop and first floor offices with dwellings on higher floors. Fires occurring in one occupancy may then produce a hazard to people or property in other occupancies. To provide adequate warning of fires occurring within the building, fire alarm systems may need to extend across occupation boundaries or to be interconnected with systems in other occupancies. Cooperation and liaison between occupants will then be needed.

3.6 Specification of system type

Because of the wide range of systems covered by the recommendations of this Part of BS 5839, it should be appreciated that the specification of requirements for a system simply by reference to the number or title of this Part of BS 5839 without further restriction will have little meaning. The type of system to be installed should always be included in the specification, and the specification for a type P2, L2 or L3 system should always include details of those areas of the building which are to be protected. Where mixed or combined types of systems are required in a building, the type or types of protection required in each part of the building should be identifiable from the specification.

4 Exchange of information

4.1 General

The system requirements, including those imposed by the configuration and usage of the premises, should be ascertained as accurately as possible by consultation between the purchaser of the system and other interested parties. On the basis of these consultations, documents should be prepared showing the following:

(a) details of the installation proposed, including system type;

(b) any special accommodation required for the equipment;

(c) any special structural provision required for the equipment or its wiring, such as chases, ducts or conduits;

(d) any remote communication link.

It is desirable that, at the contract stage, one organization (usually the main contractor) should take overall responsibility for the performance of the system, and that this responsibility is clearly defined in the documentation. It should be noted that extension, correction or modification of software-controlled systems may involve modification of the control software. Consideration should be given at the contract stage to providing for continued support of such changes throughout the expected lifetime of the system.

4.2 Action in the event of an alarm of fire

To a large extent the design of the fire alarm system will depend on the actions required after the alarm has been given. It is thus essential that these actions are preplanned and the subject of early discussion.

In particular, if the preferred mode of evacuation of the building is such that different actions may be required in different areas of the building, then the alarm system should be so designed that the necessary commands, messages or signals can be distributed easily. In many cases proper control of evacuation will require a system capable of giving speech messages (see 9.12). The area in which the fire is first detected will usually determine the initial distribution of alarm signals. The relationship between the location of the fire and the alarm distribution should be carefully defined and specified prior to the design of the system, since it may reflect strongly on the facilities required in the control equipment and on the wiring arrangement. For example, a high building using a phased evacuation scheme could require an evacuation signal in some areas, while in others only an alert signal would be given initially, and it is essential that the control equipment and the sounder distribution network is capable of providing this differentiation. Particular care should be taken in parts of the building where signals relating to more than one area may be audible (such as stair enclosures). This code is concerned only with the design of the fire alarm system; the requirements for the evacuation scheme should be determined in consultation with the relevant authorities (see also the relevant Part of BS 5588).

If the building contains alarm systems associated with hazards other than fire, then the various hazard alarms should be properly coordinated and be distinct from each other. In these buildings the relative priorities should be carefully assessed, and the system arranged so that a higher priority alarm cannot be prevented or obscured by one of a lower priority. Although in general fire will have the highest priority, there are buildings in which other hazards may have higher priorities than fire.

4.3 Consultations

The interested parties who should be consulted on behalf of the user or occupier may include the following:

(a) the installer of the system;

(b) the local fire authority;

(c) the Health and Safety Executive;

(d) the fire insurer;

(e) consultants (including architects);

(f) the supplier of any communication link;

(g) the central alarm receiving station, if one is used.

Any deviations from the recommendations of this Part of BS 5839 should be agreed by the interested parties.

4.4 Multi-occupancy buildings (X)

If the building is under the control of more than one occupant, a fire in a part of the building under the control of one occupant may spread to or otherwise affect a part or parts under the control of others, and it is important that all those who might be affected by the fire should be consulted. These consultations should take place early in the planning of the new system, since the interactions with other occupancies may significantly affect the design of the system.

5 Planning schedule

A typical list of events to be taken into consideration in preparing a planning schedule is as follows, probably, but not necessarily, in the order stated:

(a) a survey of the building or examination of the plans, and an assessment of the usage of the building including any periods of non-occupation;

(b) choice of type and purpose of system, including possible future needs for extension or alteration;

(c) consideration of the action to be taken in the event of fire;

(d) in a multi-occupancy building, consultation with other occupants;

(e) system specification and/or design for estimating purposes;

(f) quotation;

(g) consideration of proposals, prices and delivery times;

(h) consideration of servicing requirements;

(i) agreement on the action to be taken in the event of fire;

(j) ordering;

(k) detailed system design for installation;

(l) agreement on any variation of specification;

(m) production and delivery of equipment;

(n) wiring (including installation and testing);

(o) installation of equipment;

(p) connecting up and testing (including audibility testing);

(q) commissioning and certification;

(r) documentation;

(s) user training;

(t) acceptance by the client and other interested parties;

(u) handover of the system;

(v) operational audit.

In large buildings it will be normal practice for all these stages to be included in the critical path chart. Control and indicating equipment for large installations will almost certainly have to be specially manufactured, and the importance of ordering in good time is self-evident. To avoid conflict with building or decorative work, wiring should be carried out at times or stages of work agreed with the person in charge of the building and with other contractors working in the same areas. Installation of equipment should be carefully integrated with the operations of other trades to minimize damage from damp, dust, wet processes, etc. Temporary physical protection may be necessary, both against the effects of other authorized work and as security against unauthorized intruders and vandalism.

The final connection, switching on and commissioning of the fire alarm system should be made at times agreed between the interested parties. There may, however, be an interim period of partial operation, either because of partial occupation of the building or to provide protection against risks during construction. Such operation is a matter for agreement between the interested parties (see **26.7**).

Section two. Design considerations

6 General

6.1 Purposes of fire alarm systems

A fire alarm system may be required to give an early alarm of fire in a building for one or both of the following purposes:

(a) to enhance the safety of the occupants by increasing their chance of escape to safety or by initiation of other emergency actions;

(b) to increase the probability of early extinction of fire and hence to reduce the loss of, or damage to, property.

The design criteria for a fire alarm system may vary according to whether it is required primarily or exclusively for the protection of life or property.

6.2 Protection of property (type P)

A fire alarm system, although it can do nothing to reduce the incidence of fire, can help to lessen the resultant loss by reducing the delay between ignition and the start of effective fire-fighting. The provision of a fire alarm system may be related to the cost of insuring the property, and would then require the insurer's approval.

A satisfactory fire alarm system for the protection of property is one which automatically detects a fire at an early stage, raises an effective alarm in time to summon the fire-fighting forces, both building staff and the fire brigade, and indicates the location of the fire in the building.

The usefulness of a fire alarm system in reducing property loss depends critically on the preplanned actions in the event of fire (see **4.2**) and the provision of satisfactory fire-fighting resources. Fire-fighting appliances such as hose reels and fire extinguishers should be provided (see BS 5306 : Parts 1 and 3) and staff should be trained in their use. The attendance time of the fire brigade (works or local authority) should be considered, together with the likely spread of fire that might occur after detection; in general an attendance time less than 10 min is preferred, and fire alarm systems are unlikely to give satisfactory protection where the attendance time exceeds 15 min. If the attendance time of the fire brigade is incompatible with the probable rate of spread of fire an automatic fire extinguishing system should be considered; guidance on the choice of suitable systems is given in BS 5306 : Part 0.

In some premises the probable rate of spread of fire may be so high that, even with the shortest practical attendance time, the fire is likely to be difficult to extinguish and to lead to a large loss. In such cases, although a detection system may in some fires give a useful warning, an automatic extinguishing system should be installed. Amongst other such cases, an automatic extinguishing system should be considered in any store in which combustible goods or packaging are stacked to a height exceeding 5 m.

6.3 Protection of life (types L and M)

Fire can kill or maim in many ways, e.g. by asphyxiation, radiant heat, poisoning or burning. However, most accidental fires begin with smouldering and the evolution of smoke and other combustion products, and it is known that in most fires the phenomenon that first threatens human life is the reduction of visibility in escape routes.

The longest delay in giving the alarm is likely to occur when no one is present to detect the fire, either at ignition or while it is in its early stage of growth. Since the response of an automatic detection system does not depend on the presence or actions of people, automatic detection is likely to give a better guarantee of success than manual detection. However, manual call points should always be provided since people can often give an earlier alarm of fire when they are present.

Fire alarm systems will often be required in order to meet statutory or legal obligations and the system may require the approval of the fire authority.

In premises in which normally active occupants can be expected to react to an emergency in a rational manner, a manual fire alarm system by which an alarm can be sounded throughout the building may be sufficient to meet the purposes outlined in **6.1**(a). This is a type M system. In other premises where a type M system would not alone provide an acceptable level of protection, a type L3 system may suffice.

It is accepted that many people are unwilling to walk through smoke when visibility is less than about 10 m, even though this in itself constitutes no great hazard. This visibility has been adopted as representing the point in the progressive smoke logging of an escape route at which its use is no longer possible, and an alarm of fire should therefore be given while sufficient time remains for the occupants to use the escape routes before the visibility falls to this level. The choice, siting and spacing of detectors as recommended in clause **13** should achieve this for a type L3 system.

In residential premises, where a greater than normal time is required to evacuate the building, a further enhanced level of fire protection is likely to be required. Such a case might arise, for instance, where the routine does not ensure immediate availability of staff members to take charge in an emergency, or where the occupants require assistance to evacuate the building. If the required level of fire protection is not achieved by the structure of the building, then an automatic fire detection system may be needed to complement the building structure by providing an early alarm of fire. A type L1 or L2 system should achieve the required level of protection.

6.4 Actuation of ancillary services

The fire alarm system may be designed to close or open circuits to ancillary services by means of relays or similar devices. Facilities of this kind may be required in any system, whether for life protection, property protection, or a combination of both. Systems operating ancillary services may have special requirements for the number, zoning and siting of detectors, provision of power supplies, control, indication or other facilities. The recommendations of this Part of BS 5839 may not fully satisfy these special requirements, and reference to specifying authorities or other codes of practice may be necessary. Further recommendations are given in clause **19**.

6.5 Installation in potentially explosive or flammable atmospheres

If it is necessary to install fire alarm equipment or wiring in areas where there may be a potentially explosive or flammable atmosphere, then the appropriate recommendations of BS 4683, BS 5345, BS 5501, BS 6467 and CP 1003 should be followed.

6.6 Circuit design

6.6.1 *General.* Care should be taken to ensure compatibility of all components which are part of the fire alarm system or connected with it in any way (see **6.7**).

When considering the compatibility of components with respect to operating or signal voltages (including tolerances), due allowance should be made for voltage transients. If surge protection or suppression is not provided as an integral part of the equipment, then surge suppression components should be provided on the connections to any vulnerable equipment.

The design of a fire alarm system should provide reliable facilities for transmission to the control and indicating equipment of signals from manual call points or detectors, and for the transmission of any resultant fire signal to sounders and indicating equipment and to any ancillary equipment which is to be operated by the fire alarm system (see **6.4**).

Except in small manual systems (see **15.2.2**) or radio-linked systems (see **18.3**), circuits should be so arranged that an indication is given at the control and indicating equipment within 100 s of the occurrence of any disconnection, open or short circuit in a cable which would disable one or more detectors and/or call points, or of a failure of any other interconnection, and this should be done without giving a false alarm.

Even where the wiring of a system is monitored, the regularity of routine testing is important and should be considered at the design stage. It may be considered desirable to include a method of manually testing circuits and such a method should always be provided where wiring or other interconnections are unmonitored. A manual call point may be used to provide a method of manual testing for detector and/or call point circuits, but the call point used should be one remote from the control equipment so that all the wiring of the circuit is tested.

NOTE. In some systems the connections to call points are such that operation of a call point will not fully test the cables feeding detectors.

2 **6.6.2** *Circuits containing fire detectors.* The wiring arrangement of the system should be such that:

(1) if separate circuits are used for each zone, then a fault or faults on one circuit cannot affect any other circuit;

(2) if any circuit is used for more than one zone, then a single fault on that circuit cannot remove protection from an area greater than that allowed under **7.2**(a) to (d) for a single zone;

(3) if a circuit is used for more than one zone and multiple faults within one fire compartment could remove protection from an area greater than that allowed under **7.2**(a) to (d) for a zone, then the circuit within that compartment is suitably protected (see **17.15**);

(4) two simultaneous faults should not remove protection

If the system is such that the removal of a detector or call point from the circuit could affect the operation of other detectors or call points then:

(a) removal of a detector or call point should cause a 'fault' signal to be generated at the control equipment indicating the need to replace the missing detector or call point as soon as possible; and

(b) the operating instructions (see **26.1**) should draw the user's attention to any adverse effects on the remainder of the system due to the removal of one or more detectors and/or call points.

1 1 Where detectors are designed to be removable from their bases, with or without locking devices, removal of any detector(s) from the circuit should not affect the operation of any manual call point. During the design stage, consideration should be given to the possibility of malicious removal of detectors. If malicious removal is considered likely, detectors of a type that can be removed only by the use of a special tool should be used.

NOTE. A special tool in this context is a tool not likely to be carried by a member of the general public. Slot-headed screws would not be acceptable, since various articles can be used as ordinary screwdrivers.

The system should be so designed as to minimize any disruption during maintenance and testing. In particular it is desirable that provision should be made so that individual detectors can be tested without either sounding an alarm or requiring the complete system to be disabled to prevent such an alarm. In a single zone system, isolation of all the detector or call point signals is permissible, but a facility should be retained for giving a general alarm from the control and indicating equipment. Any provision for the isolation of detectors or call points for maintenance or testing should be such as to allow the operation of alarm sounders in response to the operation of detectors or call points that have not been isolated (see 29.4.4).

1 **6.6.3** *Circuits containing fire alarm sounders.* If alarm sounders use the same wiring as detectors, then no alarm sounder should be affected by the removal of any detector. Any sounder that is necessary in order to reach the audibility levels recommended in clause 9 should be capable of electrical disconnection from the alarm sounder circuit only by the use of a special tool and the disconnection should generate a fault warning at the control and indicating equipment. If such alarm sounders are located so that they are easily accessible, consideration should be given to the effects of malicious interference.'

2 The wiring of sounder circuits should be so arranged that, in the event of a short circuit developing in any part of the wiring of sounder circuits during a fire, a minimum of one alarm sounder will continue to sound. This minimum provision should ensure that a general alarm can be given at the start of a fire and for a significant period thereafter, and that in the event of the fire burning through a sounder cable, the alarm will be maintained at at least one point in the building, usually near the control equipment.

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The minimum sounder circuit provision does not ensure that the reduced alarm is audible throughout the building. In some installations the minimum provision against loss of signal may not be sufficient. If audibility of the alarm throughout the building is required to be maintained even in the event of attack by fire on the sounder cables, then either:

(a) cables likely to resist fire for a considerable time should be used; or

(b) a greater number of separate sounder circuits should be provided; or

(c) sounder cables protected against cable faults (see **6.6.5**) should be used.'

6.6.4 *Ring systems.* If devices such as detectors, call points or sounders are connected to control equipment by a ring circuit, then, provided that the devices can receive or send signals in either direction, they will continue to operate even with a single open circuit or high series resistance in the ring. Such faults should be indicated at the control and indicating equipment within 60 min of their occurrence. A simple ring circuit, however, cannot give protection against short circuit faults and hence such faults need to be indicated, without giving a false alarm of fire, within 100 s (see **6.6.1**). Where sounders are used on simple ring circuits, the distribution wiring to each sounder circuit should be protected against overload due to short circuit by a fuse or similar device.

6.6.5 *Circuits protected against cable faults.* In some ring systems (usually those using computer techniques with addressable devices) short circuit isolating devices can be provided, such that a short circuit will only affect the section between the isolators. The isolators may be independent devices, or may be contained within other devices on the circuit. In such a system a single fault, whether to open or to short circuit conditions, can affect at most the section of the loop between the nearest isolators. (Other circuit arrangements may be possible having the same general effect.) Where the effect of the fault is to reduce to one the number of signal paths to any detector or call point, the control equipment should indicate the fault within 60 min of its occurrence and should preferably indicate the position of the fault. It is essential that action is taken to repair such faults, since if a fault is left unrepaired the system has no protection against further faults. However, if, because of redundancy in the circuit design, at least two signal paths to each detector and to each call point remain, it is necessary only to ensure the indication of the fault within 24 h of its occurrence.

NOTE. Cable faults which disable one or more detectors and/or call points should be indicated, without giving a false alarm, within 100 s of their occurrence (see **6.6.1**).

In the event of two faults, any devices between the two faults will usually be isolated and no longer function. If both sides of a ring feeding one fire compartment pass through a second compartment, a fire in this compartment could damage both cables and thus isolate the devices in the first compartment (see **17.15** and, if applicable, **6.6.2**).

6.7 Compatibility

All the individual components of a fire alarm system should be mutually compatible. The organization responsible for ensuring compatibility should be identified at an early stage: this will usually be the principal contractor for the fire alarm system.

Compliance of an individual component with a Part of either BS 5839, BS 5445 or BS 5446 does not necessarily guarantee that it will work satisfactorily in conjunction with another component complying with a Part of BS 5839, BS 5445 or BS 5446. For example, even though a fire detector made by one manufacturer and a control and indicating equipment made by a second manufacturer individually comply with the relevant Parts of BS 5839, BS 5445 or BS 5446, they may not work satisfactorily together. Where the components of a particular installation are made by different manufacturers, it is essential that compatibility between components is taken into account by the designer of the installation. The designer should consider the following subjects, and the data provided with each item should at least provide the information necessary for the consideration of its compatibility with other items.

In relation to a given control and indicating panel such consideration should include at least the following.

(a) For all devices:

(1) the requirements of the system in order to meet electrical safety;

(2) any provision for earthing;

(3) the earth insulation resistance;

(4) the method of adjustment where adjustment is required to ensure compatibility;

(5) any preferred method(s) for monitoring line continuity;

(6) whether the current taken or delivered has an appreciable reactive component;

(7) the characteristics of any signals passing between components;

(8) the ability of the control and indicating equipment to operate in conjunction with the number of devices to which it will be connected;

(9) any software provided for programming the system or its components, and the compatibility of other components with the software;

(10) any limitations on the numbers, types, sizes or other parameters (such as impedance) of wires that can be connected.

(b) For fire detectors:

(1) the form of output provided;

(2) the operating voltage, including tolerances;

(3) the quiescent current;

(4) the alarm current or maximum permissible alarm current rating;

(5) the method of resetting the device after an alarm;

(6) the states of the detector which indicate normal, fault and fire conditions;

(7) any requirements for indications of operation to be provided in the vicinity of a detector, together with any resultant changes in system conditions, e.g. reliability or power consumption;

(8) the number of conductors required.

(c) For alarm devices:

(1) whether polarized connection is required;

(2) whether precautions may be required in order to suppress any interference generated by the device;

(3) what methods for monitoring the interconnections can be employed;

(4) whether the power supply arrangements can provide sufficient power;

(5) whether a high starting current is required.

(d) For manual call points:

(1) whether of open or closed circuit operation;

(2) whether of polarized operation;

(3) the method of discrimination between alarm and fault conditions;

(4) the method of resetting the device after an alarm.

(e) For power supplies:

(1) the correct voltage for the type of battery employed (i.e. lead acid or alkaline types);

(2) the correct charging characteristics for the type of battery (i.e. constant current or constant voltage);

(3) the relationship between polarity and earth, or if the potential is earth free;

(4) the current rating in relation to calculated maximum demand;

(5) the permissible limits of ripple;

(6) the degree of stabilization;

(7) the formula for power capacity for the system, including the storage capacity of the standby supplies and the required standby duration;

(8) the permissible range for the supply voltage;

(9) whether the standby power supplies are able to provide the necessary current for the specified duration.

(f) For automatic fire protection equipment:

(1) whether the energy required by the automatic fire protection equipment is available from the control and indicating equipment or whether additional power supplies will be required;

(2) whether the voltage(s) required by the automatic fire protection equipment are compatible with those available from the control and indicating equipment;

(3) whether compatible with proposed monitoring facilities;

(4) whether requiring positive or negative switched input;

(5) whether normally energized or normally de-energized.

(g) For remote indication and control panels:

(1) the functions provided;

(2) the signal conditions for each function;

(3) the terminal connections.

(h) Equipment for transmitting fire alarms and fault warnings to remote manned centres should be compatible with the equipment at the remote manned centre.

6.8 Compliance with British Standards

In general, all components used in the system should comply with relevant British Standards, and should have undergone type testing to those standards. Components having approval to a recognized quality approval scheme (comprising third party certification of product conformity against a relevant standard, based on testing and continuing surveillance, together with assessment of the supplier's quality systems against the appropriate Part of BS 5750) should be preferred.

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

6.9 Program controlled systems

Fire detection systems are available in which the primary function is carried out by microprocessors or similar devices, in which the particular characteristics of a system are dependent on a stored program. In addition to the recommendations of this Part of BS 5839, such systems should comply with the following recommendations.

(a) Facilities provided for the alteration of the stored program should be protected against unauthorized interference (see clause **27**).

(b) Those functions of the system which are recommended in this Part of BS 5839 should not depend on programs stored on rotating disks, other storage media using moving parts, or any other form of easily corruptible memory.

NOTE 1. Memories that are designed to be written to as part of their normal operation, such as RAM, are considered to be easily corruptible.

(c) The decision algorithm used within the control system should be such that the sensitivity of the system cannot fall outside that specified in the relevant Part of BS 5839, BS 5445 or BS 5446, except in time related systems (see **14.6**). Where manual changes to the algorithm or its parameters are possible the ability to carry out the alterations should be restricted to authorized competent personnel (see item (a) and clause **27**).

(d) The operation of processors should be continuously monitored; this is particularly important where it is possible for the stored program to be accidentally corrupted (e.g. by transient interference) in such a way as to interfere with the correct operation of the system. In the event of failure a fault warning should be given which should be automatically reset after the system has been restarted; either the fault should be automatically recorded, or a warning of automatic resetting given.

(e) To improve reliability, a methodical and formal approach to software design should be followed.

(f) Following reinitialization, repair of any fault, or restoration of any power supply failure, the system should be capable within 30 s of sounding a general

alarm, and within a further period of 10 min normal operating conditions should be attained without further manual intervention (other than the silencing of any fault warning). Particular care should be taken where volatile memories are used.

NOTE 2. It is acceptable for the restoration of functions additional to the recommendations of this Part of BS 5839 (e.g. giving additional information about evacuation routes) to require manual intervention and/or to take longer than 10 min.

6.10 Pre-alarm warnings

In some types of system an early warning can be given of conditions which might (or might not) represent a fire. Such warnings should not initiate a full fire alarm, but may be used to alert personnel to the need for an inspection, thus reducing the number of false alarms and possibly giving earlier fire action (see 29.3.5).

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'6.11 Deviations from the recommendations of the code

The recommendations of this code are intended to be suitable for the majority of normal applications. There will, however, be a few applications in which the recommendations may be unsuitable, and in which deviations from the code may be necessary. Before agreement of any deviation by interested parties (see 4.3), consideration should be made of at least the following factors:

(a) the quantity and type of contents, including the ease of ignition, heat release rate, and probable rate of fire growth and spread;

(b) the probable false alarm rates of different types of detector;

(c) the method of transmission of fire products from the fire to the detector, including any possible adverse environmental effects;

(d) the type of occupant, including discipline, fitness and training;

(e) the attendance time of fire-fighting forces (including both the local authority fire brigade and any industrial fire brigade);

(f) the degree of fire protection given by other methods (such as partial sprinkler protection);

(g) any needs for special facilities for control or indication;

(h) any special provisions (either already existing or likely to be needed) for maintained power supplies;

(i) the type of work carried out in the building (for example, hot, smoky or dusty operations may need special detection provision);

(j) any special requirements for alarm devices, either due to the type of occupant or to the sound environment in the building;

(k) the fire routine for the building.

NOTE. All deviations should be listed in the installation and commissioning certificate (see appendix B).'

7 Zones

7.1 General considerations

In most buildings an alarm of fire may initiate a number of different activities, e.g. the provision of assistance, the commencement of emergency evacuation procedures, summoning the fire brigade, etc., and it is essential that these activities are coordinated. In the preplanning of emergency procedures for a building it is therefore important, for ease of communication and synchronization of effort, to determine a convenient number and arrangement of easily identifiable zones into which the building can be divided.

When a signal of fire is given it is necessary that there should be no confusion about the zone from which it is received. To facilitate response by persons providing assistance, the zone should be small enough for a fire to be located quickly. It is often important that there is adequate fire separation between the zones; this is particularly so if the initial evacuation procedure is to move occupants

entail movement from the zone of the fire to one of temporary refuge.

In larger premises in particular, the fire alarm system should therefore be designed and arranged so that it is both fully compatible with the emergency procedures and provides at some central or convenient point, or points, an indication of the zone from which an alarm has originated. In the case of two-stage alarms, clear and unambiguous signals should indicate the emergency procedure to be adopted throughout each zone.

In general the signals used in different zones in the same premises should be the same unless the background noise in one or more zones is such as to require different sounders (see 9.4).

If the system has been installed for life safety purposes (type L or M), then each zone should be readily accessible from the point(s) where the indication of the location of fire is provided. In general, access to any zone should be by normal circulation routes; however, where small areas of the building are defined as zones for specific purposes (such as the existence of a special risk) it may be permissible for access in the immediate vicinity of that zone to be by another route, for example through another room.

NOTE. In systems other than addressable systems, signals coming from individual detectors or groups of detectors cannot be separately identified. In these systems, therefore, to allow zone identification it is usual for each zone to be fed by a separate circuit. It has thus become common for the concepts of 'zones' and 'circuits' to be used interchangeably. In addressable systems, however, several zones (defined as subdivisions of the premises, see 2.20) can be fed from a single circuit whilst retaining zone identification. It is thus important that in such systems the concepts of 'zones' and 'circuits' be treated separately.

7.2 Recommendations for the size and number of zones

The size and number of zones into which the premises are divided should comply with the following.

(a) The floor area of a single zone should not exceed 2000 m^2.

(b) The search distance, i.e. the distance that has to be travelled by a searcher inside the zone in order to determine visually the position of the fire, should not exceed 30 m. Remote indicator lamps outside doors, etc., may be helpful, especially if doors are likely to be locked. By making an area easier to search, the use of remote indicator lamps may reduce the need for a large number of small zones.

(c) If the total floor area of a building is 300 m^2 or less, then it may be considered as a single zone even though there may be more than one storey.

(d) If the total floor area of a building is greater than 300 m^2, then all zones should be restricted to a single storey, except that:

(1) if the total floor area of a fire compartment is 300 m^2 or less, and any communication with other fire compartments is only at the lowest level of the building, then that fire compartment may be considered as a single zone even though there may be more than one storey within it; and

(2) if detectors or call points are fitted in stairwells, lightwells, liftwells and other flue-like structures extending beyond the one floor but within one fire compartment, then the volume of the well or shaft should be considered as one or more separate zones.

(e) Where a zone extends beyond a single compartment, the zone boundaries should be boundaries of fire compartments. Thus it is permissible to have two complete fire compartments in one zone, or two complete zones in one fire compartment; it is not permissible to have a zone which extends into parts of two compartments, or a compartment which extends into parts of two zones.

(f) In systems containing only manual call points (type M systems) location of a fire will usually be known to the person operating the call point. If satisfactory

provision is made for this information to be passed to the person in charge of the building, limitations on the size of the zone may be relaxed. It should however be borne in mind that if the area covered by a zone is excessive it may be difficult to locate a call point from which an alarm originated.

NOTE 1. This relaxation on the size of the zone does not apply to the recommendations for power supplies in type M systems given in 16.6.

(g) For systems in buildings in multiple occupation (see 4.4) the zoning arrangement should take account of the fact that premises may not all be occupied at the same time and no zone should include areas in more than one occupancy.

(h) In very large systems such as those covering more than one building it may be necessary to create sectors in order to restrict the number of zones from which alarms may originate simultaneously or in succession. Such restrictions should only be applied after consultation among the interested parties listed in 4.3.

1 (i) In premises having phased evacuation schemes, the zoning of fire detectors should be compatible with the evacuation procedures.

Particular care should be taken in enclosures common to more than one floor, such as stairways and atria (see also 4.2).'

Where a special fire risk is present within a larger protected area, and it is considered important to obtain rapid identification of a fire in that risk, the risk should be considered as a separate zone.

In premises providing sleeping accommodation the factors mentioned in (a) to (h) should be considered in relation to the fire routine adopted for the premises. In any zone in which automatic detectors are provided for the purposes of life safety it is of paramount importance that the precise location of the origin of an alarm of fire can be quickly determined.

If the arrangement of an area is complex and time is likely to be wasted in a search for the fire, then notwithstanding any limits shown above, the area should be further subdivided into zones that are easier to search.

NOTE 2. In some clauses of this Part of BS 5839 an area constraint is given based on the area allowed under 7.2 for a single zone. The area allowed should be considered as subject to all the constraints of 7.2, and not simply the 2000 m^2 allowed by 7.2(a).

7.3 Zoning of manual call points

Manual call points included within a zone may be wired to the detector circuit for that fire zone as long as the recommendations given in 6.6 are followed. It should be remembered, however, that people escaping from a fire will not necessarily operate the manual call point nearest to the fire. To prevent misleading indication of the position of the fire, it may be preferable for manual call points to be indicated separately from detectors. If manual call points have been sited, for example, on the staircase landings, so that in a multi-zone building their indication of the position of the fire may be misleading, then it is preferable for them either to be arranged as a separate zone, or to be incorporated in the zone described in item (d)(2) of 7.2.

7.4 Zoning of fire detectors

Zoning of fire detectors should be such that upon activation of any device the fire alarm system will respond in the correct manner. This is particularly important where phased

1 evacuation is involved, as evacuation procedures could be adversely affected if incorrect alarm signals were given.

For example, careful consideration should be given to the type of alarm that should result from the operation of fire detectors located in positions which may not be related directly to that of the fire incident, such as in atria, stair enclosures, shafts, ducts, etc.

8 Communications with the fire brigade and other off site organizations

8.1 General

For a fire detection system to give the maximum benefit, its alarm should be passed on to the fire brigade with the smallest possible time delay. It may be permissible for the alarm to be passed on by telephone, if there is an adequately trained person on the premises, but frequently the only reliable method will be over an automatic link. For property protection, consultation with the insurers is advisable.

Provision may also be made for communications with other off site bodies, including service organizations and key-holders. The information transmitted should be sufficient for its purpose, without being so excessive as to cause confusion.

If a building is divided into separate occupancies, then tenants or occupiers should make reliable arrangements to call the fire brigade. The responsibility for calling the fire brigade should be both clearly specified and clearly understood; uncertainty in responsibility can lead to a number of calls being made almost simultaneously or, more seriously, to the fire brigade not being called at all. Consultation with the fire authority is advisable for systems serving buildings in multiple occupation.

If public telecommunications operator lines are used in the transmission of fire alarms to the fire brigade, then it is desirable to limit the risk of the lines being damaged by fire before the alarm has been transmitted. Within the building the lines should be routed to avoid areas where fire is likely to start or to spread rapidly, and should be protected as recommended in 17.11. Lines for fire alarm transmission should be discussed with the public telecommunications operator so that, where practicable, the use of overhead lines can be avoided near the building.

If a special telephone line is provided for the transmission of emergency calls (either automatic or manual) through a switched network, then the line should be barred from receiving incoming calls. It should never be used for outgoing calls other than emergency calls, unless emergency calls can be transmitted despite the presence of other signals.

Alarm signals should not be routed through private exchanges which may themselves be involved in the fire or which may be automatically closed down in the event of fire.

8.2 Automatic transmission of the alarm

Some of the available methods of automatic connection to the fire brigade are described in appendix A.

The lines and the equipment for transmitting and receiving the alarm signal (including any link between the control equipment and a separate signalling unit) should, if practicable, be monitored. In the event of a failure of lines or equipment, a fault warning should be given at a continuously manned point, usually at the remote manned centre, and the occupier of the premises should, if practicable, be informed so that arrangements can be made for the continued protection of the premises.

If the alarm is transmitted to the fire brigade via a remote manned centre, then users should satisfy themselves of the reliability of the method of communication used between the remote centre and the appropriate fire brigade. The 999 system is normally only usable if the remote manned centre and the protected premises are in the same fire authority area. If the public switched network is used it is important that the fire brigade number is one nominated by the brigade as reserved for emergency calls. Calls via a fire brigade administrative number should not be used.

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.

8.3 Non-automatic transmission of the alarm

If communication with the fire brigade is by means of telephones, care should be taken that the operation of fire alarm and fault warning sounders does not interfere with telephone speech.

NOTE. Cases have been reported in which the telephone mouthpiece has picked up the sound of the fire alarm sounders. The resultant signal has confused the tone-selective dialling system leading to failure of the emergency call. The frequency range used for tone-selective dialling is the same as that recommended in this Part of BS 5839 as having the best audibility.

If the alarm is intended to be sent by a designated person, such as an operator or receptionist, then consideration should be given to possible effects of the fire on that person and to any consequential need for fire protection.

9 Audible and visual alarms

9.1 General

Advice on the connection of sounder circuits is given in **6.6.3**. Wiring used for sounders should be in accordance with **17.2**(a).

A fire alarm system may be required to have a sounder outside a building. The position of this sounder should be agreed with the fire brigade, it should be adequately protected from the weather, and its case should be clearly marked 'FIRE ALARM'.

In buildings in multiple occupancy it may be necessary for an alarm of fire to be given in premises other than those in which the alarm has been initiated.

A clearly labelled facility should be available for starting or restarting the fire alarm sounders. Operation of this facility should not be dependent on the state of any silencing device.

9.2 Fire alarm sounders for property protection (type P)

The primary purpose of systems installed for property protection is to summon fire-fighting assistance. The number of alarm sounders within the building need only be sufficient to summon local fire fighting effort, such as trained staff or a works fire brigade. In the areas where an alarm is required, it should meet the audibility recommendations of **9.4**.

A sounder should be provided near the control and indicating equipment to draw attention to the indications of fire. The sound level of this sounder should be suitable for its application, e.g. the sound level required in a fully manned security room may be low, while that required where the control equipment is unwatched in a noisy environment would be high. An external sounder should be provided to guide fire-fighting assistance to the correct entrance point to the building.

In practice most buildings having property protection systems will also require an alarm system to protect the staff in the building. If this is integrated with the property protection system, then the alarm sounders should also satisfy the recommendations of **9.3**.

9.3 Fire alarm sounders for life protection (types L and M)

The number of fire alarm sounders used should be sufficient to produce the sound level recommended in **9.4** in all accessible parts of the building. It is essential that an audible fire alarm can still be given in the event of failure of one sounder, and hence a minimum of two sounders should be provided even if the recommended sound level could be achieved with a single sounder. At least one sounder should be provided in each fire compartment.

Sounders should be suitably distributed throughout the building having regard to the attenuation of sound caused by walls, floors, ceilings and partitions. Particular attention should be paid to attenuation where sounders in corridors are expected to serve surrounding rooms. Most single doors will give an attenuation of at least 20 dB, and solid doors, such as fire doors, may give attenuations greater than 30 dB. Thus it is unlikely that sound levels in a room will be satisfactory if it is separated from the nearest sounder by more than one door. A larger number of quieter sounders rather than a few very loud sounders may be preferable in order to prevent excessive sound levels in some areas.

9.4 Audibility of alarms

9.4.1 *Level of sound.* A minimum sound level of either 65 dB(A), or 5 dB(A) above any other noise likely to persist for a period longer than 30 s, whichever is the greater, should be produced by the sounders in all accessible parts of the building except as may be recommended in **8.3**. If the fire routine for the premises requires the audible alarm to arouse sleeping persons then the minimum sound level should be 75 dB(A) at the bedhead with all doors shut. This will not guarantee that every person will be awakened but can reasonably be expected to wake a sleeping person in most circumstances.

Due to the short period for which the fire alarm sound should be experienced, damage to hearing is unlikely to be caused by sound levels below 120 dB(A). Where levels higher than this might be required, special provisions (such as visual signals) may be necessary.

NOTE. An instrument complying with BS 5969, type 2, with slow response and A weighting, is suitable for measuring the sound level.

9.4.2 *Discrimination.* The type, number and location of fire alarm sounders should be such that the alarm sound is distinct from the background noise. The note of the fire alarm sounders should be distinct from any other sounders likely to be heard, and in particular should be distinct from the audible fault warning signal given in the control equipment. All fire alarm sounders within a building should have similar sound characteristics, unless particular conditions such as an area of high background noise makes this impracticable; in this case other types of fire alarm may also be provided (see also **9.4.5** and **9.7**).

9.4.3 *Frequency.* The ear of a young person is most sensitive to sounds at frequencies between 500 Hz and 8000 Hz. Age and hearing damage reduce the sensitivity of the ear, particularly to frequencies above 2000 Hz. Partitions, dividing walls and doors will attenuate sound; in general, the higher the frequency of the sound the greater will be the attentuation.

The fire alarm sounder frequencies should therefore ideally lie in the range 500 Hz to 1000 Hz. If a two-tone alarm is used, at least one of the major frequencies should lie within this range. Where the frequency range of background noise is such as to mask the 500 Hz to 1000 Hz range, then the use of sounder frequencies outside this range may be acceptable.

9.4.4 *Sound continuity.* The sound of the fire alarm should be continuous although the frequency and amplitude may vary, for example as in a warbling note, provided that the distinction from the alert signal described in **9.9** is clear.

9.4.5 *Audible alarms in noisy areas.* In parts of buildings where there are noisy machines, the power requirements of the high power sounders needed to comply with the recommendations of **9.4.1** may place excessively high demands on the capacities of standby supplies. In such cases, the sounders of the fire alarm system (the primary sounders) may be reinforced by secondary sounders operated directly from the mains supply and without standby supplies, provided that all of the following apply:

(a) when the machine noise ceases and the secondary sounders are out of service, the primary sounders meet the sound levels recommended in **9.4.1**;

(b) the primary sounders in all other parts of the premises are distinctly audible at all times when operated;

(c) failure of the supply to the secondary sounders will either result in the silencing of the noisy machines or in the giving of an audible and visible fault warning at the control and indicating equipment.

'**9.4.6** *Intelligibility.* Any speech message carrying information or instructions relevant to fire action should be intelligible above the background noise in any part of the building to which the message is addressed. Where the level of sound of this message falls below that recommended in **9.4.1**, the message should be preceded for at least 6 s by an attention-drawing signal, having at least the loudness recommended by **9.4.1** and which is used only as a fire warning signal. Where the fire action in the building depends on the reception of verbal messages, the attention-drawing signal should not normally last for more than 10 s.

NOTE. Advice on planning and installation of such systems is given in BS 6259.'

9.5 Grouping of fire alarm sounders

In a small building the sounding of alarms can (and usually will) be so arranged that any alarm operates the sounders throughout the building.

If the fire alarm system extends to several buildings, or to other parts of a building unlikely to be affected by a fire in one zone, then the system may be so arranged that the alarms sound initially only in the zone of origin, or in that zone and in adjoining areas, or in that zone and in other areas where fire might be particularly dangerous, perhaps because of flammable contents or difficult egress.

It is essential that the grouping of fire alarm sounders is based on consideration of the fire routine of the building or individual premises and on the action which would be required of people in those areas if fire should occur. The grouping should be so designed that, wherever the origin of the fire, any person needing immediate warning, whether for evacuation or any other action, will receive that warning automatically and without any manual intervention. The grouping should be reflected in the fire instructions issued for the use of the occupants (see also **9.9** and **9.10**).

'Where fire alarm sounders are grouped, the control equipment should have facilities both for controlling each group individually and for sounding an alarm (either alert or evacuate) in all groups simultaneously. The wiring should be so arranged that failure of a sounder or of sounder wiring in one group will not cause the failure of any other group.'

9.6 Control sounders

9.6.1 Fire alarm control and indicating equipment should incorporate, or have located near it, an audible device that sounds in the event of the operation of the first detector or call point to operate in any zone. This signal may, but need not, be the same as the general fire alarm sounders.

The signal may be manually silenced but should sound again when the first detector or call point in another zone operates.

9.6.2 The operation of a silencing switch, either for the general fire alarm sounders or for the signal described in **9.6.1**, should cause an audible signal to be given in or near the control equipment. This audible signal, which may be the same as that for a fault warning, is intended to act as a reminder that the silencing switch has been operated. It should give a distinctive sound different from that of any other alarm sounder used to give a fire alarm and different from that of the signal described in **9.6.1**.

NOTE. The provision of a visual indication of operation of such a silencing switch may be desirable.

9.6.3 The signals described in **9.6.1** and **9.6.2** should not be so loud as to interfere with the making of calls to the fire brigade (see **8.3**).

9.7 Visual alarm signals

In areas where a normal type of sounder may be ineffective, e.g. where the background noise is excessive, where the occupants are deaf or where hearing protection is likely to be worn, visual signals should also be used.

In general, visual signals should only be used to supplement audible alarms; they should not be used on their own. The operation of a sounder should not be prevented by a defect in a visual signal or vice versa.

Any visual signal forming part of the fire alarm system should be clearly distinguishable from any other visual signal used in the premises. Where flashing lights, such as xenon flash tubes or rotating beacons, are used it is important that there is no possibility of confusion with two-stage alarms (see **9.9**). The flashing rate should be in the range 30 to 120 cycles per minute.

The intensity of the light should be sufficient to draw the attention of people in the vicinity, but not so high as to cause difficulty in vision due to glare.

Wiring to visual alarm signalling devices should comply with recommendations for wiring to alarm sounders, i.e. should be in accordance with **17.2**(a).

9.8 Coded fire alarm signalling

Coded fire alarm signalling on alarm sounders (e.g. one ring meaning 'first floor' and two rings meaning 'second floor', etc.) should not be used. Such coded signals on alarm sounders are liable to misinterpretation however well drilled fire-fighting staff or occupants may be.

9.9 Two-stage fire alarms

In certain large and/or high rise buildings it may be desired to evacuate first those areas of the premises at the greatest risk, usually those closest to the fire or immediately above it. In such cases a two-stage alarm may be used in which an evacuation signal is given in a restricted area, together with an alert signal in other areas. If such a system is considered, early consultation with the fire authority is essential. It is important that in any such system the evacuation signal should immediately and automatically be given in the zone of origin of the alarm. Consideration should be given to the communications that may be needed to control evacuation.

The boundaries of each of the restricted areas in which signals can be given should be those of fire compartments having accepted standards of fire separation from other compartments. The 'evacuate' signal should be in accordance with **9.4**; the 'alert' signal should be intermittent, 1 ± 0.5 s on and 1 ± 0.5 s off. Provision should be made for manually changing the 'alert' signal to the 'evacuate' signal in any area. Provision may also be made for automatically changing from the 'alert' signal to the 'evacuate' signal. These provisions should be defined in the discussion of the action in the event of fire (see **4.2**).

If an alarm is given from a manual call point by an escaping person, then the position of the call point may not be directly related to that of the fire. Any areas not to be given an evacuation alarm in response to such a signal will require careful consideration.

9.10 Staff alarms

In some premises an initial general alarm may be undesirable. In places of entertainment, shops, dance halls or exhibitions, for example, an evacuation controlled by staff may be preferred. In some hospital departments, distress or disturbance due to alarms may create additional problems for staff. In such premises it may be desirable, subject to statutory or other requirements, to restrict the local alarm in the first instance to the staff. A restricted alarm system should only be used where staff, including night staff, are sufficient in number and fully trained in the action that they are to take in the event of a fire.

The restricted alarm may be given by means of sounders or other types of communication (including personal paging systems) not noticeable to public, residents or patients. Sounders may be supplemented by an adequate number of visual signals throughout the premises for staff recognition only. A restricted alarm system should incorporate means of summoning fire-fighting staff to the outbreak when the alarm is given.

Premises having a restricted alarm system should also have provision for sounding a general alarm, which should be sounded either if a responsible person considers it desirable to do so, or automatically after a predetermined period. The responsibility and criteria for sounding the general alarm should be decided as part of the action to be taken in the event of fire, and should be clearly specified and understood. Restriction of the alarm in this way should not prevent immediate transmission of the alarm to the fire brigade or other remote manned centre. The authorities concerned should be consulted very early in the design stage as to the specification of an appropriate system.

9.11 Silencing devices

It should be a principle of design and operation of a fire alarm system that once an alarm state has been initiated it should continue until normal conditions have been restored. However, a silencing device should be provided which can silence general alarms or, in two-stage systems, alert signals.

The operation of a silencing device should:

(a) require a manual operation;

(b) cause the audible signal described in **9.6.2** to be given;

(c) not cancel any visual signal of the alarm at the control equipment;

(d) not prevent the proper receipt of alarms from any zone(s) not already providing an alarm;

(e) not prevent the correct operation of any control for starting or restarting the alarm sounders (see **9.1**);

(f) not prevent the transmission of an alarm to a remote manned centre.

In addition to the silencing switch at the control equipment, provision may be made for silencing switches in individual zones remote from the control equipment. Operation of a remote silencing switch should:

(1) require a manual operation;

(2) result in an audible signal at the remote switch which should continue while the alarm sounders remain silenced;

(3) be automatically reset on operation of the main silencing switch or cessation of the alarm condition.

The responsibility and criteria for operating any silencing device should be decided as part of the action to be taken in the event of fire, and should be clearly specified and understood. Automatic silencing of alarms or alert signals should not be used.

The reset switch should not be used as a method of silencing the alarm sounders, since this may destroy the indication of the location of a fire. It is preferable for the control equipment to be so arranged that the equipment cannot be reset until the silencing device has been operated.

9.12 Audible alarms by intercommunication or public address equipment

Where intercommunication or public address equipment is used in lieu of conventional sounders, the following should be ensured.

(a) That the alarm of fire is automatically and simultaneously transmitted to all areas in which the alarm is required, taking priority and overriding every other facility and circuit condition of the equipment.

(b) That other signals, e.g. meal-break, start and stop work, cannot be confused with the fire alarm signals and cannot be broadcast at the same time as fire alarm signals.

(c) That the power supply equipment complies with the recommendations of clause **16**. If the intercommunication or public address equipment shares the power supply of the fire alarm system, then the total standby and alarm loads of both systems should be considered when calculating the battery capacity.

(d) That in the event of mains failure, the duration of the standby supply cannot be made to fall below that recommended in clause **16** by the use of the system for purposes other than giving the fire alarm.

(e) That the cable and wiring of the system comply with clause **17** and are monitored in accordance with 6.6 ⚠1

(f) That the amplifier is constructed to comply with clauses **4** and **5** of BS 5839 : Part 4 : 1988.

(g) That where the fire alarm system does not include control equipment having control sounders, the recommendations of **9.6** are met.

(h) That where the fire action in the building depends on a continuing ability to give signals over the public address system, consideration should be given to the consequences of failure of amplifiers, tone generators, synthesizers, pre-recorded tapes, etc., and to any consequential need for duplication. In general, systems using moving parts (such as tapes) should be considered as less reliable than other systems.'

Where the transmitted alarm is a voice message the following should be ensured and reference should be made to BS 7443.

(1) That a suitable alarm (either pre-recorded or synthesized) is immediately and automatically transmitted on the receipt of a fire signal; this transmission should not depend on the presence of an operator.

(2) That the time interval between successive messages does not exceed 30 s, and that 'fill-in' signals similar to those of conventional sounders are used wherever periods of silence might otherwise exceed 10 s.

(3) That during fire alarm conditions all audio input sources are automatically disconnected except the speech modules (or equivalent message generators) which give the warning, or those microphones designated as fire microphones. These should be retained in circuit so that announcements and instructions relating to the emergency can be given. At least one fire microphone should normally be sited near to the control equipment. It may be necessary for additional fire microphone positions to be provided at places well separated from the first. In such cases the system should be so designed that it is not possible for messages from more than one microphone, speech module or message generator to be broadcast simultaneously.

(4) That all voice messages are clear, short, unambiguous and, as far as practicable, preplanned.

(5) That the level of sound in the building complies with the recommendations of 9.2 for property protection systems, or 9.3 for life protection systems.

Where the transmitted alarm is not a voice message, its audibility should comply with the recommendations of 9.2 for property protection systems or 9.3 for life protection systems.

9.13 Limitation of alarm information

In some systems much information about both the state of the system and any fire condition is available. It is important that, in order to avoid confusion, the amount of information given is limited to that which is both necessary and sufficient.

9.14 Use of the fire alarm sound for other purposes

In general, fire alarm sounds should be used for other purposes only if the response required is identical to that which would be required in a fire, i.e. immediate evacuation of the area in which the alarm is sounding by the use of any route designated as a fire exit. If any other response is required then fire alarm sounds should not be used unless accompanied by other information. However, as an established exception, it may be permissible in schools to use a coded signal of short duration to indicate the start or finish of predetermined periods. The duration of the coded signal should not exceed 5 s. Where new systems are being installed, or where sounders are being replaced, the use of sounders capable of delivering several distinct sounds should be considered, with one of the sounds being reserved for fire alarm use.

10 Manual call points

10.1 General

Manual call points should comply with BS 5839 : Part 2.

It is important that manual call points are clearly identifiable and simple to use without the need for instructions as to their method of operation. The method of operation of all manual call points in an installation should be identical unless there is a special reason for differentiation. If necessary a striker should be provided adjacent to the call point to facilitate breaking the frangible cover.

A person operating a manual call point should not be left in doubt as to the success of the operation. The delay between operation of a call point and the giving of the general alarm should therefore not exceed 3 s.

NOTE. A maximum delay of 8 s applied to systems installed before 1 January 1990.

If the design of the system is such that the indication of the alarm could be unwittingly cancelled at the call point after the glass has first been broken, then the delay between operation of the call point and the giving of the general alarm should not exceed 1 s.

Requirements additional to those of BS 5839 : Part 2 may be necessary where call points are to be used in flammable or explosive atmospheres (see 6.5), or where frangible element fragments are objectionable, such as in food preparation areas.

10.2 Siting

Manual call points should be located on exit routes and in particular on the floor landings of stairways and at exits to the open air. (Special consideration may need to be given for staged alarm systems (see 7.3 and 9.9).) They should be so located that, to give the alarm, no person in the premises need travel more than 30 m. It may be necessary to have travel distances to a call point much less than 30 m where the expected occupants of the building are likely to be slow in movement, or where potentially hazardous conditions exist, e.g. in close proximity to cellulose spray booths. The action to be taken in the event of fire may make the provision of additional manual call points necessary.

In general, call points should be fixed at a height of 1.4 m above the floor, at easily accessible, well illuminated and conspicuous positions free from obstruction. Manual call points should be sited against a contrasting background to assist in easy recognition. They may be flush mounted in locations where they will be seen readily, 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.

10.3 Manual call points in automatic systems

If manual and automatic devices are to be installed in the same building for the purpose of providing a general alarm of fire, then they may be incorporated into a single system; zoning of such systems is covered in 7.3, and the connection of call points to circuits containing fire detectors is covered

in **6.6.2**. Where manual call points are incorporated in an automatic system the delay between the operation of the call point and the indications of alarm should comply with the recommendations of **10.1**.

11 Types of fire detector

11.1 General

Fire detectors are designed to detect one or more of three characteristics of a fire: smoke, heat and radiation (flame). No one type of detector is the most suitable for all applications and the final choice will depend on individual circumstances. It will often be useful to employ a mixture of different types of detector.

Most, if not all, fire detectors are affected not only by the level of the detected phenomena but also by the behaviour of the phenomena with time. In some cases this is deliberate, as with detectors responding to rate-of-change of phenomena; in others it is the effect, for instance, of delays in smoke entry or of thermal lags. In systems using analogue detectors, the time response of the system can often be controlled or modified by the processing software in the control equipment.

All fire detectors will respond to some extent to phenomena other than fire; reducing the incidence of such false alarms is covered in clause **14**.

11.2 Heat detectors

There are two main types of heat-sensitive detector. One is the 'point' type of detector responding to the temperature of the gases in the immediate vicinity of a single point. The other is the 'line' type of detector which responds to the temperature of the gases in the vicinity of a line (not necessarily straight). Line detectors can be integrating or non-integrating: in the integrating type the response to temperature at one point on the line is modified by the temperature of the remainder of the line, while in the non-integrating type the response to temperature at one point is independent of temperatures at other points on the line.

In both main types (point and line) there are two main subdivisions.

(a) *Fixed temperature (static) elements.* These are designed to operate when they reach a pre-selected threshold temperature.

(b) *Rate-of-rise of temperature elements.* These are designed to operate when their temperature rises abnormally quickly.

Point heat detectors should comply with BS 5445 : Part 5, except in high temperature areas (see **11.5.2** and **12.3.2**), where heat detectors complying with BS 5445 : Part 8 should be used.

Heat detectors complying with BS 5445 will 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. Reference in this clause to static and rate-of-rise elements should not be taken as requiring physically separate elements, but as requiring a detector response equivalent to that of a detector containing the separate elements. Particularly in analogue output detectors, the response of a single temperature sensor can be electrically modified to produce the desired detector response.

11.3 Smoke detectors

There are two commonly used classes of detectors for detecting smoke.

(a) *Ionization chamber smoke detectors.* These are based on the fact that the electric current flowing between electrodes in an ionization chamber is reduced when smoke particles enter the chamber.

(b) *Optical smoke detectors.* These operate by detecting the scattering or absorption of light by smoke particles.

There are 'point' type smoke detectors that detect smoke at one position and which may be based on optical or ionization chamber principles, aspirating smoke detectors in which air is taken from a number of positions to a central detector and 'beam' type smoke detectors working on the optical obscuration principle. Beam detectors are effectively line detectors since they can detect the presence of smoke in only 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 comply with BS 5445 : Part 7 or, for residential applications, BS 5446 : Part 1 (excluding self-contained smoke alarms). Smoke detectors (other than self-contained smoke alarms) complying with BS 5446 : Part 1 may also be suitable for an industrial or commercial environment that is similar to that present in residential premises. Optical beam smoke detectors should comply with BS 5839 : Part 5.

In an aspirating smoke detector, the tube from the protected space to the central detector may have one or more holes through which smoke may be drawn. Design of the system should take into account any dilution of smoke taken into one hole by clean air taken into others. The amount of air entering each hole is usually small, and should not be considered as modifying air or smoke flows within the protected space. In general, each hole may be considered as a separate point smoke detector, and siting of the holes may be based on the siting requirements for point smoke detectors. The system should be such that separate signals are obtained from each zone. The design and sizing of the tubing system should comply with the manufacturer's recommendations.

11.4 Flame detectors

Flame detectors detect ultraviolet and/or infra-red radiation. Both types use radiation-sensitive cells that 'see' the fire either directly or through built-in lenses or reflectors.

Infra-red flame detectors are intended to respond to the flickering radiation emitted by the diffusion type of flame normally found in fires. Because of the presence of other infra-red sources, such as the sun, infra-red flame detectors will usually have some method of discriminating between fire and non-fire radiation; flicker sensing or the use of one or more specific infra-red emission bands are common techniques.

Ultraviolet flame detectors detect the ultraviolet radiation emitted from flames, and normally operate in the range of wavelengths from 200 nm to 270 nm. Solar radiation in this range is absorbed by the high altitude ozone layer, and hence ultraviolet detectors do not normally respond to sunlight.

11.5 Choice of fire detectors

11.5.1 *General.* In any automatic fire detection system a detector has to discriminate between a fire and the normal environment existing within the building. The system chosen should have detectors that are suited to the conditions and that provide the earliest reliable warning. Each type of detector responds at a different rate to different kinds of fire. With a slowly smouldering fire such as the initial stages of a fire involving cardboard, a smoke detector would probably operate first. A fire that evolves heat rapidly and with very little smoke could operate a heat detector before a smoke detector. With a flammable liquid fire a flame detector could operate first.

In general, smoke detectors give appreciably faster responses than heat detectors, but may be more liable to give false alarms (see **14.3**).

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

Heat and smoke detectors rely on transport of the products from the fire to the detector by convection. The plume above a fire is relatively narrow, and in general these detectors rely on the presence of a ceiling (or other similar near-horizontal surface) to direct the products outwards from the plume to the detector. Heat and smoke detectors are therefore suitable for use in most buildings, but are generally unsuitable for open-air applications.

Flame detectors are particularly suited to outside applications, where there is no ceiling to direct the products outwards; they are especially suited to risks in which smouldering is unlikely (such as in liquid fuels). Flame detectors in buildings are mainly used to supplement heat and smoke detectors, particularly under high ceilings and provided that an unobstructed view is possible.

The choice of detector may also be affected by the environmental conditions within the premises. In general, heat detectors have a greater resistance to adverse environmental conditions than have other types.

11.5.2 *Heat detectors.* Heat detectors are, in general, less sensitive than smoke detectors. They are unlikely to respond to smouldering fires, and, as a simple rule of thumb, will require the flames from the fire to reach about one-third of the distance to the ceiling before they will operate. They are therefore not suitable for the protection of places where unacceptable losses could be caused by small fires, e.g. in computer rooms. Before final selection of detector type, an estimate should be made of the extent of the damage likely to occur before operation of a heat detector.

Heat detectors with rate-of-rise elements are more suitable where ambient temperatures are low or vary only slowly, while fixed temperature detectors are more suitable where the ambient temperature is likely to fluctuate rapidly over short periods. Where very high temperatures are likely to be encountered (see **12.3.2**) heat detectors complying with BS 5445 : Part 8 should be used.

11.5.3 *Smoke detectors.* Ionization chamber smoke detectors are particularly sensitive to smoke containing small particles such as are produced in rapidly burning flaming fires, but 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. Both types of smoke detector have a sufficiently wide range of response to be of general use. In some premises, however, there may be specific risks for which one type is particularly suitable (or particularly unsuitable); this should be determined at an early stage.

Certain materials when overheated (e.g. PVC) or when smouldering (e.g. polyurethane foam) produce smokes having mainly large particles to which ionization chamber smoke detectors are relatively insensitive.

Tobacco smoke usually reaches ceiling mounted smoke detectors only after it has coalesced to form large particles; this, and the usually low rate of arrival of tobacco smoke, make ionization chamber smoke detectors less likely to give a false alarm than optical smoke detectors under these conditions.

Smoke detectors cannot detect the products from clean-burning liquids (such as alcohol) which do not produce smoke particles. This is not usually a serious disadvantage because a fire will normally involve other combustible materials at an early stage. Clean-burning fires can be detected by their resulting thermal turbulence, so optical beam smoke detectors incorporating thermal turbulence detection are particularly suitable for such risks.

Smoke detectors incorporating thermal turbulence detectors may be unsuitable for installation immediately above blower heaters or industrial processes that produce appreciable waste heat.

Where there are production or other processes that produce smoke, fumes, dust, etc. which might operate smoke detectors, an alternative type of detector should be used, i.e. heat or flame.

11.5.4 *Flame detectors.* Because of their inability to detect smouldering fires, flame detectors should be used in specialized applications or as a supplement to heat or smoke detectors, and not be considered as general purpose detectors.

Because they do not depend on the convective transport of fire products to the detector, but on the virtually instantaneous and straight-line transmission of flame radiation, flame detectors can respond to a flaming fire more quickly than can heat or smoke detectors, and do not need to be mounted on a ceiling. They are particularly suitable for use in applications such as the general surveillance of large open areas in warehouses or timber yards, or the local surveillance of critical areas where flaming fire may spread very rapidly, e.g. at pumps, valves or pipework containing flammable liquids, or areas of thin vertical combustibles such as panelling or oil paintings. Where flammable liquids are involved the areas will often have potentially explosive atmospheres (see **6.5**).

For flame detectors to work with maximum efficiency, they should have a clear line-of-sight to the area being protected. Although reflected radiation may be sufficient for operation, much of the radiation is then absorbed rather than reflected; a significantly bigger fire will be needed for operation if reflected radiation is used.

The transmission of radiation depends on the ratio of the radiation wavelength to the particle size in the smoke. Infra-red radiation will penetrate smoke well, while ultraviolet radiation may be rapidly absorbed. If there is a chance that the fire may have an initial smouldering phase in which the smoke produced could smoke log the area, then infra-red detectors should be used, since any ultraviolet radiation could be absorbed by the smoke before it reaches the detector.

12 Detectors installed primarily for the protection of property (type P)

12.1 Coverage

A fire detector installation is intended to enable a fire to be detected at a sufficiently early stage for it to be easily extinguished without extensive property damage. In general people are the most sensitive fire detectors, but they are not always present or alert; there may be parts of the premises that are not normally attended during working hours, and outside working hours there may be no one on the premises. The use of detectors can then significantly reduce the property loss, provided that suitable provision has been made for the necessary subsequent action.

When fires start in unoccupied areas they may grow, if undetected, to a stage where they cannot be easily extinguished; since any area may be unoccupied at some time, for maximum protection total coverage of the premises should be provided. Every portion of the building(s) should be suitably protected and each effectively enclosed space should be considered separately for this purpose, although lavatories and water closets need not have independent coverage. Such a system, giving total coverage for property protection, is a type P1 system.

In some premises, however, the fire risk may be sufficiently low in some parts of the premises that the installation of an automatic fire detection system in those parts is not considered to be justified. In such premises a type P2 system, covering only part of the premises, can give a useful reduction in the probability of fire loss at a lower installation cost than would a type P1 system.

In those areas protected by a type P2 system, the spacing and siting of detectors should generally be the same as those of a type P1 system. If a fire starting outside the protected area spreads inside it then the fire growth rate in the 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 P2 system should therefore be separated from unprotected areas by fire-resisting construction.

Before a fire detection system is installed for insurance purposes, early consultations should be held with the insurers.

12.2 Spacing and siting of heat- or smoke-sensitive detectors

12.2.1 *General.* Heat- and smoke-sensitive detectors depend on the convective movement of fire products from the fire to the detector. The spacing and siting recommendations for these detectors are based on the needs to restrict the time taken for this movement and to ensure that the products reach the detector in adequate concentration.

12.2.2 *Spacing.* For open areas under flat horizontal ceilings, the horizontal distance from any point in the area to the detector nearest to that point should not exceed 5.3 m for heat detectors or 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.

NOTE. For estimation purposes, in any room or compartment the number of point-type detectors fitted should not normally be less than the room or compartment area divided by 100 m^2 for smoke detectors, or 50 m^2 for heat detectors, except as varied by **12.2.3**.

12.2.3 *Ceilings and roofs.* In a building the hottest gas and the greatest concentration of smoke (visible or invisible) will generally collect at the highest parts of the enclosed areas and it is here, therefore, that heat or smoke detectors should be sited. Except in shallow voids (see **12.2.11**), detectors should be sited so that their sensitive elements are not less than 25 mm or more than 150 mm below the ceiling or roof for heat detectors, and not less than 25 mm or more than 600 mm below the ceiling or roof for smoke detectors.

If a protected space has a pitched roof or north-light roof, then detectors should be installed within each apex. If the difference in height between the top and bottom of an apex is less than the maximum depth allowed between the roof and the detector (150 mm for heat detectors or 600 mm for smoke detectors) then the roof may be treated as if it were flat.

For detectors mounted in the apex of a pitched or north-light roof, the recommendations of **12.2.2** for the horizontal distance from the point to the detector may be increased by 1 % for each degree of slope of the roof up to a maximum increase of 25 %, and the area limits per point-type detector given in **12.2.2** may be increased in proportion to the square of the increased distance. For example, if the roof slopes at 10° the distance may be increased by 10 % to 1.1 times the given distance, and the area covered may be increased to 1.21 times the given area.

12.2.4 *Effects of ceiling height.* As the smoke and hot gas from a fire rise, they become diluted with clean, cool air from around the plume. Hence the size of fire required in order to operate heat or smoke detectors increases rapidly as the height of the ceiling above the fire increases. To some extent the effect can be overcome by the use of more sensitive detectors.

In addition to reducing the smoke density, the dilution will increase the total volume of fire products in the plume, and hence cause it to spread further on reaching the ceiling.

Optical beam smoke detectors are less sensitive to the effects of height than are point-type detectors, since the increased size of plume will involve a greater proportion of the beam and help to alleviate the effects of reduced smoke density.

In general it should be considered that the protection of compartments exceeding 9 m in height presents special problems, depending on such factors as the height and configuration of the contents.

12.2.5 *Limits of ceiling height.* Except in the exceptional cases of this clause and **12.2.6**, detectors should not normally be mounted on ceilings higher than the general limits of table 1. If small sections of a ceiling (not exceeding in total 10 % of the ceiling area) exceed in height the general limits of table 1, those higher sections may be protected by point-type heat detectors provided that the ceiling height in the higher sections does not exceed 10.5 m, or by point-type smoke detectors provided that the ceiling height in the higher sections does not exceed 12.5 m.

12.2.6 *Ceiling height limits with rapid attendance.* Although an increased ceiling height means that the fire will be larger when it is detected, the size of the fire when fire fighting starts will also depend on the delay between detection and the start of fire-fighting. If this delay is small, then the increase in fire size at detection due to a higher ceiling can be acceptable.

If the detection system is automatically connected to the fire brigade either directly or via a central (fire alarm) station as described in appendix A, and the usual attendance time of the fire brigade is not more than 5 min, then the rapid attendance limits of ceiling height given in table 1 may be applied. If small sections of a ceiling (not exceeding in total 10 % of the ceiling area) exceed in height the limits of table 1, those higher sections may be protected by point-type heat detectors if their height does not exceed 15 m, or by point-type smoke detectors if their height does not exceed 18 m.

12.2.7 *Low ceilings.* Under low ceilings the converse to **12.2.4** applies. Since there is little dilution, the detector will respond to very small fires. For smoke detectors, care in siting is necessary to avoid nuisance operation by tobacco smoke and smoke from other small sources. Less sensitive detectors may be useful, and the detector manufacturer may be able to supply a cover to prevent direct entry of smoke from below without inhibiting normal entry from the side at ceiling height.

12.2.8 *Corridors.* In a corridor less than 5 m wide, the horizontal distance given in **12.2.2** may be increased by half the difference between 5 m and the width of the corridor, e.g. in a corridor 3 m wide the distances may be increased by 1 m. A corridor wider than 5 m should be treated as an open area as recommended in **12.2.2**.

Table 1. Limits of ceiling heights

Detector type	Ceiling heights	
	General limits	Rapid attendance
	m	m
Heat detectors BS 5445 : Part 5 grade 1 grade 2 grade 3	 9.0 7.5 6.0	 13.5 12.0 10.5
Point smoke detectors as described in 11.3	10.5	15.0
High temperature heat detectors BS 5445 : Part 8	6.0	10.5
Optical beam smoke detectors BS 5839 : Part 5	25.0	40.0

12.2.9 *Walls and partitions.* Detectors (other than optical beam smoke detectors, see **12.4.3**) should not be mounted within 500 mm of any walls or partitions. Where rooms are divided into sections by walls, partitions or storage racks reaching to within 300 mm of the ceiling, the dividers should be considered as if they reached the ceiling and the sections should be considered as separate rooms.

12.2.10 *Obstructions.* If the passage of smoke or hot gas from a point to a detector is likely to be disturbed by a ceiling obstruction (such as a beam) having a depth greater than 150 mm but less than 10 % of the height of the ceiling, then the distances allowed by **12.2.2**, **12.2.3** and **12.2.8** should be decreased by twice the depth of the obstruction. Detectors should not be mounted within a distance of 500 mm from any such obstruction. Ceiling obstructions deeper than 10 % of the ceiling height should be treated as walls, and the recommendations of **12.2.9** should be followed.

Isolated attachments to the ceiling such as lighting fittings and luminaires do not normally act as obstructions to the general flow of smoke. They may, however, cause a local disturbance, and detectors should not be mounted closer to such attachments than twice the depth of the attachment.

12.2.11 *Voids.* Voids less than 800 mm in height need not have independent coverage unless the void is such that extensive spread of fire or fire products, particularly between rooms or compartments, can take place within it before detection. Where it is considered necessary to install detectors in shallow voids having poor ventilation (for

instance, under-floor service voids) then special care should be taken with the positioning of the detectors.

In a fire the initial smoke layer will usually take up only the top 10 % of the void height. In shallow voids the thickness of the layer may be small compared with the detector's dimensions, and therefore care should be taken that the sensing element of the detector lies within the top 10 % of the void. To do this it may be necessary to mount the detector in an unusual orientation; precautions against the deposition of dirt or dust may be needed.

12.2.12 *Vertical shafts and ceiling penetrations.* Where stairways, enclosed chutes through floors, or shafts for lifts, hoists or escalators penetrate ceilings, detectors should be so sited that at each level at least one detector is placed on the ceiling within 1.5 m of the penetration. A detector should also be sited at the top of each stairway, enclosure or shaft. If an elevator or stairway has a sloping ceiling then there may be a need for detectors to be sited on that ceiling.

12.2.13 *Enclosed stairways.* In enclosed stairways detectors should be sited on each main landing.

12.2.14 *Lantern-lights.* A detector should be sited in any lantern-light used for ventilation or having a height above the ceiling greater than 800 mm. Detectors fitted in lantern-lights are liable to rapid temperature variations due to solar and/or internal heating. Where heat detectors are used they should not include rate-of-rise elements, and should be protected from direct sunlight.

12.2.15 *Stratification.* As the plume from a fire rises, it draws in air from round about it. This dilutes the fire products and brings the temperature of the plume closer to that of the surrounding air. If the temperature of the surrounding air rises with height, then it is possible for the plume to be so cooled in the lower part of the room height that it is cooler than the higher air. The plume will then spread out to form a smoke layer before it reaches the ceiling, and will thus not operate ceiling mounted detectors.

In general, the temperature variation with height in a room has its greatest gradient at the height at which most of the heat is fed into the room. Convection from the room heaters tends to stir the air above the heaters, bringing it to a roughly constant temperature, while the air below the heaters remains cool. The most likely height for smoke stratification to occur is therefore the level of the room heaters.

If the room heaters are at low level, then the fire plume is unlikely to be significantly cooled before reaching the heater level, and thus is likely to rise through the heater level without stratifying. If the room heaters are at high level, however, smoke stratification is likely to occur at about the heater level. It should be remembered that the heat input to the room may not be confined to the main room heaters; solar heating of the roof or heating by ceiling-level hot water pipes can be very effective in causing stratification.

Because of the variables associated with different heating patterns, it is usually difficult to predict with certainty the level at which stratification will occur. If detectors are mounted at an expected stratification level, and stratification does not occur or occurs at a higher level than the detectors, then detection may be dangerously delayed. However, if ceiling level detectors are used, then as the fire gets bigger and releases more heat the plume will break through the stratification layer and the detectors will operate. Thus ceiling level detectors should always be used, even where supplementary detectors are mounted at an expected stratification level.

Since the normal ceiling temperature is unlikely to approach the operating temperature of a heat detector, stratification is unlikely to affect the response of heat detectors, and even in the presence of stratification smoke detectors are likely to operate before heat detectors.

12.2.16 *Ventilation and air movement.* In siting heat or smoke detectors, consideration should be given to the possible patterns of air movement in the premises. Air conditioning and ventilation systems with high air change rates may adversely affect the response of detectors by directing fresh air over them, by drawing heat and smoke away from them, or by diluting the hot gases produced by a fire. In these conditions the siting and provision of detectors both require special consideration. In general, if the room ventilation rate exceeds four changes per hour then additional detectors may be required. For applications in computer suites or data processing areas, BS 6266 should be consulted.

Detectors should not be mounted directly in the fresh air input from air conditioning systems. In general, a spacing of not less than 1 m between the detector and the air inlet should be maintained. Where the air inlet is through a perforated ceiling, the ceiling should be imperforate for a radius of at least 600 mm round each detector.

The use of exploratory smoke tests to identify the optimum positions for detectors in ventilated areas is recommended. Consideration should also be given to the detection of fires which might occur when the ventilation is turned off.

12.2.17 *Remote indication of operation.* If a detector is concealed, for example in a void, then it may be desirable to provide a remote indication of its operation. If necessary a label should be provided at the indicator to show the location of the detector.

12.2.18 *Additional detectors.* The use to which any room, space, area or void is to be put, or its structural features, may necessitate the installation of detectors additional to those otherwise recommended.

12.2.19 *Adverse environments.* Where possible, detectors should not be mounted in places where they are subjected to local adverse environmental conditions, e.g. on a machine producing high levels of vibration, shock or pollution. If it is not possible to avoid such conditions, or if the adverse environment is general in the area, then the manufacturer should be consulted.

12.3 Additional recommendations for siting of heat-sensitive detectors

12.3.1 *Rapidly changing ambient temperatures.* Where sudden changes in temperature are likely, e.g. in kitchens, boiler houses, furnace or kiln rooms, the risk of false alarms caused by rapidly rising temperatures should be minimized by the use of heat detectors without a rate-of-rise element. Such circumstances should be the subject of consultation with interested parties.

12.3.2 *High temperatures.* Where ambient temperatures are likely to exceed 43 °C, e.g. in kitchens, boiler houses, furnace or kiln rooms, the nominal operating temperature of a heat detector may need to be greater than that permitted by BS 5445 : Part 5. In such cases a heat detector complying with BS 5445 : Part 8 should be used. The nominal operating temperature should not exceed the expected maximum ambient temperature by more than 30 °C. Such circumstances should also be the subject of consultation with interested parties.

12.3.3 *Heat-sensitive line detectors.* Heat-sensitive line detectors may be particularly suitable for protecting items of plant or cabling. When used for these purposes, the detector should be mounted as close as possible to the place where fire or overheating might occur, and either be mounted above the risk or in thermal contact with it.

12.4 Additional recommendations for siting smoke detectors

12.4.1 *General.* Among other factors that can establish temporary or permanent conditions having an effect on the siting of smoke detectors are the following:

(a) the various forms of fan-assisted overhead heating;

(b) air-cooled equipment with the exhaust air blowing out into the room or factory area;

(c) ambient air currents which may cause false alarms or inhibit correct operation;

(d) roofs or ceilings of unusual shape or special construction, deep beams or smoke curtains;

(e) lofty buildings, e.g. buildings with ceiling heights exceeding 10 m;

(f) stairways;

(g) rooms with cooking equipment;

(h) some boiler rooms and plant rooms;

(i) areas where vehicles powered by internal combustion engines (particularly those with overhead or vertical exhaust outlets) may be used.

12.4.2 *Smoke detectors in ventilation ducts.* Smoke detectors may be sited to monitor smoke within ventilation extract ducts. In general such detectors are intended to assist in the prevention of spread of smoke by the ventilation system, by allowing any recirculation to be shut off in the event of a fire.

Although they may be connected to the fire alarm system, these smoke detectors should not normally be considered as constituting on their own a satisfactory fire detection system. The dilution caused by the extraction of clean air together with smoke reduces the effectiveness of duct-mounted smoke detectors as a general fire detection and alarm system, and if the air-handling equipment is switched off the smoke detectors will be unable to obtain the air samples necessary for satisfactory operation.

Where the air from several extract points is combined into one duct the effectiveness of a smoke detector in the combined duct may be further reduced by dilution or stratification of the smoke. To avoid this further reduction it may be necessary to install a smoke detector near each of the extract points.

In order to avoid the effects of air turbulence, smoke detectors or probes should be installed in a straight stretch of ducting, at a distance from the nearest bend, corner or junction of at least three times the width of the ducting.

If placed in high or variable speed air flows, some designs of smoke detector may malfunction, either by failure to give an alarm or by giving false alarms. Manufacturers of such detectors will usually provide ancillary sampling tubes or windshields, and these should be installed where necessary. Aspirating or air sampling detection systems in which air is drawn into the sampling point at a controlled rate by a pump are generally independent of the rate of air flow near the sampling point, and may offer significant advantages over conventional smoke detectors where the air speed in the duct is likely to vary widely.

12.4.3 *Optical beam smoke detectors.* Optical beam smoke detectors should be installed in accordance with the manufacturer's instructions, with not more than 3 m of the beam within 500 mm of any wall or partition. Those parts of the beam within 500 mm of the beam's transmitter, receiver or reflector(s) need not be counted in the 3 m restriction.

Because of the uncertainty in the position of a fire within the beam length, the maximum length of the area protected by a single optical beam smoke detector should not exceed 100 m. Within this limitation the manufacturer's recommendations on beam length should be followed.

If there is a probability of people walking in the area of the beam, then the beam should be at least 2.7 m above the floor.

Where optical beam smoke detectors are used in roof void areas having droppable smoke curtains, the beams should be so arranged that they are not broken by the smoke curtains when they are dropped.

12.5 Recommendations for siting of flame detectors

Some types of flame detector respond to the instantaneous level of radiation received, while others depend on the level received over a period. In either case the response will depend on the distance between the flame detector and the fire, since the radiation level received is inversely proportional to the square of this distance. Increased distance from the fire to the flame detector will therefore lead to an increase in the size of the fire at detection. Advice on the maximum spacings to be used should be sought from the manufacturer.

A clear line-of-sight to the area being protected is preferred. Reflected radiation of sufficient intensity can actuate a flame detector, but the use of reflected radiation will significantly increase the fire size at detection, Where possible, flame detectors should be sited to avoid a direct line-of-sight to likely sources of non-fire radiation which might cause false alarms.

13 Detectors installed primarily for life safety (type L)

13.1 Manual systems

In the event of a fire in a building, those people who are at risk can be made safe either by escaping from the fire, or by the fire being extinguished. Neither of these methods can be used until people are made aware of the fire. To this end, most premises (except domestic dwellings) should be provided with some means of giving the occupants warning in case of fire. In some very small premises simple hand-operated devices such as hand bells or gongs may be sufficient. However, in most other premises a more sophisticated alarm system will be necessary, able to be heard throughout the premises and perhaps incorporating automatic fire detection.

The effectiveness of an alarm system depends on the stage of the fire at which it is operated. If the alarm can be sounded before the fire has affected the means of escape then, except perhaps for those caught in the earlier stages of the fire, it should be possible for all the occupants to escape without too much difficulty. An earlier alarm may help even those who may be close to the site of ignition; a later one may render escape difficult or impossible.

A type M system, operated by manual call points only, may be all that is needed in the following circumstances:

(a) if there are likely to be alert (and preferably trained) people about near the site of ignition; and

(b) if the normal occupants of the building are likely to be able to escape at a reasonable rate without assistance; and

(c) if the escape routes are adequately protected by structural means from the spread of a fire or its products, or alternative escape routes will always be available.

13.2 Automatic detection

13.2.1 *General.* In circumstances where a particularly early warning of fire is necessary for the safety of life, automatic fire detectors should be installed. They should never be considered as sufficient on their own, however, but should be used to complement a manually operated fire alarm system. For example, the installation of automatic detectors may be required in order to compensate for a reduction, or low level, of supervision, either permanently or at certain times; to compensate for a special vulnerability of the usual occupants, for example, illness, age or unfamiliarity with the building; or to improve safety where it is impracticable to provide the degree of structural separation that would normally be desirable to prevent spread of heat or smoke. Fire detectors may also be installed in any other instance where an improved level of protection is desired. The extent of protection (see **3.3**) required in any premises should be decided in the consultations described in clause **4**. The extent of protection may be considered at three levels: protection of escape routes; protection of vulnerable areas (including escape routes); and total coverage.

13.2.2 *Protection of escape routes.* The first level of protection is a type L3 system. This should give warning to the occupants in time for those not already directly affected by the fire to use the escape routes.

It will not be sufficient simply to have automatic fire detectors on the escape routes, since by the stage at which these detectors would operate the fire may be spreading rapidly, or the escape routes near the fire may already be blocked by smoke. For the protection of escape routes it will therefore also be necessary to install detectors in adjoining rooms. 1

13.2.3 *Protection of vulnerable areas.* The second level of protection is a type L2 system, requiring the installation of detectors in those parts of the premises where the most vulnerable people are likely to be, or where the most dangerous fires are likely to start, as well as for the protection of escape routes. The specification of the system should define those areas to be covered.

13.2.4 *Total coverage.* The third level of protection requires fire detection in all parts of the premises. Such a system is a type L1 system, and gives the maximum degree of improvement in safety that can be achieved by a fire detection system.

13.3 Choice of fire detectors

13.3.1 *General.* The general considerations of **11.5** apply. Detectors installed for purposes of life safety will usually be of the smoke-sensitive type, although heat-sensitive types may be used for some purposes.

13.3.2 *Point and beam type smoke-sensitive detectors.* These should comply with BS 5839 : Part 5 BS 5445 : Part 7 or, for residential premises only, BS 5446 : Part 1 (other than self-contained smoke alarms). 1 1

13.3.3 *Heat-sensitive detectors.* These should comply with BS 5445 : Part 5 or, in special cases, BS 5445 : Part 8 (see **11.5.2**).

13.4 Siting and spacing

In those areas where detectors are installed for life protection, the siting, spacing and area coverage of detectors should be generally as recommended in clause **12**, modified as recommended in **13.5** to **13.7**. In corridors, the increased distance allowed in **12.2.8** should only be applied if smoke detectors are sited in all rooms opening onto the corridors. Additional suitably sited detectors may be necessary to actuate fire protection devices ancillary to the fire alarm system, such as extinguishing systems or door closers. 1

13.5 Type L3 systems: protection of escape routes

13.5.1 *General.* A type L3 system should be so designed that in any fire an alarm is given at a sufficiently early stage to allow time for the escape routes to be used before they are blocked by smoke. The latest time by which the alarm should have been given depends on the layout of the building and on the abilities of the occupants to respond to an emergency. To give satisfactory protection of the escape routes, detectors should be installed both on the escape routes and in rooms opening onto the escape routes 1

13.5.2 *Detection in escape routes.* In general the escape routes should be the normal circulation areas within the building, i.e. the normal routes by which people move round the building. In some cases a circulation area may be the only escape route available, for example, corridors outside bedrooms. Escape through such a route would be immediately made less likely by smoke penetrating from an adjacent area. Some parts of escape routes may fall outside the normal circulation areas, such as where an escape route leads through a room. All such routes should be treated as escape routes.

The basic provision of a type L3 system is the siting of smoke detectors in all escape routes and circulation areas. Further smoke detectors should be sited on the ceiling at the top of any stairway, and on landing ceilings such that the vertical distance between adjacent detectors does not exceed 10.5 m. Any points at which ceilings below escape routes are penetrated (for instance, by shafts for lifts or hoists) should have detectors sited as recommended in **12.2.12**.

Heat detectors are unsuitable for use in escape routes because, in a slow-burning fire, the temperature required to operate them may only be reached after the smoke density in the escape routes has reached an intolerable level.

13.5.3 *Detection in areas other than escape routes.* A fire which occurs in any room or enclosure and which is allowed to develop will eventually affect adjoining escape routes. In particular, passage of hot fire gases through a door crack can produce smoke sufficiently dense and cool for a corridor to become smoke-logged before adequate warning can be given by detectors in the corridor. For earlier detection of fire, a detector (either heat- or smoke-sensitive) should be fitted within the room. For this purpose the detector can be mounted near the doorway, either on the ceiling or on the wall above door level; it need not be sited as recommended in clause **12**. The need for detectors in rooms should form part of the consultations of clause **4**.

A detector (either heat or smoke) should be sited in each room (other than a toilet) that opens directly onto any stairway.

The absence of structural separation is not always apparent, and paths by which smoke and heat may travel are sometimes evident only from a detailed study of the construction. In some circumstances a fire in a room, if allowed to develop, may affect adjoining escape routes by means of penetration other than at the door opening, e.g. by wall cavities and ceiling or roof voids. Particular note should be taken of possible fire spread through uncompartmented roof spaces. Where the possibility of fire spread is not eliminated by structural means, detectors should be sited either in the areas where fire might start or in the areas through which the fire products might reach the escape routes. Where detectors are hidden the use of remote indicators as described in **12.2.17** should be considered.

Fires starting in lifts or lift wells may develop and allow smoke to move into lift and stair lobbies before any smoke reaches detectors at the top of the lift well. Particularly where the lift main supply cables are run inside a lift well, consideration should be given to providing additional protection to the lift well, for example by a heat-sensitive line detector alongside the lift main supply cables, or by an optical beam detector with a vertical beam.

Detectors may be necessary in dormitories (see **13.6.3**).

13.6 Type L2 systems: vulnerable areas

13.6.1 *Escape routes.* In general, the most vulnerable areas in any building are the circulation areas, since once these are blocked it will be difficult for the occupants to carry out any of the preplanned actions of the fire routine. Hence the first step in any type L2 system should be to comply with the recommendations for a type L3 system for escape route protection (see **13.5**).

13.6.2 *Other areas.* In addition to the escape routes, the other areas to be protected will normally fall into the following two classes:

(a) those areas in which the normal occupants are especially vulnerable to fire starting in their vicinity; and

(b) those areas having a particularly high probability of ignition and from which fire or fire products could spread to affect the building occupants.

The areas to be protected should be decided during the consultations described in clause **4**, and should be clearly laid down in the system specification. Advice on the protection of specific areas is given in **13.6.3** to **13.6.7**, but all areas of the building should be considered when deciding where detectors should be sited. If detectors are installed for the protection of a room's occupants, then smoke detectors should be used; if they are installed in order to give warning of fire before it spreads to other areas of the building, then either smoke or heat detectors may be used.

13.6.3 *Sleeping accommodation.* Any fire starting in a room immediately hazards all the room's occupants. If a fire is likely to start in a room where the occupants are asleep, and there is no wakeful watch on the room, then the recommendations of **12.2** and **12.4** should be followed for the siting of smoke detectors in the room. The detectors chosen should be capable of giving sufficiently early warning of smouldering or slow-burning fires to prevent sleeping occupants from being overcome (see **11.5.3**).

Both the probability of ignition and the number of people affected will increase with the number of room occupants; if the number of occupants is such that it constitutes a dormitory (even though it may be partitioned into cubicles) then the installation of smoke detectors may be essential for the protection of the occupants and should be considered even in a type L3 system.

13.6.4 *Day accommodation.* In rooms not intended for sleeping accommodation the safety of the room occupants will rarely justify the installation of fire detectors. However, it should be realized that in some types of premises (such as old persons homes) people using a day lounge will frequently be asleep, and such rooms may need to be treated as sleeping accommodation. Smoke detection should also be considered where the room occupants will have difficulty in raising an alarm or need assistance in escaping from a fire.

Fires starting in day accommodation may grow while the room is unoccupied until they endanger people elsewhere in the building. Where the fire separation between the room and the remainder of the building is such that a dangerous spread of fire or fire products could occur, then either heat or smoke detectors should be installed in the room.

13.6.5 *Store rooms.* Detectors need only be installed in store rooms where structural separation is insufficient to protect against spread of fire to other places in the building; it is unlikely that detection will be required to protect any people who might be in the store room.

13.6.6 *Kitchens.* Fires starting in kitchens are unlikely to hazard normally active occupants of the kitchen, but may hazard occupants of the remainder of the building. Smoke detectors should not be used in kitchens; where detection is considered necessary, heat detectors should be used.

13.6.7 *Service ducts.* Where service ducts are large enough to be regularly entered, for instance for maintenance purposes, then consideration should be given to the safety of persons who might be in the duct when a fire starts. Such consideration should include the following:

(a) the installation of detectors in the duct in case of fire starting in the duct;

(b) the sound level given in the duct by the general alarm;

(c) the means of escape for persons in the duct.

13.7 Type L1 systems: total coverage

Where a total cover system is installed, detectors should be sited in all areas of the building generally following the recommendations of **12.2**. In those areas where fire would have a direct effect on the occupants or their escape routes, smoke detectors should be installed. Where fire would only affect the occupants or the escape routes after fire spread has occurred beyond the room of origin, either heat or smoke detectors may be installed.

14 False alarms

14.1 General

It is essential that the utmost care should be taken by system designers, installers and users to reduce the incidence of false alarms. Common causes of false alarms include the following:

(a) mechanical and electrical faults, often resulting from the effects of vibration, impact or corrosion;

(b) ambient conditions such as heat, smoke or flame from cooking or work processes, fumes from engine exhausts, or high air velocities due to strong winds outside the building;

(c) work being carried out in a protected area without knowledge of, or in neglect of, the necessary precautions;

(d) communication faults arising from servicing or testing work carried out without prior notification to the fire brigade or central alarm station, or arising from activities of the public telecommunications operator;

(e) electrical transients or radio interference;

(f) inadequate servicing;

(g) the build-up of dust or dirt within a detector, or the entry of insects;

(h) change of use or changes within the building;

(i) accidental or malicious operation of manual call points or detectors.

Installations which are the subject of a series of false alarms should be referred to the installer and/or system designer (see **29.3.3**). Where the fire alarm system raises persistent false alarms during normal working hours the provision of a time related system may be considered (see **14.6**).

The action to be taken by the user after a false alarm is given in **29.3**.

14.2 Heat detectors

False alarms may be caused by abnormal increases in temperature due to space heating equipment, industrial processes or sunshine. They may be prevented by installing detectors with appropriate higher temperature settings, or, in the case of direct sunlight, by introducing an appropriate shade. Where these conditions are likely, the recommendations of **12.3.1** and **12.3.2** should be followed.

False alarms from rate-of-rise heat detectors may also be caused by a rapid temperature increase to normal room conditions following exposure to low temperatures. Such a sequence may occur, for instance, in a loading bay with large doors to the outside; while the doors are open the detector may be exposed to winter conditions, followed by rapid heating when the doors are closed. If such conditions are likely, then detectors without a rate-of-rise response should be used.

14.3 Smoke detectors

False alarms signalled by smoke detectors may be caused by smoke and other fumes, dusts (including slow accumulations of dust and disturbed aerial dusts), fibres, steam or condensation; all these may be due to normal processes or activities or to unusual extremes of the environment. Insect infestation may be a significant problem in the late summer period.

Optical beam smoke detectors will often give false alarms if the beam is accidentally obstructed; apart from those obstructions due to human activities, obstructions due to perching by birds or by bats have been reported. Some types of beam detectors may give false alarms when subjected to bright sunlight or intense light sources such as photographic flash-guns.

Ionization chamber smoke detectors are highly sensitive to smokes made up of very small particles, including diesel exhaust and fumes from self-cleaning ovens. Some types are sensitive to high air speeds and may give false alarms if mounted in windy situations. Because of the very low currents used in the ionization chambers, high humidities may cause problems, particularly if the detectors have previously been contaminated by hygrophilic contaminants.

14.4 Flame detectors

Ultraviolet flame detectors sense the ultraviolet radiation emitted by flames. They are liable to respond to sources such as lightning, ionizing radiation, ultraviolet lamps and quartz-halogen lamps unless the detection system can discriminate between various sources, but they do not respond to sunlight. (The component of solar ultraviolet to which detectors would respond is filtered out by the high-altitude ozone layer of the earth's atmosphere.) The effect of transient signals, e.g. those caused by electric storms, may be eliminated by an integrating circuit. Known sources of ultraviolet light should be screened from the detector, taking care that the screen does not also obscure likely sites for fire. Ordinary window glass will screen ultraviolet radiation.

Most infra-red flame detectors operate by detecting the flickering component of the infra-red radiation from a fire. This type of detector should be insensitive to steady infra-red sources such as very hot objects or sunlight, but may be operated if this steady light becomes modulated by, for example, moving tree branches or the blades of a fan.

In order to reduce the possibility of false alarms, some types of infra-red flame detector improve the discrimination between flames and other sources, e.g. sunlight, by the use of techniques such as the use of long wavelengths or of one or more specific infra-red wavelengths emitted by flames. Other techniques such as combining infra-red and ultra-violet sensing can be used. Types of detector using these and similar techniques are unlikely to suffer from the false alarm problems associated with some older types of flame detector.

14.5 Addressable systems

A two-state addressable system may have a false alarm potential of the same order as a conventional system.

A multi-state addressable system may provide advance information of impending problems. Providing this information is acted on, it could make a significant reduction in certain categories of false alarm.

An analogue detector system in which a central micro-processor compares the incoming data against several predetermined threshold levels is likely to have a false alarm level similar to that of a multi-state detector system. However, the ability to compare outputs from a number of detectors in the same general area, or from one detector against its own past history, may allow a further reduction in the incidence of false alarms.

14.6 Time related systems

Where human or industrial activity during working or wakeful hours could result in false alarms, particularly where the presence and behaviour patterns of people make it unlikely that a fire would go undetected by human agency, it may be useful to consider a time related, dual sensitivity system. Various options are available and each should be considered in the light of the fire risk and type of occupancy. No such options, for either new or existing systems, should be implemented until agreement has been reached under the procedures outlined in clause **4**. It should be borne in mind that where such systems are employed, their type classification (see clause **3**) may change with the time of day.

Instances of where time related systems might be employed include the following:

(a) schools;

(b) hotels, boarding houses and other residential premises;

(c) factory and commercial premises that are active for only part of the day.

A few examples of time related systems are listed below.

(1) In an analogue detector system it might be possible to increase the alarm thresholds (i.e. decrease the sensitivity of the system to fire) during working hours. Outside working hours the threshold might be reduced (i.e. the sensitivity increased).

(2) Heat detectors employed during working hours could be supplemented by smoke detectors outside working hours.

(3) During working hours the system could be so arranged that initiation of the alarm condition by automatic detectors does not immediately result in the sounding of the alarm of fire: a responsible person would be alerted to investigate the alarm, although the alarm sounders might be automatically sounded after a preset period. However, the sounders should sound immediately in response to any manual operation.

(4) As a last resort, the system could be switched to manual detection during working hours, and be switched back to automatic detection outside working hours.

Switching to the more sensitive form of detection should not rely on human action or discretion; it should be an entirely automatic procedure at a predetermined time. The risk of false alarms is deemed, in this instance, to be subordinate to the need to guarantee the required level of protection outside working hours. No automatic switching devices should be readily accessible to the system user, although in places like a hotel bar it is permissible to delay the change to the more sensitive state by a manual switch operation. Repeated switch operations may be used to extend the delay, but the delay should not extend more than 45 min after the last operation of the switch. In commercial premises it may sometimes be acceptable for the automatic changeover to occur when the main access door is closed and locked for the night.

Weekends should be pre-programmed into the system time switch. The procedures for dealing with public and works holidays and with time changes to and from British Summer Time should be clearly understood by the user, so that the correct degree of cover is available at all times. A manual override switch, on or adjacent to the control equipment, should be available to allow full cover to be provided during periods when the building is unexpectedly unoccupied. The override switch should not be capable of switching the full cover to the restricted cover, and the system design should not permit the action of this switch to be temporarily or permanently cancelled by any automatic function.

An indicator light on or adjacent to the control and indicating equipment should show whether the system is switched to the working or silent hours state.

14.7 Transmission delay units

In some (but not all) circumstances where there is a high incidence of false alarms which cannot be reduced by other measures, it may be desirable to delay the automatic

transmission of an alarm to the fire brigade for a sufficient time to allow the alarm to be investigated. For this purpose the incorporation of a transmission signal delay unit may be considered.

A transmission delay unit should not be incorporated into a fire alarm system unless the responsible person is satisfied that all other reasonable measures have been taken to prevent false alarms of fire, that the unit would not prejudice the level of fire precautions within the protected premises, that the delay will only be used when staff are available to investigate the cause of the alarm, and that both the proposed unit and the arrangements for its use are acceptable to the fire insurer and the fire brigade. In many applications rapid attendance by the fire brigade is essential, and in such cases the use of transmission delay units will not be acceptable. Even where rapid attendance by the fire brigade is not essential, the total possible delay should be related to the expected attendance time. Transmission delay units are unlikely to be acceptable in certain applications such as hospitals or residential care premises or where there are special evacuation difficulties.

If a transmission signal delay unit is fitted, then the normal sequence of events in the event of an alarm should be as follows.

(a) If the alarm is raised by a manual call point, then the normal functions of the system in both sounding the internal alarm and transmission of the alarm to the remote manned centre should continue without delay (i.e. the transmission signal delay unit should not operate).

(b) If the alarm is initiated by an automatic detector, then the internal alarms should sound without delay. The call to the fire brigade or remote manned centre may be delayed for an initial period not exceeding 2 min.

1 unless agreement has been reached to delay the sounding of the fire alarm on initiation of the fire condition by automatic detectors (see item (3) of 14.6)

(c) If during the initial delay period described in item (b) a manual operation is performed at the control equipment indicating that an investigation is in progress, then the alarm may be delayed for a further period, not exceeding 5 min from the manual operation, subject to agreement with interested parties.

1 (d) If during any delay period the alarm is found to be a real fire, then a manual operation at the control panel or the operation of a manual call point should cause an immediate transmission of the alarm.

1 and should sound the fire alarm if not sounded immediately on initiation of the alarm condition (see item (b))'.

(e) If the alarm can be shown to be false, with no actual fire, then the internal alarms should be silenced, a note made of any indication which might throw light on the origin of the alarm, and the system should be reset. Resetting of the system should inhibit transmission of the alarm unless the system again goes into the alarm state.

A transmission signal delay unit should normally act only on alarms rising from automatic detectors. It should not delay or prevent the transmission of alarms arising from manual call points, and it should not delay or otherwise affect the operation of audible or visual alarms or any other part of the fire alarm system. The period of delay should not be readily alterable. The alarm should be automatically transmitted to the fire brigade after a fixed delay period not greater than 2 min, unless a manual override operation has been carried out. A simple, accessible alarm transmission switch should also be provided so that a call to the fire brigade can be made without delay if necessary. Satisfactory arrangements (such as a time switch) should be made to disconnect the device during periods when the internal investigation of alarms cannot be undertaken immediately.

It should be appreciated that the delays within any signal delay unit will be additional to any delays inherent in the alarm transmission system. If the investigations of **8.2** show that the transmission system may cause significant delays between the sending of the alarm from the protected premises and its reception by the fire brigade, then this delay should be taken into account in assessing the desirability of a transmission signal delay unit.

15 Control equipment

15.1 General

Control and indicating equipment may comprise equipment for the reception, indication, control and relaying of signals originating from detectors or call points connected to it, and for the activation of alarm sounders and alarm signalling devices.

15.2 Choice of equipment

15.2.1 *Automatic systems.* Control and indicating equipment for automatic fire alarm systems should comply with BS 5839 : Part 4*. If manual call points are to be incorporated in an automatic system, then the control and indicating equipment should be such that the response of alarm sounders meets the recommendations of **10.1**.

15.2.2 *Manual systems (type M).* Control and indicating equipment for manual systems should comply with BS 5839 : Part 4*. However, if the area covered by a manual system could fall within the limits of a single zone under the recommendations of **7.2**, irrespective of how many zones are actually used, then control and indicating equipment complying with all the recommendations of appendix G may be acceptable subject to the approval of the appropriate authority.

15.2.3 *Facilities.* The facilities provided by the control equipment should meet any special requirements for the premises; in particular, they should satisfy the requirements defined in 4.2 for action in the event of an alarm of fire. 1

15.3 Siting

15.3.1 *Availability to staff.* In residential premises the members of staff on duty will be the first to require the information given by the indicating equipment, particularly that indicating the zone affected, and it is important that the equipment should be sited with this in mind.

15.3.2 *Availability to the fire brigade.* The control and indicating equipment should preferably be accommodated in an area on the ground floor and in the immediate vicinity

* The control and indicating equipment for systems installed, commissioned and handed over before 1 January 1990 may comply with

of the entrance to the building likely to be used by the fire brigade. If different entrances may be used by the fire brigade, perhaps at different times of day, then it may be necessary to provide repeated indications at other points of entry. The fire brigade should be consulted on the positioning of the equipment and on the diagrammatic representation of the building (see **15.4.3**).

15.3.3 *Light level.* The ambient light level in the vicinity of the control and indicating equipment should be such that any visual indications can be clearly seen, and any instructions for use be easily read. Where necessary, additional lighting should be provided. This may be operated from the fire alarm supply, provided that in the event of mains failure it is lit only in the fire condition and that the additional load is calculated as part of the alarm load of **16.4**.

15.3.4 *Sound level.* The sound level in the vicinity of the control and indicating equipment should not be such as to prevent the audible indications (such as the fault warning sounder) from being heard.

15.3.5 *Fire risk.* Control and indicating equipment should be sited in areas of low fire risk, so that the equipment is unlikely to be involved in a fire before adequate warning has been given. If the system uses automatic detectors, then the area in which the control unit is sited should be covered by the detection system.

15.3.6 *Multiple occupation (X).* In a building in multiple occupation it is essential that the siting of the control and indicating equipment is agreed between the occupants, and that access to the equipment is available to all the occupancies. This is usually most easily achieved by siting the equipment in an area of common use, such as an entrance hall.

15.3.7 *External siting.* If it is necessary for practical reasons to mount the control and indicating equipment outside the building, then adequate precautions should be taken to protect the equipment from the effects of weather. Similar precautions may be necessary if the equipment has to be installed in a severe environment within a building.

15.4 Indication of origin of alarms

15.4.1 *Purpose.* Except in buildings where a fire can be located without delay, the fire alarm system should indicate the origin of the alarm. The indications should be such that they can be easily, quickly and unambiguously related to the position in the building from which the alarm has originated. They should be clear both to staff who may have to assist in evacuation or fire-fighting, and to fire brigade personnel.

15.4.2 *Indications.* The primary indication of the origin of the alarm should be an indication of the zone of origin (see clause **7**). In very large premises a graded series of displays may be needed, with a central indicator panel specifying the sector of origin, and a further panel within the sector to show the zone of origin. Except in small premises, a display giving only the identification of individual detectors maybe difficult to interpret, and could lead to difficulties in assessing the spread of fire or the occurrence of secondary fires. Such a display, if provided, should be subsidiary to the main zonal display.

15.4.3 *Method of indication.* The method of indication should be developed to match the extent of the premises. Many variations are possible and desirable to meet different situations. The method used should ensure rapid location of the fire, and should enable decisions to be made as to which parts (usually fire compartments) need to be evacuated. Where one fire compartment is split into several zones, the indication should preferably show the absence of fire separation between those zones.

The location may be shown by one or more of the following.

(a) A display of letters and/or numbers, together with a suitable key (which may be a plan of the building).

(b) A permanent mimic diagram.

(c) A display of a mimic diagram on a visual display unit (VDU). Because the reliability of a VDU is considered suspect, a back-up provision should be made which may take the form of (a) or (b), a second VDU or a printer. Where a display depends on one or more VDUs, failure of a single VDU should not prevent location of the fire source.

(d) By other suitable means.

NOTE. Printers are not considered suitable as a primary indication, since in the event of ink, ribbon or paper being exhausted the indication will be lost. They may, however, be acceptable as a back-up to another display.

On or adjacent to the control and indicating equipment should be a diagrammatic representation of the building, showing at least the building entrances, the circulation areas and escape routes, and the division into zones. Where this is not provided by the display of (a) to (d) above, a correctly oriented plan of the premises should be displayed.

15.4.4 *Power.* Any power required for a display should be derived from the fire alarm system power supply and should be taken into account when assessing the capacity of the power supply.

15.5 Security

The operation of all manual controls and isolating devices should be limited to authorized personnel. Where this limitation is not provided on the control equipment (for instance, by the use of a key switch), then it may be provided by restricting access to the equipment by the use of a lock, a key-operated switch or, in a disciplined environment, by the use of a list of authorized personnel. Where controls need to be operated during a fire, access should not be controlled by a keyboard-entered code.

16 Power supplies

16.1 General

The vast majority of fire alarm systems rely for their operation on electrical power. No source of electrical power is totally reliable; every source will at some time fail, even if only for a limited period. The general principle on which the requirements for fire alarm power supplies are based is that the reliability with which a fire alarm system responds to a fire should as far as possible be unaffected by the unreliability of its main supply source. To this end, in all but very simple manual alarm systems, the main supply should be backed up by a standby supply able to support the system while the main supply is corrected. In general, a sufficiently high reliability is given by a normal supply from the public mains, backed up by an automatically connected battery-powered standby supply in case of main supply failure.

The duration and power required from the standby supply will depend on the purposes of the system, the extent of the facilities and the method of monitoring the normal supply. In most cases, standby supplies complying with **16.3** and **16.5** will be satisfactory, but there may be cases in which greater capacities would be required, for example premises in remote areas where more than 24 h might be needed to locate and repair a fault in the main supply.

If provision is made for a normal supply and a standby supply, then each should be capable of supplying the largest load to be placed on it under normal, fire and fault conditions. Care should be taken in the design of the power supply to ensure continuity of supply to the fire alarm system; transition between supplies should not cause momentary interruptions. Where devices such as fuses are fitted in order to protect power supplies, the operation of a single protective device should not interrupt both power supplies and cause the system to fail.

The condition of the normal supply should be indicated by a green lamp, lit when the normal supply is on.

16.2 Connection of a fire alarm system to a public or private power distribution supply

Any cable or apparatus directly connected to a public or private distribution supply should be in accordance with the current edition of the IEE Wiring Regulations (Regulations for Electrical Installations, published by the Institution of Electrical Engineers). Systems intended for operation from public supplies should be suitable for connection to the following types of power supply systems in accordance with the IEE Wiring Regulations:
TN-C, TN-S, TN-C-S, TT.

Connections to the mains supply should be via an isolating protective device (e.g. an isolating switch-fuse) reserved solely for the purpose, its cover coloured red and labelled 'FIRE ALARM: DO NOT SWITCH OFF'. The isolating protective device should be secure from unauthorized operation. It may be desirable for the isolating protective device to be contained in a securely closed box with a frangible cover.

An additional warning label should be provided, depending on whether the isolating protective device is fed from the live side or the dead side of the main isolating device. If fed from the live side, the label on the isolating protective device for the fire alarm system should read in addition: 'Warning: this supply remains alive when the main switch is turned off' and a label should be placed on the main isolating device reading 'Warning: the fire alarm supply remains alive when this switch is turned off'. If fed from the dead side, a label should be fixed to the main isolating device reading 'Warning: this switch also controls the supply to the fire alarm system'.

The design of the system should ensure that residual current devices are not necessary as a preventive measure against electric shock. However, in some cases the provision of such devices has been required as a condition of supply to the building; in such cases the protection should be so arranged that interruption of the general building supply in response to a fault on the general wiring does not result in interruption of the fire alarm supply.

It is important that the electricity supply to the fire alarm system should be so arranged that continuity of supply is ensured. Particular care should be taken where it is the practice to switch off the supply to the premises, for example, during maintenance of equipment, when unoccupied, or for economy in the consumption of electricity. The electrical design should ensure that such switching off of the power supply does not cause failure of the fire alarm system during the period of isolation (except possibly in unoccupied premises provided with a simple manual system).

In some systems more than one power supply unit may be provided, i.e. distributed power supplies. In such cases failure or disconnection of the supply to any individual unit should be indicated at the main indicator panel as a fault. Any switch that can disconnect the power supplies to all or part of the system should be coloured red and labelled 'FIRE ALARM: DO NOT SWITCH OFF'.

16.3 Types of power supply

16.3.1 *Normal supply.* The normal supply for the system should be derived from the public supply system, transformed or modified as necessary.

Where no public supply system is available, privately generated power may be used. The possible frequency and duration of breaks in such supplies should be investigated and taken into account in assessing the necessary capacity of the standby supply.

16.3.2 *Standby supplies*

16.3.2.1 *Secondary batteries.* The most commonly used type of standby supply is a secondary battery with an automatic charger. Where such a battery is used it should be of a type having a life of at least 4 years under the conditions of use likely to be experienced in the fire alarm system. Automotive lead-acid batteries (e.g. the type normally used for starting service in cars) are not generally suitable for fire alarm service and should not be used.

Because the life of the battery is frequently dependent on its charging conditions, care should be taken that the battery charger satisfies any requirements specified by the battery supplier. Where replacement batteries or battery chargers are used, similar care should be taken to ensure charging compatibility. Replacement cells should be compatible with the existing cells in both charge and discharge characteristics. The supplier of the system should specify a method of test that is likely to predict failure of the battery in the interval between routine tests.

Recommendations for battery capacities are given in **16.5**. The charging rate of the battery should be such that, having been discharged to its final voltage, the battery can be charged sufficiently to comply with the recommendations of **16.5** after a charging period of 24 h.

Recommendations for siting of batteries are given in **16.7**.

16.3.2.2 *Secondary batteries with standby generators.* In some premises, in addition to supplies taken from the public mains, a generator is provided which generates power continuously as part of the normal operation of the building. In other premises an emergency generator may be provided which should be automatically started on failure of the normal supply. Generators of either type may be used to replace partially the standby capacity recommended in **16.5.1** provided that in the event of failure of both the public mains supply and the locally generated supply the normal operation of the building cannot continue unless a supply is connected from some other source (such as a portable generator brought in for the purpose).

16.4 Maximum alarm load

16.4.1 *General.* The maximum alarm load is the maximum load imposed by the fire alarm system on a power supply under fire conditions. It will include the power required to operate the sounders, detectors, fault warning devices, the illumination of **15.3.3** and any ancillary services powered by the fire alarm system (see clause **19**), etc.

Normal and standby supplies should each be capable of supplying the maximum alarm load irrespective of the condition of the other supply.

The load imposed on the power supply by the simultaneous operation of detectors and/or manual call points should not cause an existing fire alarm to cease. In systems using microprocessors or stored programs, the imposition of the maximum alarm load should not cause incorrect operation.

16.4.2 *Automatic systems (types L and P).* The maximum alarm load for an automatic system is the power required to operate all the sounders simultaneously, together with any visible or audible indications at the control and indicating equipment, any power drawn for the operation and/or indication of ancillary systems and the transmission of signals to remote manned centres. Because of the possibility of the spread of fire products throughout the building, the system should be able to support the maximum number of detectors that can simultaneously give signals indicating fire, and the operation of manual call points in all zones.

16.4.3 *Manual systems (type M).* The maximum alarm load for a manual system is the power required to operate all the sounders simultaneously, together with any visible or audible indications at the control and indicating equipment, any power drawn for the operation and/or indication of ancillary systems and the transmission of signals to remote manned centres. Because of the possibility of the spread of fire products throughout the building, the system should be able to support the operation of manual call points in all zones.

16.5 Duration of the standby supply

16.5.1 *Systems installed primarily for life safety (type L)*

16.5.1.1 *Purpose.* In a system installed to protect life, the fire alarm system should be in an operating condition at all times that people are present on the premises. The standby supply should have sufficient capacity to maintain the necessary protection until the cause of the failure of the normal supply has been investigated and the supply restored, or until other measures have been taken for the safety of the occupants. The type of standby supply should comply with **16.3.2**.

16.5.1.2 *Supervised systems.* Premises in which the fire alarm system will be supervised at intervals of not more than 12 h, or that have a link over which a warning of failure of the normal supply can be given to a remote manned centre, should have a standby supply capable of maintaining the system in operation for at least 24 h, after which sufficient capacity should remain to provide an evacuation alarm in all zones for at least 30 min.

16.5.1.3 *Unsupervised systems.* In premises not supervised as described in **16.5.1.2**, the standby supply should be capable of automatically maintaining the system in normal operation for a period of not less than 24 h after the detection of a fault in the normal supply and the initiation of remedial action. If the building is likely to be unoccupied and the fire alarm system unsupervised for periods longer than 24 h, so that on reoccupation the standby supply could be exhausted and the system inoperable, then facilities should be provided to give protection for a period of at least 24 h after reoccupation, with sufficient capacity at the end of that time to sound an evacuation alarm in all zones for at least 30 min. These facilities may be manually connected, e.g. a spare fully charged battery could be manually switched in.

16.5.1.4 *Standby generators.* In systems using standby generators (see **16.3.2.2**), the initial 24 h standby recommendations of **16.5.1.2** and **16.5.1.3** can be reduced to the period which would be required to bring in and connect another source of power in the event of failure of both mains supply and local generator. In general, a period of not less than 6 h should be allowed, after which sufficient capacity should remain to provide an evacuation alarm in all zones for at least 30 min.

16.5.2 *Systems installed primarily to protect property (type P)*

16.5.2.1 *Purpose.* A system intended for property protection should provide correct operation at all times, but particularly when there are no people on the premises to provide manual detection. The standby supply should have sufficient capacity to maintain the system in operation until the fault is discovered and corrective action taken. The standby supply should normally consist of secondary batteries complying with **16.3.2.1.**

16.5.2.2 *Supervised systems.* Continuously attended premises, or premises having a link to a remote manned centre that can initiate action in the event of failure of the normal supply, should have a standby supply capable of maintaining the system in operation for at least 24 h, after which sufficient capacity should remain to provide operation of the alarm sounders for at least 30 min.

16.5.2.3 *Other systems.* In premises other than those described in **16.5.2.2**, the standby supply should be capable of maintaining the system in operation for at least 24 h longer than the maximum period for which the premises are likely to remain unattended, after which sufficient capacity should remain to provide operation of the alarm sounders for at least 30 min.

If unusually long unattended periods may occur, for example during a long holiday, the duration of the standby supply necessary to satisfy the recommendation above may be reduced by arranging for regular inspections of the premises at intervals such that in the event of failure of the normal supply at least 24 h standby supply capacity remains at the time of the next inspection. Thus if daily inspections are made, and assuming that failure occurs immediately after one inspection, it will take 24 h to detect the fault, at which time a further 24 h supply will remain; hence a total duration of 48 h will be needed.

16.6 Power supplies for manual systems (type M)

Power supplies for manual systems should generally comply with the recommendations of **16.1** to **16.5**. However, if the area covered by a manual system could fall within the limits of a single zone under the recommendations of **7.2** (other than item (f)), irrespective of how many zones are actually used, then power supplies complying with the recommendations of **G.7** may be used subject to the approval of the appropriate authority. The 'battery only' supplies described in **G.7**(d) and (e) should only be used if public or private electricity mains are not available.

16.7 Siting

16.7.1 *Central batteries.* Accommodation for central batteries should comply with BS 6132 or BS 6133.

If unsealed secondary cells are used then provision should be made for adequate ventilation. For large battery installations consideration should be given to the provision of a separate battery room or locked cabinet, preferably not containing any other services. The battery room or locked cabinet may also accommodate batteries of a similar type used for other purposes, but in such cases all equipment and wiring associated with the different systems should be separated so as to prevent a fault on one system from jeopardizing another. Where there is a risk of flooding, precautions should be taken to prevent flooding of the battery room.

Care should be taken to ensure that the structure can support the weight of all equipment.

A battery room or cabinet should be secured against unauthorized admission and should display notices indicating its purpose, the importance of not smoking and the need to use insulated tools and to remove metallic personal adornment (including wrist-watches with metal bracelets) to avoid accidental short-circuits.

16.7.2 *Fire risk.* To reduce the probability of the equipment being involved in a fire before adequate warning has been given, batteries and power supply equipment should be sited in areas of low fire risk. If the system uses automatic detectors then the areas in which the equipment is sited should be covered by the detection system.

16.7.3 *Multiple occupancy buildings (X).* If separate occupancies with a common fire alarm system exist in a building, then arrangements should be made for the continuity of power supplies and for rectification of any failure. These arrangements may require equipment to be sited in an area of common access.

17 Cables, wiring and other interconnections

17.1 General

The satisfactory operation of a fire alarm system depends very much on the interconnections between its components. Unless these interconnections operate correctly when required a system will not fulfill its functions.

It is essential that connections between detectors or call points and the control equipment are functioning correctly when a fire occurs. The control equipment should be able to maintain the alarm without a continued signal from the detector or call point, i.e. destruction of the connection after the initial operation would not affect the sounding of the alarm.

Most connections, other than those to detectors or call points, will be required to function correctly for significant periods during a fire. Such connections include those by which power is supplied to the control equipment, and those linking the control equipment to the alarm sounders.

Where multicore cable, flexible cable or flexible cord are used for interconnections in fire alarm circuits, none of the conductors should be used for circuits other than those of fire alarms.

The components of most fire detection and alarm systems are connected by cables and wiring but it is possible to connect by other means such as radio or fibre optics. The recommendations for radio-linked systems are given in clause **18.** Where fibre optic cables are used they should comply with **17.6**, except item (d).

In practice no system can have total reliability, but one of the objectives of good system design is to reduce the

probability of the system being inoperative in the area of a fire when the fire starts. This probability has three elements: the probability that a fault occurs, the amount of the system it puts out of operation and the time taken from its occurrence to its repair (the 'down time').

The probability of an interconnection fault can be reduced by the use of adequately strong cables, by correctly positioning cable paths, by the provision of mechanical protection at vulnerable points and by the provision of alternative signal paths. The amount of the system put out of operation depends on the extent of individual circuits. Monitoring of connections does not ensure that the fire alarm system will remain effective at all times, but is essential in reducing the 'down time'. It gives a warning that damage has occurred, and thus allows the repair process to be initiated and hence reduces the period for which the system is inoperative. Monitoring of circuits and mechanical protection are complementary precautions, rather than alternatives.

If the fault is due to fire, monitoring can give no protection, since no time will be available for repair. If an interconnecting cable itself has insufficient resistance to fire, then the circuit should either be arranged to have alternative signal paths or additional physical protection of the cables should be provided.

In some systems data flowing between components may be multiplexed by one of a variety of data transmission methods. The environment within which these signals are passed may have a significant effect on the permissible types of interconnections. Examples of possible problem areas are as follows:

(a) electrical noise corrupting transmitted data;

(b) incorrect choice of cable for the speed of data transmission;

(c) fracturing of fibre optic cable due to vibration, etc.

Where failure of a cable will not result in the failure of any alarm either within the premises or at a remote manned centre there are no restrictions on either the cable or its protection in this Part of BS 5839.

17.2 Applications

A wide variety of different cables can be used in various parts of a fire alarm system. However, because of their varying abilities to resist both fire and electrical or mechanical damage, many of these cables may be restricted in their suitability for specific applications.

The applications are classified according to the need for fire protection as follows.

(a) *Applications in which prolonged operation during a fire is required.* Cables used for the interconnection of components of a fire alarm system and required to continue to operate after a fire is first discovered (e.g. sounders, control and indicating equipment and power supplies) unless they are protected against cable failure as detailed in **17.15**. Cables used within the protected premises for the transmission of the alarm to a remote centre should be included in this class. In general it may be assumed that interconnections between sounders, control and indicating equipment and power supplies which can resist fire for at least 0.5 h will be satisfactory. In special cases, however, a longer period may be required (for example in buildings with a two-stage alarm system). 1

(b) *Applications in which prolonged operation during a fire is not required.* Cables which are not required to continue for appreciable periods after the fire is discovered or they are attacked by fire. These cables will usually be only those to detectors or call points, but may also include those to ancillary devices (such as door holders) in which failure of the cable due to a fire will not lead to a dangerous condition.

17.3 Recommended cable types

The following types of cable are recommended, subject to the restrictions on their use and the recommendations for further protection given in **17.4** and **17.5**:

(a) mineral-insulated copper-sheathed cable complying with BS 6207, with or without an overall PVC sheath;

(b) cables complying with BS 6387, meeting at least the requirements for categorization as AWX or SWX; 1

(c) cables complying with BS 6387, meeting at least the requirements for categorization as A or S;

(d) PVC-insulated and sheathed cables complying with BS 6004;

(e) PVC-insulated non-sheathed cables complying with BS 6004;

(f) general-purpose elastomer-insulated textile-braided and compounded cable complying with BS 6007;

(g) PVC-insulated cable of types BK, BR and BU complying with BS 6231;

(h) PVC-insulated and sheathed steel-wire-armoured cable complying with BS 6346;

(i) sheathed steel-wire-armoured cables with cross-linked polyethylene or hard ethylene propylene rubber insulation complying with BS 5467;

(j) polyethylene-insulated PVC-sheathed coaxial cable, with a central conductor of not less than 16 strands/0.2 mm in diameter, but otherwise complying with the dimensional requirements of BS 2316 : Part 3 for Uniradio Sheet M210;

(k) cables designed for the detection of heat.

Where cables are to be installed under conditions of unusually high or low ambient temperature, the recommendations of **17.14** should be observed.

NOTE. Silicone rubber insulated cable with a composite PVC/aluminium sheath was included as a separate category in BS 5839 : Part 1 : 1980. This type of cable should now comply with BS 6387 and hence would be covered under items (b) or (c).

17.4 Protection from fire

17.4.1 *Applications not requiring prolonged operation during a fire.* Where prolonged operation during a fire is not required, any of the cables listed in **17.3** may be used without additional fire protection.

Cables designed for the detection of heat (see **17.3**(k)) or coaxial cable (see **17.3**(j)) may be used for the interconnection of detectors within a zone, provided that the system is such as to give a fire alarm in response to the occurrence of fire at such a cable.

17.4.2 *Applications requiring prolonged operation during a fire.* Cables required to continue to operate during exposure to fire should be either as described in item (a) or (b) of **17.3**; cables other than these may be used in applications requiring prolonged operation during a fire provided they are protected against exposure to the fire by either:

(a) burial in the structure of the building and protection by the equivalent of at least 12 mm of plaster; or

(b) separation from any significant fire risk by a wall, partition or floor having at least 0.5 h fire resistance as ascertained by compliance with any of the following:

(1) specifications tested or assessed under the appropriate Part of BS 476;

(2) other appropriate British Standard specifications;

(3) specifications referred to in building legislation applicable for the building.

NOTE. The mechanical protection of cables by conduit, ducting or trunking should not be considered to give protection against fire.

Where appropriate, compliance is for integrity and insulation. The test by fire is considered to be applied to the side of the construction remote from the cable.

17.4.3 *Reduced protection.* Where possible, cables should be routed through areas of low fire risk. Where cables pass through areas of very low fire risk or where cables are protected by an automatic extinguishing system or sprinkler installation, a reduction in the degree of fire protection recommended may be acceptable following consultation with interested parties (see **4.3**).

17.5 Protection of cables from electrical or mechanical damage

17.5.1 *Electrical protection.* Mineral-insulated copper-sheathed cable (see **17.3**(a)) should be electrically protected by ensuring that associated equipment complies with the cable manufacturer's requirements for voltage surge suppression.

Polyethylene-insulated coaxial cable (see **17.3**(j)) should not be used with nominal voltages exceeding 50 V.

Cables designed for the detection of heat (see **17.3**(k)) should be used within their manufacturer's ratings.

17.5.2 *Mechanical protection.* Some of the types of cable listed in **17.3** are not sufficiently robust to withstand the mechanical hazards which they may experience in practice, such as impact, abrasion or attack by rodents. In order to protect such cables from damage both during and after installation, it will be necessary to provide mechanical protection by installation in conduit, ducting or trunking (see **17.8**) or by laying the cable in a channel.

The following recommendations should be followed:

(a) cable as described in **17.3**(a), (h) or (i) may be used without mechanical protection;

(b) PVC-insulated non-sheathed cable (see **17.3**(e)) should always have mechanical protection;

(c) cables other than those described in **17.3**(a), (e), (h) or (i) should be given mechanical protection if:

(1) they are not monitored; or

(2) they are less than 2.25 m above the floor; or

(3) physical damage or rodent attack is likely.

The above recommendations for resistance to mechanical damage would be expected to be sufficient for most applications. However, where particularly arduous conditions might be experienced (such as impact by fork-lift trucks), it may be necessary to provide additional protection designed to meet the expected hazards.

Where it is appropriate to use armoured cable to protect against physical damage, the cables described in **17.3**(h) or **17.3**(i) should be used.

17.6 Alternative cables

Types of cable or cable system other than those described in **17.3** may be used only if it can be shown that, in the application in which they are to be used, all the following apply:

(a) their resistance to heat and fire is not less than that of the types described in **17.3** and recommended by **17.4** as suitable for the application;

(b) their resistance to ambient conditions, including resistance to mechanical impact and abrasion, is not less than that of the types described in **17.3** and recommended by **17.5** as suitable for the application;

(c) they are not prone to faulty assembly or installation;

(d) their electrical properties under both normal and fault conditions are suitable for the application;

(e) they are operated within their manufacturer's ratings.

Where possible, alternative types of cable should be certified or approved as satisfactory for their application under a recognized certification or approval scheme.

17.7 Conductor sizes

In selecting conductor sizes, regard should be paid to physical strength and to limitations imposed by voltage drop. Voltage drop down a cable should not be such as to prevent devices from operating within their specification limits, even under minimum supply and maximum load conditions. Consideration should be given to any possible extensions to the system.

Unless otherwise recommended, conductors should be of copper, each having a cross-sectional area of not less than 1 mm^2, or, if stranded, not less than 0.5 mm^2. Cables having a total conductor cross-sectional area of less than 1 mm^2 should not be drawn into conduit. Where twisted-pair cable constructions are used and the pair is contained within a common insulating sheath, individual conductors having cross-sectional areas down to 0.5 mm^2 may be used.

17.8 Conduit, ducting and trunking

If fire alarm cables are run in conduit, either screwed metal or rigid PVC conduit may be used. Rigid PVC conduit should comply with classification 405/1 or 425/1 of BS 6099 : Section 2.2 (but see the ambient temperature recommendations of **17.14**).

If fire alarm cables are run in trunking or ducting, then either metal trunking or ducting, or non-metallic ducting

or non-flame propagating trunking complying with BS 4678 : Part 4 should be used. It should be noted that the flame propagation test does not necessarily indicate the ability of the trunking to maintain the circuit integrity under fire conditions.

Other types of conduit, ducting or trunking may be used only if it can be shown that, in the application in which they are to be used, their resistance to ambient conditions including resistance to mechanical impact and abrasion is not less than that of the types specified as suitable for the application, and they are not prone to failure due to faulty assembly or installation.

17.9 Joints

All joints, except those in detectors, call points, sounders, control and indicating equipment or other similar system components, should be enclosed in suitable junction boxes labelled 'FIRE ALARM' to avoid confusion with other services. Jointing and termination methods should be chosen to minimize any reduction in reliability and resistance to fire below that of unjointed cable.

17.10 Segregation of wiring

Conductors carrying fire alarm power or signals should be separated from conductors used for other systems. The separation may be by one or more of the following:

(a) installation in conduit, ducting, trunking or a channel reserved for fire alarm conductors;

(b) a mechanically strong, rigid and continuous partition of non-combustible material;

(c) mounting at a distance of at least 300 mm from conductors of other systems;

|| (d) wiring in cables complying with BS 7629;

(e) wiring in mineral-insulated copper-sheathed cable (see 17.3(a)) with an insulating sheath or barrier. The exposed-to-touch rating of the IEE Wiring Regulations should not be exceeded.

If a cable which should be segregated from cables of other services is not enclosed in ducting, trunking or a channel reserved for fire alarm circuits, then it should be suitably marked or labelled at intervals not exceeding 2 m to indicate its function and the need for segregation. Ducting, trunking or a channel reserved for fire alarm circuits should be marked to indicate this reservation. The fire alarm cable should be completely enclosed when the cover of the ducting, trunking or channel is in place, and all covers should be securely fixed.

Segregation of the fire alarm power supply cables need not be applied on the supply side of the isolating protective device (see 16.2). Cables carrying power in excess of extra-low voltage should be separated from other fire alarm cables. In particular, the mains supply cable should not be brought in through the same cable entry as cables carrying extra-low voltage power or signals.

17.11 Telecommunication cables

Public telecommunications operator lines used for the transmission of alarms to the fire brigade should be mechanically protected (see 17.5.2) and should be considered as needed to give prolonged operation in a fire (see 17.4.2).

17.12 Overhead lines

Overhead lines should be avoided wherever possible for fire alarm system interconnections. If they are used, BS 6701 : Part 1 should be followed. If overhead lines cross or are installed in close proximity to electricity power lines, public telecommunications operator lines or other overhead lines, agreement relating to protection should be reached with the appropriate operator.

17.13 Damp, corrosive or underground locations

Cables intended for installation in damp, corrosive or underground locations, or in plasters or cements having a corrosive effect on metallic sheathing, should be PVC-sheathed overall. Where the environment may attack PVC, a suitable alternative sheath should be adopted. In some locations further protection may be necessary.

17.14 Ambient temperatures

Care should be taken that the combination of ambient temperature and temperature rise caused by load current does not result in a conductor temperature which exceeds the limit for the insulation.

Where high conductor temperatures are anticipated, cables having appropriate heat-resisting insulation should be used, such as:

(a) 85 °C rubber-insulated cable complying with table 1 or 5 of BS 6007 : 1983;

(b) 150 °C rubber-insulated cable complying with table 6 of BS 6007 : 1983;

(c) 85 °C rated PVC-insulated cables complying generally with BS 6004 but having type 4 or 5 insulation and sheath complying with BS 6746;

(d) 90 °C rated XLPE- or EPR-insulated cables complying with BS 5467 or BS 6724.

PVC conduit should not be used where the ambient temperature is likely to exceed 60 °C. Where temperatures below −5 °C for classification 405/1 of BS 6099 : Section 2.2 or −25 °C for classification 425/1 of BS 6099 : Section 2.2 are likely, suitable precautions should be taken to avoid physical damage.

17.15 Systems protected against cable failure

If circuits are protected against single cable faults (see 6.6.5) then a reduced standard of cable protection may be acceptable. If the design is such that a single fault on the interconnections between components will:

(a) at most have an effect on the components immediately adjacent to the fault;

(b) not affect the correct working of the remainder of the system;

(c) give a fault warning as recommended in **6.6.5**;

(d) indicate that section of the cabling affected by the fault;

then any of the cables described in **17.3** can generally be allowed for any application.

Care should be taken in the planning and siting of cable runs for such systems so that a fire restricted to a single fire compartment cannot so damage the cable as to prevent the correct operation of devices in any other compartment. If such siting cannot be avoided, then wiring able to withstand prolonged exposure to fire should be used within the critical compartment(s).

18 Radio-linked systems

18.1 General

18.1.1 *Radio links.* Some alarm systems are available in which some or all of the interconnections between components are made by radio links. Because of the special properties of radio signals, some of the recommendations applicable to wired systems, particularly those for power supplies and fault monitoring, are unsuitable for, or cannot be applied to, radio-linked systems. In such systems the recommendations of this clause should be followed.

18.1.2 *Choice of system.* Radio-linked systems have both advantages and disadvantages. Before adopting such a system for any specific application, the advantages and disadvantages should be carefully considered so that a correct choice of system can be made.

18.1.3 *Advantages of radio-linked systems.* The advantages of radio-linked systems include the following.

(a) Since, in general, no wiring is needed between system components, the system can be much easier, quicker and cheaper to install. The system can extend beyond a single building without inter-building wiring, provided that the buildings are in the same ownership and no third party is involved. Disruption of normal activities during installation is minimized, and the system can be easily modified or extended.

(b) The absence of wiring means that damage or disfigurement of existing surfaces is kept to a minimum. This can be particularly important in dealing with buildings having valuable or historic decoration.

(c) Individual identification of each detector or call point is a normal feature of radio-linked systems.

(d) Radio links will function without impairment in a fire, reducing the need for fire-protected cables.

(e) On some systems, radio-linked repeater indicator panels can be easily added as required elsewhere in the building.

(f) Short-term temporary cover of special risks can be easily arranged.

18.1.4 *Disadvantages of radio-linked systems.* The disadvantages of radio-linked systems include the following.

(a) Because limitations of allowed frequency spectrum can lead to interference between simultaneous signals, it is considered unwise to send monitoring signals at very frequent intervals. Hence for some (but not all) faults, there may be a significant delay (possibly several hours) between the occurrence of a fault and its indication on the control equipment.

(b) Radio links cannot transfer significant amounts of power. Each detector, call point or sounder has to be supplied with local power, either from local mains or from batteries.

(c) There is a possibility of the radio path being interrupted by temporary or permanent screening. This should be indicated as a fault, but in the interval before the fault is indicated (see **18.3**) the area could be unprotected. The problem becomes more important when screening affects several detectors in one area.

(d) The possibility exists that the receiver may be blocked by interfering signals from other sources. Radio alarm systems operate on frequencies which are not protected by the regulatory body from other interfering signals on those frequencies.

NOTE. The possibility of interference from other sources can be much reduced by proper receiver design, for instance by a suitably narrow receiver bandwidth, or by redundancy techniques in the transmission.

18.2 Power supplies

18.2.1 *Power supplies for control and indicating equipment.* Power supplies for control and indicating equipment (other than repeater panels) should comply with the recommendations of clause **16.**

18.2.2 *Power supplies for sounders and repeater indicator panels.* Power supplies for sounders and for repeater indicator panels should comply with the recommendations of clause **16**, except that the normal supply may be derived from the local mains supply, which need not have an isolating protective device (see **16.2**). Failure of the normal supply to a sounder or repeater panel should give a fault warning at the main control and indicating equipment.

18.2.3 *Power supplies for detectors and manual call points.* Power supplies for detectors and manual call points should be derived from either:

(a) the normal mains supply plus a reserve battery (primary or continuously charged secondary); or

(b) a primary battery plus a reserve second primary battery. The primary battery used for the normal supply should have an operational life of at least 1 year. If intended to be replaceable by the user the battery should be of a type readily available from electrical suppliers.

Power supplies having one or more primary batteries should give at least 30 days warning of impending failure of any primary battery. This warning should be by a fault

indication at the control and indicating equipment. It should not be possible to cancel this warning permanently. If the warning is cancelled without the fault being corrected, the warning should resound within 4.5 h. In the event of total failure of the power supply to a detector or call point the warning given should be distinguishable from that indicating impending failure.

18.3 Radio links

Systems in which radio links are used to connect together part or all of the components should be security coded (in such a way as to prevent interaction between separate systems) and should operate on frequencies allocated by the Department of Trade and Industry (DTI) on the low power telemetry and telecontrol bands. Equipment should conform to the appropriate DTI specifications.

Links should be monitored in such a way that the failure to receive a signal from a detector, call point, sounder or other remote component will be indicated at the central control and indicating equipment within a period of 4.5 h from the occurrence of the fault.

18.4 Installation

18.4.1 *Initial signal strength.* During installation steps should be taken to ensure that signals produce adequate signal strength at the relevant receivers.

The manufacturer should specify methods by which it can be assured that the signal strength is adequate and the signal type suitable for reliable operation in the environment in which the system is installed, including any possible interfering signals of similar type either from within the protected premises or from other premises.

18.4.2 *Variations of signal strength.* Changes in the buildings structure or content after installation can cause fluctuations in the received signal strength, particularly where the changes include the introduction of large areas of metallic screening across the signal path. Where this is likely, for example, in a loading bay handling metal drums, precautions should be taken to ensure signal continuity, for instance by the use of remote aerials or repeater amplifiers. Particular care should be taken where the changes could lead to simultaneous loss of signals from several detectors.

18.4.3 *Cabling.* Where cables are used in the system, for instance for power supplies or to take signals to remote aerials, they should comply with the recommendations of clause 17.

19 Ancillary services

Subject to any overruling consideration, safety factors and consultation with the relevant authority, the fire alarm system may be designed so that detectors and/or call points, in addition to giving an alarm and calling the fire brigade, will close or open circuits of ancillary services by means of relays or similar devices. Examples of such services are as follows:

(a) actuation of fixed fire-extinguishing systems;

(b) closing of windows, smoke and fire doors;

(c) control of ventilating systems;

(d) covering of tanks containing flammable liquids and controlling their valves to isolate the contents from direct contact with the fire, etc.

Means of temporarily disabling an item or items of ancillary equipment for routine servicing or maintenance of that equipment may be provided such that it does not affect the operation of the fire alarm system.

If operation of the fire alarm system during servicing or testing may have undesirable effects on ancillary equipment, then means should be provided for disabling the automatic operation of the ancillary equipment. The disablement may take the form of a transfer from automatic to manual operation. A visual indication of disablement should be provided.

Power supplies to ancillary services should be such that the power supply to the fire alarm system is not prejudiced. Whilst indications of the state of ancillary systems, and ancillary systems which take power only when there is a fire, may be operated from the fire alarm supply, ancillary systems which take power (other than for indicators) in the non-fire state should not be operated from the fire alarm supply. Any additional loads taken by ancillary systems should be taken into account in the calculations of power supply capacity.

20 Radio and electrical interference

20.1 Generated interference

Alarm systems should be so designed and installed that they do not cause radio interference in excess of the limits specified in BS 800.

20.2 Received interference

Particular care should be taken in the design and installation of the fire alarm system to avoid interference from other equipment (including radio transmitters such as portable telephones), external sources such as lightning, or power transients. Such interference may affect the normal operation of the fire alarm system.

Section three. Workmanship, installation and commissioning

21 Work off site

21.1 Verification

Arrangements may be specified in the contract for pre-delivery inspection of the equipment, including operational tests, to be carried out on the supplier's premises in the presence of the purchaser's representative.

21.2 Packing

The materials and components should be protected and packed suitably for the method of transport to the site and storage on site. Individual packing cases should be of a size and weight suitable for convenient handling, and labelled so that individual units can be readily identified on site without being unpacked. Equipment intended to be mounted in enclosures that will be recessed into walls should be arranged so that it need not be removed from its packing or wrapping until it is fixed into its permanent enclosure. It is essential that equipment containing radioactive materials (see appendix E), corrosive liquids or other hazardous materials should be clearly labelled to emphasize the risk of damage during transportation or storage on site.

22 Work on site

The work on site should consist of the following:

(a) siting and accommodation of control equipment, power supplies, sounders, visual alarms, detectors and manual call points;

(b) cabling and wiring, including the provision of channels, ducts, conduits and trunking;

(c) installation of equipment;

(d) inspection, initial testing, commissioning and certification.

23 Siting and accommodation

23.1 General

Siting of equipment should comply with the relevant recommendations of clauses **9**, **10**, **12**, **13**, **15** and **16**.

Care should be taken in planning the accommodation for the equipment to ensure that the structure can accept the necessary loadings, and that heavy or bulky equipment can be readily transported to or from its installed position. Access to equipment in service should be provided to allow it to be kept in a clean condition, and to be easily maintained.

Where provision is not made on the control equipment, provision should be made adjacent to it for the following items:

(a) the diagrammatic representation of **15.4.3**;

(b) operating instructions for the correct action in the event of a fire or fault indication;

(c) the log book (see **28.2.2**).

* In preparation (revision of CP 413).

23.2 Protection against lightning

All metallic parts of the system, including conduit, trunking, ducting, cabling and enclosures, should be well separated from any metalwork forming part of a lightning protective system. Further guidance is given in BS 6651 : 1985, in particular in clause **18** and in **A.2** of that standard.

23.3 Hazardous areas

Siting of equipment and routing of cables should take account of any special hazards which might exist in the area when the building is occupied. Such hazards might imperil either the system or personnel working in the area. In locations having a potentially explosive atmosphere the recommendations of **6.5** should be followed.

24 Installation of cables and wires

24.1 Cable ducts, channels and trunking

24.1.1 *General.* Where fire alarm systems are to be installed in new buildings, ducts and channels may be required in the structure. Ample facilities should be provided for drawing cables into ducts and into conduits or trunking installed in ducts. Conduit and trunking sizes should be such as to permit easy drawing in and out of the cables concerned; it is advisable to allow space for future extensions. Where necessary, access should be provided by means of suitably located removable or hinged covers.

The fire alarm systems initially installed in a building may, during the life of the building, require additions, modifications,or replacement. In order to avoid alteration to the finished structure, careful consideration should be given at the planning stage to the size and layout of ducts, chases, etc., so that they may, as far as can be foreseen, provide an adequate degree of flexibility for both initial requirements and additions and modifications. If conduit, ducting, trunking or other enclosures are to be buried in the building structure, then provision should be made for any foreseen additions to be carried out without change to the finished building structure.

Ease of maintenance and adequate protection against mechanical damage and unauthorized interference are also of importance. Reference should be made to BS 8313* which deals with the design and construction of ducts, chases, etc. for the accommodation of services. Where surface boxes are likely to be subject to unauthorized interference, the boxes should not be predrilled or be of a type incorporating 'knock-out' cable entries.

24.1.2 *Vertical ducts.* Vertical cable ducts should be continuous throughout the height of a multi-storey building (but see **24.3**) and their position and number should allow convenient lateral distribution on each floor. Provision for the support of cables at frequent intervals is necessary.

24.1.3 *Horizontal ducts and channels.* Horizontal ducts or channels may be required between the control point and vertical ducts and from vertical ducts to the various rooms, etc. These may be formed within the structure or provided by means of conduit or trunking concealed or surface mounted as appropriate.

24.2 Cable holes

24.2.1 *External walls.* Where a cable passes through an external wall a smooth-bore sleeve of metal or other non-hygroscopic material should be sealed into the wall. It should slope downwards towards the outside and should be plugged with a suitable non-hardening waterproof compound to prevent the entry of rain, dust or vermin. Care should be taken to ensure that the ends of the sleeve are free from sharp edges to guard against damage to cables during installation.

24.2.2 *Internal walls.* Where a cable passes through an internal wall a smooth clearance hole should be provided. If additional mechanical protection is necessary then 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 to guard against damage to cables during installation.

24.2.3 *Floors.* The considerations for external walls (see **24.2.1**) apply similarly to floors, but the sleeve should extend as far above floor level as is required for protection of the cable it is to carry, and in any case not less than 300 mm. Where a cable passes through a horizontal structural element external to the building, the hole should be plugged with a suitable non-hardening waterproof compound to prevent the entry of rain, dust or vermin.

24.3 Precautions against spread of fire

24.3.1 *Fire stopping round ducts, etc.* Where cables, conduits, ducts, channels or trunking pass through floors, walls, partitions or ceilings, the surrounding hole should be as small as reasonably practical and made good with fire-stopping material to the full thickness of the floor, wall etc. Spaces through which fire or smoke might spread should not be left around the cable, conduit, duct, channel or trunking.

24.3.2 *Fire stopping inside ducts, etc.* In addition to the recommendations of **24.3.1**, if cables, conduits or conductors are installed in channels, ducts, trunking or shafts that pass through floors, walls, partitions or ceilings, then barriers with the appropriate level of fire resistance should be provided inside the channels, etc. to prevent the spread of fire.

If cables or wires are run in ducts which penetrate walls or floors required to provide fire-resisting separation, and the ducts are formed of construction having at least the same fire resistance as that required of the walls or floors, then the cables or wires need only be fire-stopped where they pass into and out of the ducts. If the cables or wires are in trunking, or if the duct construction has a lesser standard of fire resistance than the structure penetrated, then the ducts or trunking should be fire-stopped at the points where they pass through the walls or floors; the standard of fire-stopping should be such as to maintain the fire resistance of the walls and floors at the required level.

24.4 Cabling and wiring

24.4.1 *General.* The installation should be undertaken generally in accordance with the latest edition of the IEE Wiring Regulations.

NOTE 1. Although those parts of the fire alarm system connected to a safety source are specifically excluded from coverage by the IEE Wiring Regulations, the general principles of good practice in wiring installations outlined in the regulations should be followed throughout the fire alarm system.

The recommendations of **16.2** and clause **17** should be observed. Precautions should be taken where cables or metallic conduits are installed in damp or corrosive situations.

NOTE 2. Some plasters and cements have a corrosive effect on metals.

24.4.2 *Cables and wires.* The cables and wires should be of a type recommended for the purpose in clause **17**. It is essential that the cable manufacturer's instructions with respect to voltage surge suppression are followed implicitly. All terminations should be carried out by a competent person.

If multi-core cables are used it may be advisable to install cable having spare cores to avoid the necessity of running extra cables at a later date, or the risk of this not being done on the grounds of undue cost. Such provision should allow for conductor current carrying capacity related to use of the additional cores.

24.4.3 *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 labelled 'FIRE ALARM' to avoid confusion with other services. Jointing and termination methods should be chosen to minimize any reduction in reliability and resistance to fire below that of the unjointed cable.

24.4.4 *Surface wiring.* Surface-laid cables should be neatly run and securely fixed at suitable intervals.

24.5 Earth continuity

Where metallic conduit, ducting or trunking is used it should be of a type which will ensure earth continuity and mechanical rigidity throughout.

If metallic conduit or the metallic sheath of a cable is intended to serve as a protective conductor and terminates at an insulated equipment enclosure, then care should be taken to provide an adequate connection to any earthing terminal provided within the insulated enclosure and/or an adequate bridging link to any other metallic conduit or metallic cable sheath terminating at the enclosure.

Where metallic conduit terminates at a thin-walled metal enclosure, connection should be made by using a thick-walled or flanged conduit coupler with a suitable locking washer. Care should be taken to ensure electrical continuity by removal or penetration of non-conductive paint or other coating at the interface between the enclosure and conduit coupler. The location of the connection to the enclosure should be protected against rust or corrosion after making the connection.

25 Installation of equipment

25.1 Delivery and storage

To reduce the risk of damage and deterioration, equipment, apparatus and material should not be delivered until installation can proceed, unless suitable storage accommodation has been arranged.

25.2 Protection

Adequate steps should be taken at all times to protect the finish of equipment during the construction and installation period. Particular attention should be paid to protection of equipment enclosures against ingress of dust and moisture.

25.3 Secondary batteries

Cells of secondary batteries should be fitted and charged in accordance with the manufacturer's instructions.

25.4 Radioactivity

If detectors contain radioactive material, then the installer may have responsibilities under legislation (see appendix E).

26 Inspection, initial testing, commissioning and certification of systems

26.1 Record drawings and operating instructions

On completion of the installation, adequate instructions on its use, routine attention and test procedures should be supplied to the person responsible for the use of the premises. The installer should draw the attention of the user to those clauses of this Part of BS 5839 that may reflect on the use of the fire alarm system, and in particular those clauses dealing with false alarms (clause **14**) and user responsibilities (clauses **28** and **29**).

The installer should supply the user with a log book and a certificate of installation and commissioning (see **28.2.2** and appendices B and D).

Drawings should be provided to the user showing, for maintenance and record purposes, the position of the various items of equipment, junction boxes, etc. and the sizes and routes of all cables and wires. Particular attention should be paid to the locations of items needing regular attention or replacement. Wiring diagrams of junction boxes and distribution cases should be included. The records should be permanent and suitable for convenient reference. They should be prepared in accordance with BS 1635 and should be updated to include any modifications or additions made to the system.

If the purchasing specification so requires, circuit diagrams of the fire alarm system and its components should be supplied in sufficient detail for the operation of the system to be understood by the technical staff of the user.

26.2 Inspection of installation

The complete installation should be inspected to ensure that the work has been carried out in a satisfactory manner, that the methods, materials and components used comply with this Part of BS 5839, and that the record drawings and operating instructions (see **26.1**) have been supplied.

26.3 Insulation of cables and wires

Insulation testing of installed cables and wires should be made at 500 V d.c. and the insulation resistance to earth and between conductors of the installed cables and wires should be in accordance with the IEE Wiring Regulations. Tests that might damage items of equipment, especially apparatus incorporating electronic circuits, should be carried out with the cables disconnected from the equipment. If access to the equipment would be difficult after final inspection, then the separate parts of the circuits may be tested during installation, but the completed circuit should also be tested at a voltage recommended by the manufacturer.

26.4 Earthing

Earth continuity and, where appropriate, earth-loop impedance, should be tested to ensure compliance with the IEE Wiring Regulations.

26.5 Commissioning test

The system should be tested to ensure that it operates satisfactorily and that, in particular:

(a) the alarm devices comply with the recommendations of clause **9**;

(b) all detectors and manual call points function correctly and initiate the correct operation;

(c) any connection to the fire brigade or remote manned centre operates correctly;

(d) any radio links have adequate signal strength (see **18.4**);

(e) any signals to ancillary equipment are given correctly.

26.6 Certification

The installer should certify that the installation complies with the recommendations of this Part of BS 5839 or, if deviations have been agreed (see **4.3**), a statement of these deviations should be given by the installer (see appendix B).

26.7 Handover

26.7.1 *Normal handover.* When commissioning and certification are complete, the system should be formally handed over to the user. Where possible, the responsible person (see **28.1.1**) should assure himself that all the necessary documentation has been completed before accepting the handover.

26.7.2 *Early handover without beneficial use.* In some cases the fire detection system will be handed over to the owner's agent before the remainder of a building project is complete. If the system is not to be put to immediate use, then provision should be made for regular standby maintenance to minimize damage arising from the activities of other trades, e.g. ingress of dust or grit arising from

plastering, floor sanding or painting, water seepage or exposure to the elements. Smoke detectors, door or damper release mechanisms and linkages are particularly vulnerable to a lowering of efficiency from these causes.

26.7.3 *Early handover with beneficial use.* If the fire detection system is to be handed over, in whole or in part, to be used before the building is finished, then the supplier's recommended maintenance programme should be instituted from the date of the handover.

If the work of other trades is likely to produce environmental conditions more severe than those expected in normal usage, then consideration should be given to an increased frequency and extent of maintenance. If the system is to perform in a life safety role prior to building completion, then provision should be made for regular testing. The system log book (see **28.2.2**) should be properly kept from the date on which the system is put into operation.

26.8 Operational audit

In large or complex systems it may be desirable that an operational audit is made after the system has been in operation for a time (usually a few months). This audit should cover the functioning and performance of the system, including such items as the ability of the operators to use the controls and indications, the logging of events and the efficiency of maintenance.

27 Extensions and alterations to existing systems

If the work is an extension of an existing installation, then the existing equipment should be thoroughly tested to ensure that it will function satisfactorily in conjunction with the new equipment and that the power supplies have adequate capacity to supply the additional load.

Prior to undertaking changes or extensions, consideration should be given to their effect on the performance of the existing system and agreement should be obtained from interested parties. Following completion of the alterations, inspection, testing, commissioning and certification should be carried out as recommended in clause **26**.

Changes to the system that might affect its response to fire or fault conditions should only be undertaken by competent personnel. However, it is acceptable for local information such as identification of zone or sensor locations to be altered by personnel authorized by the responsible person.

Where the operation of the system depends on a stored program, provision for changing this program should be carefully controlled. In general, program changes should only be made following discussions between the relevant organizations listed in **4.3**.

Section four. User responsibilities

28 General

28.1 Supervision

28.1.1 *Responsible person.* The owner or other person having control of the premises should appoint a responsible person to supervise the system. This person should be given sufficient authority to ensure the carrying out of any necessary work to maintain the system in correct operation, the maintenance of the records listed in **28.2** and the servicing recommended in clause **29**.

28.1.2 *Procedures.* Procedures should be laid down for dealing with alarms of fire (see **4.2**), fault warnings or taking part or all of the system out of service. These procedures should be approved by the appropriate fire authority before implementation.

28.1.3 *Training.* The responsible person should ensure that users of the system are instructed in its proper use, including the procedures described in **28.1.2**. Any members of staff who will be concerned with first aid fire-fighting should be instructed in the correct interpretation of the indications given, and their relationship with the building layout. All management, staff and, in most cases, long term occupants, should be instructed and practised in the proper actions to be taken in the event of fire.

28.1.4 *Liaison.* The responsible person should establish a liaison with those responsible for changes in or maintenance of the building fabric (including redecoration, etc.) to ensure that their work does not cause faults on, or otherwise interfere with the operation of, the fire alarm system. If structural or occupancy changes occur or are planned, then the responsible person should ensure that any necessary changes to the fire alarm system are considered at an early stage.

28.1.5 *Freedom from obstruction.* The responsible person should ensure that a clear space is preserved in all directions below every detector (see **12.2.9** and **12.2.10**) and that all manual call points remain unobstructed and conspicuous.

28.2 Records

28.2.1 *Drawings and instructions.* The record drawings and operating instructions supplied in accordance with the recommendations of **26.1** should be kept up to date and available for convenient reference, and preferably in the same location as the control and indicating equipment.

28.2.2 *Log book.* The responsible person should ensure that a log book (see appendix D) is kept in which the following should be recorded.

(a) The name of the responsible person.

(b) Brief details of any servicing arrangements.

(c) Dates and times of all alarms (genuine, practice, test or false) together with their causes where known. If alarms have been caused by the operation of a detector or manual call point, then the location of the device should be recorded if known.

(d) Dates, times and types of all defects and faults.

(e) Dates and types of all tests.

(f) Dates and types of all servicing (routine or special).

(g) Dates and times of all periods of disconnection or disablement.

(h) All alterations to the system.

The log book should be available for inspection by any authorized person.

In some micro-processor or computer based systems, an automatic log may be generated, either locally (e.g. on a printer) or remotely. Such logs can be of great assistance in tracing and correcting system problems. If no automatic log is available, a non-resettable electromechanical counter may form an effective means of encouraging reliable recording of all fire signal activations. If a counter is used, its reading should be recorded as part of the information of item (c).

28.3 Radioactivity

If detectors contain radioactive material, the user may have responsibilities under legislation (see appendix E).

28.4 Prevention of false alarms

28.4.1 *General.* Many false alarms are caused by operations in the vicinity of detectors, carried out either negligently or in ignorance. The responsible person should ensure that staff and visiting contractors are aware that the building is fitted with an automatic fire detection system.

28.4.2 *Notices.* Where possible, permanent notices should be displayed at the entrance to all areas in which detectors are sited. A suitable text is:

'This area is protected by automatic fire detectors. Before undertaking any work involving heat, flame, dust or sparks, clearance must be obtained from .....'

28.4.3 *Tenders and contracts.* Tender documents for contract work to be carried out in a protected area should contain a clause making the contractor responsible for informing his staff of the presence and purpose of the automatic detection system, and the precautions to be adopted when working.

Contracts should contain a clause making the contractor responsible for any charges levied following false alarms generated by the actions of his staff.

28.4.4 *Precautions against dust and smoke.* Where temporary work involving the generation of dust, smoke, paint spray, etc. is to be carried out in an area protected by smoke detectors, precautions should be taken to prevent false alarms or damage to the detectors by contamination. Suitable measures may include the following:

(a) temporary replacement of smoke detectors by heat detectors (not possible with all systems);

(b) provision of a temporary screen between the work area and the detectors;

(c) provision of temporary covers, such as plastic or paper bags, to prevent ingress of contamination.

All of these measures will, to a greater or lesser extent, impair the sensitivity of the system to fire. Experience has shown that the risk of fire is higher during periods of construction or maintenance, and therefore the provision of manual surveillance should be considered while such measures remain in force.

28.4.5 *Completion of work.* The responsible person should ensure that when the work is completed:

(a) any temporary screening or covering is removed;

(b) any residual dust is removed;

(c) any substituted smoke detectors are replaced;

(d) the system is properly reinstated.

After reinstatement, an operational check of the system should be made by a competent person.

29 Servicing

29.1 General

To give greater assurance of reliability, correct servicing is essential. Normally an agreement should be made with a manufacturer, supplier or other competent contractor for regular servicing. The agreement should specify the method of liaison to provide access to the premises. The name and telephone number of the servicing organization should be prominently displayed at the control and indicating equipment.

For premises in continuous use, e.g. hospitals, hotels and old people's homes, the agreement should preferably include a requirement that an engineer should be on call at all times, both during and outside normal working hours, and that telephoned requests for emergency service should be executed promptly. In any case, agreement should be made that repair services will be available within 24 h.

A servicing agreement should be made immediately on completion of the installation whether the premises are occupied or not.

If it is not possible to obtain service from engineers on call at all times, or if because of special circumstances no service contract has been arranged, then the responsible person should ensure that at least one person is employed who has had suitable experience of electrical equipment and who has had special training with the manufacturer, supplier or installer to deal with simple servicing. The employee(s) should be instructed not to attempt to exceed the scope of their training.

29.2 Routine attention

29.2.1 *General.* The responsible person should ensure that the routine attention and test procedures supplied under **26.1** are properly followed.

A general guide to the routine that should be adopted to ensure the continuing good operation of the system is given in **29.2.2** to **29.2.8**. The routine to be adopted in individual premises may vary with the use of the premises; equipment installed in corrosive or dirty conditions will need to be checked more thoroughly and at more frequent intervals than that in clean and dry situations.

In some equipment a proportion of the testing recommended in this clause is carried out automatically. In this type of equipment the manufacturer may specify an increase in the intervals between testing of certain functions, and in such circumstances the manufacturer's specification may be followed.

The responsible person should ensure that all equipment is properly reinstated after testing.

In some cases it may be desirable for special facilities to be incorporated in the system to assist in servicing, e.g. a low-level 'pip tone' can be used in some sounder systems to enable the sounders to be checked without undue disturbance of the occupants. Where synthesized or recorded speech messages are used, a monitor speaker near the control equipment may enable the message to be checked without operating the main sounders.' 1

29.2.2 *Prevention of false alarms of fire during routine testing.* It is important to ensure that operation during testing does not result in a false alarm of fire.

If the fire alarm system is connected to a 999 automatic dialling unit, then transmission should be prevented (for instance by disconnection) before the routine test is carried out, since under normal conditions 999 test calls are not permitted. In certain equipment using automatic dialling, it is possible to prevent transmission of signals by lifting a telephone receiver. Use of this function to inhibit transmission is deprecated, but where used the inhibited state should be indicated by the use of a notice on the control equipment.

If transmission of signals to a remote manned centre is prevented during test, a visual indication of this state should be given at the control equipment. If a link to a remote manned centre is to be used during the test, then it is essential to notify the centre before undertaking the test, unless a recognized test procedure is regularly carried out at an agreed time.

The occupants of the premises should be notified of any test of the system that may result in the sounders being operated.

29.2.3 *Daily attention by the user.* A check should be made every day to ascertain the following:

(a) that either the panel indicates normal operation, or if not, that any fault indicated is recorded in the log book and that the other actions recommended in **29.3.4** have been taken;

NOTE. In program controlled systems, failure to correctly execute software is indicated either on an event counter, or on an automatic reset indicator.

(b) that any fault warning recorded the previous day has received attention.

If any connection to the public fire brigade or other remote manned centre is not continuously monitored then it should be tested daily in accordance with the supplier's instructions.

NOTE. On 1 day each week the daily test will be incorporated in the weekly test.

29.2.4 *Weekly attention by the user.* The following tests should be made every week to ensure that the system is capable of operating under alarm conditions.

(a) At least one detector, call point or end of line switch on one zone should be operated to test the ability of the control and indicating equipment to receive a signal and to sound the alarm and operate any other warning devices. For systems having 13 zone or less, each zone should be tested in turn; if there are more than 13 zones then more than one zone may need to be tested in any week so that the interval between tests on one zone does not exceed 13 weeks. It is preferable that each time a particular zone is tested a different trigger device is used. An entry should be made in the log book quoting the particular trigger device that has been used to initiate the test. 1 1 1 1 1

If operation of the alarm sounders has been prevented by disconnection then a further test should be carried out to prove the final reinstatement of the sounders, and, if permissible, of the alarm transmission circuits.

(b) If the batteries are open or accessible, then a visual examination of the battery and its connections should be made to ensure that they are in good condition. Action should be taken to remedy any defect, including low electrolyte level.

(c) The fuel, oil, and coolant levels of any standby generator should be checked and topped up as necessary.

(d) Any printer should be checked to ensure that its reserves of paper, ink or ribbon are adequate for at least 2 weeks normal usage.

Any defect should be recorded in the log book and reported to the responsible person, and action should be taken to correct it.

29.2.5 *Monthly attention by the user.* If an automatically started emergency generator is used as part of the standby supply, then it should be started up once each month by a simulation of a failure of the normal power supply, and allowed to energize the fire alarm supply for a continuous period of at least 1 h. The fire alarm system should be monitored to identify any malfunctioning caused by the use of the generator. At the end of the test period the normal supply should be restored and the charging arrangements for the starting battery checked for proper functioning The fuel tanks should be left filled and the oil and coolant levels topped up as necessary.

NOTE. Frequent starting of the generator followed by a few minutes on-load is not recommended. It is important that when the engine is running, the generator is loaded to at least 50 % of the engine's capacity to prevent sooting up with resultant loss of performance.

29.2.6 *Quarterly inspection and test.* The responsible person should ensure that every 3 months the following check is carried out by a competent person.

(a) Entries in the log book should be checked and any necessary action taken.

(b) Batteries and their connections should be examined and tested as specified by the supplier (see **16.3.2.1**) to ensure that they are in good serviceable condition and not likely to fail before the next quarterly inspection.

(c) Where applicable, secondary batteries should be examined to ensure that the specific gravity of electrolyte in each cell is correct. Any necessary remedial action should be taken.

(d) Primary batteries, including reserves, should be tested to verify that they are satisfactory for a further period of use by taking measurements that are indicative of the conditions of each cell, e.g. its voltage on a known and very high rate of discharge. The test conditions and the significance of the readings will depend on the type of cell and the use to which it is being put. These should be clearly specified by the supplier or commissioning company and applied with care. Primary batteries should in any case be replaced within the period of shelf life stipulated by the battery manufacturer.

(e) The alarm functions of the control and indicating equipment should be checked by the operation of a detector or call point in each zone as described in **29.2.4**. The operation of the alarm sounders and any link to a remote manned centre other than a 999 autodialler should be tested. All ancillary functions of the control panel should also be tested where practicable. All fault indicators and their circuits should be checked, preferably by simulation of fault conditions. The control and indicating equipment should be visually inspected for signs of moisture ingress and other deterioration.

(f) A visual inspection should be made to check whether structural or occupancy changes have affected the requirements for the siting of manual call points, detectors and sounders. The visual inspection should also confirm that a clear space of at least 750 mm is preserved in all directions below every detector, that the detectors are sited in accordance with clauses **12** and/or **13** and that all manual call points remain unobstructed and conspicuous.

(g) All further checks and tests specified by the installer, supplier or manufacturer should be carried out.

NOTE. The recommendations of items (b), (c) and (d) above need not be applied to batteries which power individual items of equipment (such as detectors or sounders) and which have provision for monitoring as recommended in **18.2.3**.

Any defect should be recorded in the log book and reported to the responsible person, and action should be taken to correct it.

On completion of the work, a certificate of testing (see appendix C) should be given to the responsible person.

29.2.7 *Annual inspection and test.* The responsible person should ensure that the following check and test sequence is carried out every year by a competent person.

(a) The inspection and test routines detailed in **29.2.6**.

(b) Each detector should be checked for correct operation in accordance with the manufacturer's recommendations (see **29.4**).

(c) A visual inspection should be made to confirm that all cable fittings and equipment are secure, undamaged and adequately protected.

Any defect should be recorded in the log book and reported to the responsible person, and action should be taken to correct it.

On completion of the work, a certificate of testing (see appendix C) should be given to the responsible person.

29.2.8 *Wiring check.* The responsible person should ensure that every 5 years (or more frequently if the building electrical system is tested at shorter intervals) the installation should be tested in accordance with the testing and inspection requirements of the IEE Wiring Regulations. Any defect should be recorded in the log book and reported to the responsible person, and action should be taken to correct it.

On completion of the work, a certificate of testing (see appendix C) should be given to the responsible person.

29.3 Special servicing

29.3.1 *General.* The routine attention described in **29.2** is intended to maintain the system in operation under normal circumstances. There may, however, be special circumstances in which other attention is needed.

29.3.2 *Action by the user after any fire (whether detected automatically or not).* The responsible person should ensure that the following work is carried out as soon as possible after any fire, and that normal use of the area is not resumed until the work is carried out.

(a) If the system includes detectors containing radioactive material, then any actions required to deal with contamination should be taken (see appendix E).

(b) Each detector or call point which may have been affected by the fire should be tested. This test should preferably be carried out so as to simulate fire conditions: smoke detectors should be tested by the application of smoke or other aerosol to the detector, and resettable heat detectors by the application of warm air or gas. Non-resettable detectors need not be tested by operation, but should be visually inspected for fire damage.

(c) Each fire alarm sounder should be tested.

(d) A visual examination should be made of any other part of the fire alarm system which lies within the fire area or which might have been damaged by the fire. Such parts may include power supplies, control equipment and interconnections.

(e) Any defect found should be recorded in the log book and immediate action taken to correct the defect.

(f) The organization responsible for servicing the system should be informed of the fire and of any defects on the system, and instructed to carry out a check of the system.

The responsible person should also ensure that the following work is carried out, although this may take place after normal use has been resumed.

(1) A check should be made of the state of the battery and charger.

(2) The servicing organization should carry out a further check for damage to the system, particularly any parts in which damage might be hidden, such as buried cables. The extent of a fire may necessitate a more comprehensive check of the system.

(3) If the fire was not detected by the system, or if detection occurred at an unexpectedly late stage of the fire, then the reasons for this should be investigated and, if necessary, consideration be given to system modifications to prevent any repetition.

On completion of the work, a certificate of testing (see appendix C) should be given to the responsible person. Where any changes have been made to the system the records should be up-dated.

29.3.3 *Action by the user after any false alarm.* False alarms can be a major hazard to any fire alarm system since they lead to a loss of confidence in the system. It is important that any alarm from the system is treated as an alarm of fire until it can be proved to be false, rather than being treated as false until proved to be a fire. Where an alarm has been found to be false the following immediate actions should be taken by the responsible person or a person to whom he has delegated this duty.

(a) Where possible, identify the particular detector or call point which has initiated the alarm. If detectors having individual indicator lamps are in use, any indications will be cancelled by resetting, and hence it is important that the detectors are examined before the system is reset.

(b) Where possible, establish the cause of the false alarm. It is possible that the actual cause of the alarm will have been lost in the operations resulting from the alarm; where this is so a note should be kept of any events or activities near the detector immediately prior to the alarm.

(c) Record the false alarm in the log book and inform the organization responsible for servicing.

If one detector or group of detectors gives repeated false alarms then the organization responsible for servicing should be informed and required to investigate. The average rate of false alarms from an installation should not exceed one false alarm per year for each 10 detectors connected to the system. The number of false alarms from an individual detector or detector location should not exceed one false alarm per 2 years. Installations, detectors or detector locations having higher false alarm rates should be subject to special investigation.

29.3.4 *Action by the user following a fault.* If a fault has been shown to exist, either by the system's own monitoring or by any other method, then the responsible person should ensure that the following actions are taken:

(a) determine the area affected by the fault and decide whether special action (such as fire patrols) are needed in that area;

(b) if possible, determine the reason for the fault, or note the activities immediately prior to the fault in the area affected;

(c) record the fault in the log book, inform the organization responsible for servicing and arrange for repair.

29.3.5 *Action by the user following a pre-alarm warning.* On some systems a pre-alarm warning is given if the output from a detector appears to be drifting towards the alarm level. The main purpose of the pre-alarm warning is to allow faulty detectors to be cleaned or otherwise corrected before a false alarm is given; however, it is possible that the pre-alarm warning is given in response to a slowly growing fire. The responsible person should ensure that the following actions are taken:

(a) determine the detector and area from which the warning has come;

(b) inspect the area thoroughly to ensure that there is no fire; if a fire is found, then carry out the preplanned fire routine;

(c) if no fire is found, record the warning in the log book and inform the organization responsible for servicing.

29.3.6 *Prolonged periods of disconnection.* Special attention may be needed to prevent damage to batteries from prolonged deep discharge. On reconnection, the system should be subjected to the inspection and test routines described under **29.2.7** for annual inspection and test.

29.3.7 *Other non-routine attention.* Other occasions on which attention may be required beyond that of routine servicing include the following:

(a) extensions or alterations to the premises (see clause **27**);

(b) changes in occupancy or activities in the area covered by the system;

(c) changes in the ambient noise level or sound attenuation such as to change the sounder requirements;

(d) damage to the installation, even though no fault may be immediately apparent;

(e) any change to ancillary equipment.

29.4 Detectors

29.4.1 *General.* It is essential that routine tests are adequate to ensure that the requisite degree of sensitivity to fire is maintained, and users should satisfy themselves on this point. If it is found that the sensitivity of detectors is adversely affected by the rapid accumulation of dirt, then arrangements should be made to increase the frequency of the inspections. Any detectors which have shown continued signs of instability should be replaced.

29.4.2 *Heat detectors.* Heat detectors should be visually examined for damage or other conditions, such as any coat of paint, likely to interfere with correct operation. Routine tests of operation should be carried out as recommended by the manufacturer, with at least 2 % of the installed heat detectors operated annually by the application of a heat source as a check on reliability. If possible, different detectors should be tested each year. If any of the tested detectors fails to operate properly, then the cause of the failure should be investigated. If the cause of the fault is likely to have affected other detectors, or if the cause cannot be determined, then a further 2 % of the detectors should be tested. If any failures occur in the second set, then further investigations should be made.

29.4.3 *Detectors other than heat detectors.* Detectors other than heat detectors should be checked for correct operation and sensitivity in accordance with the manufacturer's recommendations. If detectors are removed from their mounting for this checking, then a final test should be carried out for operation after remounting.

29.4.4 *System disconnection during testing.* Care should be taken to minimize disruption of the normal use of a building by alarms sounding during detector testing. It is preferable that during testing of detectors as much as possible of the remainder of the system should continue to function normally. If detectors are removed from the system for testing or servicing, replacement detectors should be immediately provided to keep the system in normal operation, or separate provision should be made for surveillance of the unprotected area.

29.4.5 *Systems using addressable detectors.* Care should be taken during the maintenance of systems in which the detector is itself coded. False information in respect of the origin of alarm could occur if individually coded detectors were exchanged.

29.5 Secondary batteries

The test specified by the manufacturer under **16.3.2.1** should be carried out at the intervals specified.

29.6 Spare parts

If a service contract is in force, then it is not necessary to carry spares other than fuses and frangible elements for manual call points. There may, however, be advantages if the user agrees with the servicing organization to hold additional spare parts.

Appendices

Appendix A. Automatic connection to the fire brigade

A.1 General

There are several methods by which alarms of fire can be transmitted automatically from the protected premises to the fire brigade.

The availability, reliability and means of testing the connection to the fire brigade should be discussed with the installer of the fire alarm system, the communications officer of the local fire brigade and, where communication is via remote manned centre, its operator.

Connection of a system to fire brigade mobilizing controls may be the subject of a licence or agreement between the installing engineers and the fire authority concerned. Contact with the local fire authority on this matter is advised.

A.2 Communication via a private line

Some methods of communication with the fire brigade necessitate the renting of a public telecommunications operator private line or other land line, together with equipment to transmit and receive the signals. Correct functioning of the line and the equipment may be monitored. The amount of information which can be transmitted will vary depending on the equipment used, but as a minimum facilities should be available for transmitting fire and fault signals. Test facilities are normally available and the user would normally be expected to initiate test calls at regular intervals. The procedure for making a test call will depend on the system used, but should be carefully laid down and followed in order to prevent a test call being mistaken for a fire alarm.

Although a number of different systems are available, in practice the system used often depends on the arrangements made by the fire authority for connections to the fire brigade control. Available systems include the following.

(a) Direct connection to the fire brigade control. This depends on the mobilization policy of the brigade concerned.

(b) Connection to a remote manned centre (commercial central fire alarm station). This possibility depends on the distance from the protected premises to the remote manned centre, since the user will have to bear the full cost of the dedicated private line, in addition to the remote manned centre operator's charges. The remote manned centre should have a direct telephone connection to the appropriate fire brigade.

(c) Some companies provide local 'collectors' to which direct line connection may be made. Signals from a number of premises can be connected to the same 'collector', where the signals are multiplexed together and transmitted over a common line to a remote manned centre. In this type of system the costs may be reduced, since the price of the line between the 'collector' and the remote manned centre is shared between several users.

A.3 Communication via the public switched telephone network

A number of systems are possible by which alarm signals may be transmitted over the public switched telephone network (PSTN). In general these may be classified into the following.

(a) Carrier and similar systems, in which the fire alarm signals are carried on the same wire as voice signals, but are separated from the voice signals in the exchange before entering the switching system. These systems are usually operated by the telecommunications operator, but are not universally available.

(b) Systems using the 999 emergency system. 999 calls are given an automatic priority over other calls, but can only be used for communication with the local emergency services. It is thus impossible to use the 999 system to communicate with a remote manned centre, or for a remote manned centre outside the local area to use the 999 system to send the alarm to the local fire brigade. Further, since the 999 system depends on voice communication, it can only accept signals which are intelligible to the operator, such as recorded or synthesized speech.

(c) Systems using the normal switching system. Commercial systems are available that automatically 'dial' the remote manned centre using the public switched telephone network. Once contact is made, a coded signal is sent identifying the type of alarm (fire, fault, test, etc.) and the address from which the alarm originates. Most such systems allow for multiple retries in the event of failure to connect initially, but it should be appreciated that dialling a 10 digit number will take about 30 s for each try. Four tries may thus absorb 2 min in simple dialling time, without any other delays.

Where the alarm is sent to a remote manned centre outside the local fire authority area, the method of communication between the remote manned centre and the fire brigade becomes important. The most reliable method is a direct line fire telephone, but private lines over long distances are expensive. The 999 system cannot be used, since it is for local alarms only. Some fire brigades have a control room telephone with an ex-directory number which can be given to remote manned centres. The fire brigade's administrative number should not be used, since at busy periods there may be considerable delays in answering it.

Appendix B. Model certificate of installation and commissioning of a fire alarm system

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

Protected area...

Address...

....

My attention has been drawn to the recommendations of BS 5839 : Part 1 : 1988;
in particular, to clauses **14** (false alarms), **28** and **29** (user responsibilities).

In accordance with BS 5839 : Part 1 : 1988, subclause **26.1**, record drawings and operating instructions have been supplied, and received by:

Signed .... Status .... Date ....

For and on behalf of (user) ....

....

- -

In accordance with BS 5839 : Part 1 : 1988, subclause **26.2**, the installation has been inspected and been found to comply with the recommendations of the code.

In accordance with BS 5839 : Part 1 : 1988, subclause **26.3**, the insulation of cables and wires has been tested.

In accordance with BS 5839 : Part 1 : 1988, subclause **26.4**, the earthing has been tested.

In accordance with BS 5839 : Part 1 : 1988, subclause **26.5**, the entire system has been tested for satisfactory operation.

In accordance with BS 5839 : Part 1 : 1988, subclause **26.6**, it is certified that the installation complies with the recommendations of the code, other than the following deviations:

Signed (Commissioning engineer) .... Date ....

For and on behalf of (installer) ....

- -

The system log book is situated ....

The system documentation is situated ....

Appendix C. Model certificate of testing of a fire alarm system

---

Certificate of testing of fire alarm system at:

Protected area ....

Address ....

....

The system is operational and has been checked and tested in accordance with BS 5839 : Part 1 : 1988:

* clause **27** Extensions and alterations to an existing system
* subclause **29.2.6** Quarterly inspection and test
* subclause **29.2.7** Annual inspection and test
* subclause **29.2.8** Wiring check
* subclause **29.3.2** Servicing after a fire
* subclause **29.3.3** Servicing following a false alarm
* subclause **29.3.3** Servicing following excessive false alarms
* subclause **29.3.4** Servicing following a fault
* subclause **29.3.5** Servicing following a pre-alarm warning
* subclause **29.3.7** Other non-routine attention (specify) ....

....

* Delete if not applicable.

Signed .... **Status** .... **Date** ....

For and on behalf of (user or service organization) ....

....

Appendix D. Model log book for fire alarm systems

D.1 General

The data to be recorded in the log book falls into the following two main categories:

(a) reference data relating to the configuration of the system, responsibilities for the system, requirements for component replacement and any other data which might be required for future reference;

(b) historical data relating to events which have occurred on the system, including fires, false alarms, testing and servicing.

The two categories of data should be separated in the log book.

For investigation purposes it is often necessary to trace the history of some feature of the system; for instance, to trace the interaction of false alarm rates with the period since the last service. Historical data should therefore be recorded in date sequence, irrespective of the type of event. It is, however, permissible to maintain an abbreviated event log in date sequence, with each entry referring to entries in separate log books for different types of event.

D.2 Changes

Provision should be made for recording changes in the reference data for the system. In some cases (such as a change in the servicing organization) it may be appropriate for a new log book to be provided, while in others (such as a change of responsible person) it may be appropriate to record the change in the existing log book. Any such change should be dated and should not obliterate the previous entry.

D.3 Model log book

Log book

Foreword

It is recommended that this log book is maintained by a responsible executive who should ensure that every entry is properly recorded. An 'event' should include fire alarms (whether real or false), faults, pre-alarm warnings, tests, temporary disconnections and the dates of installing or servicing engineer's visits with a brief note of work carried out and outstanding.

Reference data

Name and address .....

.....

Responsible person ..... Date .....

..... Date .....

..... Date .....

..... Date .....

The system was installed by .....

and is maintained under contract by ..... until .....

Tel. no. ..... who should be contacted if service is required.

Event data

Date	Time	Counter reading*	Event	Action required	Date completed	Initials

Expendable component replacement due (list): .....

.....

.....

*If an event counter is provided (see **28.2.2**).

A program controlled system may need a column to record the readings of the failure to correctly execute software counter (see **6.9**(d)).

Appendix E. Ionization chamber smoke detectors

Ionization chamber smoke detectors contain small amounts of radioactive materials. There are statutory requirements under the Radioactive Substances Act, 1960, for the storage, transport, use and disposal of radioactive materials, and under the Ionizing Radiations Regulations, 1985, employers are required, amongst other things, to notify the Health and Safety Executive where apparatus containing certain specified amounts of radioactive substances are used. In general, the amount of radioactivity from ionization chamber smoke detectors is small, and no notification or registration under legislation is required for installed smoke detectors where the source is closed, contains only americium-241, has an activity not exceeding 4 MBq and gives a dose rate less than 1 $\mu Sv \cdot h^{-1}$ at 100 mm from any accessible surface on the detector. Information on the requirements applicable to a specific detector can be obtained from the manufacturer or supplier, from the Health and Safety Executive, or from the National Radiological Protection Board*.

Appendix F. Fire alarm systems integrated with other systems

F.1 General

Although this Part of BS 5839 does not cover fire alarm systems integrated with systems for other purposes, such systems should generally comply with its recommendations, and with the guidance given in this appendix.

F.2 Priorities

In general, priorities within the system should not allow fire alarms to be prevented or delayed by the state of any other function. Any other order of priority should only be adopted following consultations between all interested parties. Any interactions between system outputs should be clearly defined.

F.3 Sounders

The alarm sound following a fire alarm should be distinct from any other alarm sound given by the system, although common sounders may be used. Where control sounders are used, they should be such that no confusion might arise from sounders used for other functions.

F.4 Manual controls

The layout of any control panel should be such that confusion will not arise between controls operating the fire alarm system and controls for other functions. Manual controls provided for other functions should not affect the operation of the fire alarm system.

F.5 Time-related systems

Where means are provided to vary the response of systems at different times of day, care should be taken that no undesirable interaction occurs between the fire alarm response and that of other systems. Where means are provided for delaying or changing responses from systems (e.g. so as to prevent false alarms), any effect on the fire alarm system should be fully considered.

F.6 False alarms

Care should be taken that the integration of different systems does not lead to an increase in the number of fault warnings or false alarms. In particular, facilities for servicing and testing of systems should be considered.

F.7 Signals to remote manned centres

Where signals to a remote manned centre are transmitted over a single link, care should be taken that faults affecting the fire alarm system can be separately identified. Faults affecting more than one system should be shown as such.

F.8 Power supplies

Where the power supply to the fire alarm system is also used to supply power for other functions, the capacity of the power supply should satisfy the recommendations of this Part of BS 5839 for the fire alarm system in the presence of the maximum demand from all the other systems sharing that supply. Excessive power demands due to faults on other systems should not reduce the capacity available to the fire alarm below the recommendations of this Part of BS 5839.

F.9 Faults

Faults in other functions should not affect the response of the system to fire. Multiple faults in another function need not be considered if a single fault in the other function is indicated as a potential fault on the fire alarm system, and would not immediately affect the response of the fire alarm system.

* National Radiological Protection Board, Didcot, Oxfordshire OX11 0RQ.

F.10 Multiplexed conductors

Conductors may be used to carry signals for more than one function. Failure of the multiplexing system should be indicated as a fault on the fire alarm system if that system is affected.

F.11 Interconnections

Interconnections essential to the operation of the fire alarm system should be protected as recommended in clause **17.**

F.12 Segregation of cables

Cables carrying fire alarm signals (even where multiplexed with other signals) should be segregated from other cables as recommended in **17.10.**

F.13 Siting of control and indicating panels

Fire alarm control and indicating panels should be sited as recommended in this Part of BS 5839 and not be dependent on the siting of panels for other purposes.

F.14 Commissioning and servicing

All personnel concerned with commissioning or servicing any part of the system which might affect the fire alarm function should be properly trained.

F.15 Extensions or alterations

Care should be taken that extensions or alterations to the system do not adversely affect the fire alarm system either during or subsequent to the work.

F.16 Isolation

The fire alarm system should not be adversely affected by provisions made for the isolation of other parts of the system.

Appendix G. Control equipment and power supplies for small manual systems (type M)

G.1 General

This appendix covers the functional recommendations for single zone control equipment for small manual systems; such equipment should meet all the recommendations given in **G.2** to **G.11.**

G.2 Indications of fire

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

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

(b) the illumination of a red visible indication clearly labelled with the word 'FIRE'.

G.3 Time delays

The indications of **G.2** should be given within 1 s of the operation of a manual call point.

G.4 Silencing

A manual operation should be required to silence the alarm; the alarm should not be automatically silenced or cancelled. A clearly labelled facility should be provided for manually restarting the alarm. The operation of silencing the alarms should result in an audible signal being given by the indicating equipment until the fire alarm is reset or is resounded. This audible signal (which may be the same as that for fault warning) should be different from that of any alarm sounder used to give the alarm of fire.

G.5 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.

G.6 Resetting

The visible indication of item (b) of **G.2** and either the supply of power of item (a) of **G.2** or the audible signal of **G.4** should persist until the system is manually reset at the control equipment. Resetting should be by the operation of a biased switch or other device fulfilling the same function.

G.7 Power supplies

The power supplies should be in accordance with one of the following methods, which are given in order of preference.

(a) Normal and standby supplies complying with **5.2** of BS 5839 : Part 4 : 1988.

(b) Normal supply derived from the public electricity mains and a standby primary battery. Each supply should be independently capable of meeting the maximum load likely to be placed on the system. Provision should be made for automatic change-over to and from the standby supply on failure and recovery of the normal supply. A fault warning should be given in the event of failure of the normal supply. Since failure of the normal supply will cause an indeterminate and irrecoverable loss of capacity from the standby primary battery, this warning should continue after recovery of the normal supply until manually reset. An automatic audible fault warning should be given for a period of at least 24 h before the battery capacity falls to a point where it is unable to provide the alarm.

(c) Normal supply derived from the public electricity mains without standby supply.

(d) Normal supply from a primary battery with a second unused primary battery held in reserve. An automatic audible fault warning should be given for a period of at least 24 h before the capacity of the primary battery used for the normal supply falls to a point where it is unable to sustain the maximum alarm load for a period of 5 min. If an automatic device is provided to transfer the supply to the reserve battery, then a suitable warning should be given after each transfer to draw the attention of the user to the need to replace the exhausted battery. The initial rated capacity of each battery should be such that it is able to supply the quiescent load of the system for 90 days, after which sufficient capacity should remain to sustain the maximum alarm load of the system for at least 30 min.

(e) A single primary battery capable of supplying the quiescent load of the system together with the additional load imposed by the recommended weekly testing routine, preferably for a period of a year but at least for 90 days. An automatic audible fault warning should be given for a period of at least 24 h before the battery capacity falls to a point where it is unable to sustain the rated alarm load for 5 min.

G.8 Indication of power supply

A green visible indication should be provided when the normal power supply is operating; this indication should be extinguished if both normal and standby supplies fail. (This indication may, but need not, be provided if the normal supply has failed and the system is operating from the standby supply.)

G.9 Visual indicators

G.9.1 The operation or failure of one indicator should not prevent the proper and separate operation of any other indicator.

G.9.2 The operation of any sounder or alarm circuit should not be prevented by any visual indicator defect and should not depend on the operation of any indicator.

G.10 Manual controls

G.10.1 Labelling and spacing

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

G.10.2 Security

The operation of all manual controls, isolating devices and control circuits should be limited to authorized personnel. The limitation should be achieved by the use of a lock, key-operated switch, or keyboard-entered code, except that limitation by keyed code should not be applied to controls which may need to be operated during a fire.

G.11 Marking

If control equipment and power supplies for small manual systems meeting all the recommendations of **G.2** to **G.10** are marked with a reference to this Part of BS 5839, they should be marked 'BS 5839 : Part 1 : 1988 : Appendix G'.

Equipment not meeting all the recommendations of **G.2** to **G.10** should not be marked with any reference to BS 5839 : Part 1.

Appendix H. Smoke alarms in the home

This appendix consists of the text of booklet FB2 'Smoke Alarms in the Home', 1988, reproduced by permission of the Home Departments.

NOTE. Copies of this and other fire safety literature produced by the Home Office/Scottish Home and Health Department/Northern Ireland Office are available from local fire authorities.

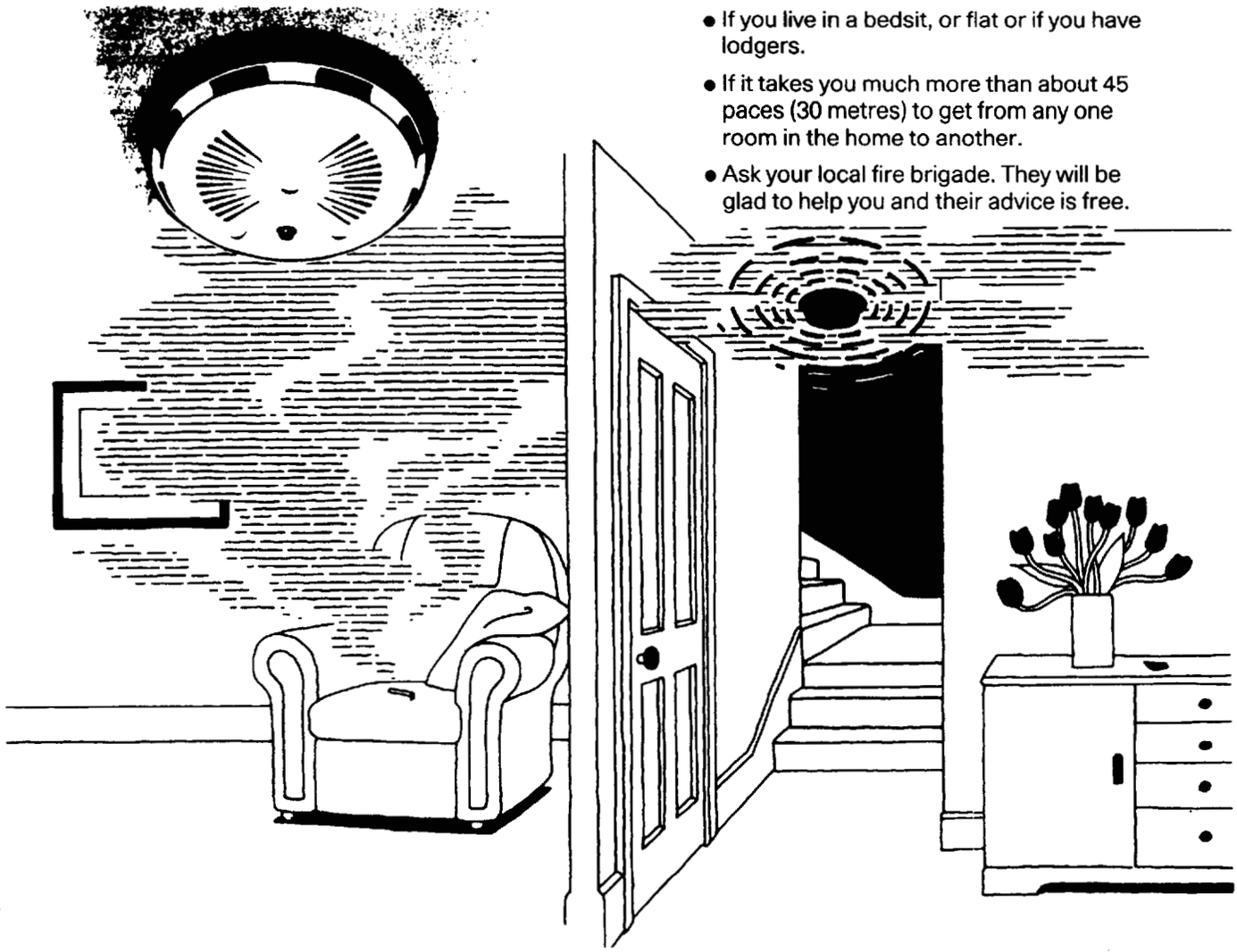
SMOKE ALARMS IN THE HOME

ABOUT THIS BOOKLET

If you are reading this booklet you are probably thinking about buying a smoke alarm for your home or may have already bought one. This booklet tells you how smoke alarms work and how to get the best from them for your safety. It covers the main types of smoke alarm on the market for use in the home and the various kinds of homes for which they are suitable.

The guidance given in this booklet is for the average family home. You may need special advice

- If you live in a bedsit, or flat or if you have lodgers.
- If it takes you much more than about 45 paces (30 metres) to get from any one room in the home to another.
- Ask your local fire brigade. They will be glad to help you and their advice is free.



THE NEED FOR EARLY DETECTION OF FIRES

No one should underrate the danger of fire. Every year, nearly 60,000 fires occur in the home in this country alone, killing about 700 people and injuring over 7,000 others. A lot of these deaths and injuries might have been prevented if only the people involved had been able to escape before it was too late. This is where smoke alarms can help. They won't stop fires starting and they can't put them out but if they are properly installed and looked after they can give you an early warning of fire and increase your chances of escape.

The longer a fire burns before it is discovered the more likely it is to cause death or injury. So a fire which starts smouldering at night when you and your family are asleep is very dangerous indeed. In fact a night-time fire is nearly three times as likely to kill as one during the day.

Some people think that the smell of smoke would wake them up. It might do. But there again it might not. And if the fire involves modern furnishings it could well be producing poisonous gases which will make sure that you never wake up. Even if the smoke did wake you up you could well find your way out blocked by thick choking smoke.

TYPES OF DETECTOR

There are two main types of fire detector on the market

Heat detectors
These react to increasing temperature.

Smoke alarms
These warn of fire by reacting to smoke and fumes drifting from the fire.

Smoke alarms will give you an earlier warning of most fires. Although heat detectors have their uses, they can't detect lethal amounts of smoke and poisonous gas and they need to get hot before they can operate. Smoke alarms are therefore far better for use in the home.

CHOOSING A SMOKE ALARM

DOMESTIC SMOKE ALARMS COME IN TWO BASIC TYPES

– ionization smoke alarms
These work by measuring the reduction of an electrical current when smoke particles enter a special chamber.

– optical smoke alarms
These contain a small photoelectric cell which triggers the alarm when the beam is disturbed by smoke.

Research has shown that ionization smoke alarms are often a little bit quicker to react to hot blazing fires than optical smoke alarms. On the other hand, optical smoke alarms seem to be better at detecting smouldering fires of the sort that might be started by a cigarette having fallen down the back of a sofa or chair (as shown at the beginning of this leaflet). There isn't a lot to choose between the two types of smoke alarm but if you are concerned about smouldering fires you should make sure that you buy an optical type.

NOTE: Some smoke alarms on the market combine both optical and ionization devices in a single unit. These "dual" detectors can give you a better all round performance if the two devices have been connected in such a way that only one needs to trigger before the alarm sounds (usually a piercing, high-pitched, continuous bleep). If in doubt consult your supplier or fire brigade.

SMOKE ALARMS CAN BE POWERED

- by batteries in the unit
- from the mains electrical supply
- from the mains, but with a standby battery so that alarms will operate even if the mains supply fails.

The last of these is the most reliable method. The first method (which probably accounts for the majority of devices readily available on the domestic market) is acceptable provided you are prepared to look after the equipment properly. The second method is also acceptable if your mains electrical supply is reliable.

If you choose a smoke alarm powered by battery alone

☑ Remember to change the battery at least once a year or sooner if your model gives its special low battery signal (usually an intermittent electronic bleeping sound).

☑ Remember to check that your smoke alarm is working when you've been away from home for more than a few days (you might have missed the low battery signal).

If you choose a smoke alarm powered from the mains

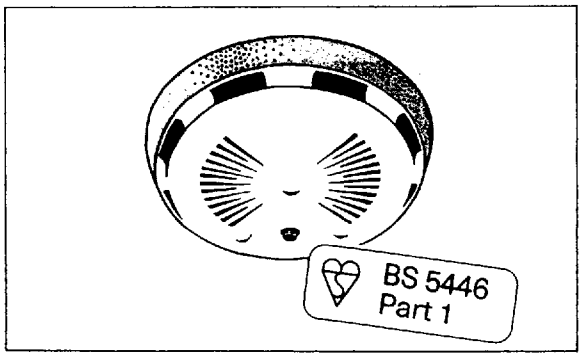
☑ Have it fitted by a competent electrician.

☑ Make sure that the mains supply is permanently connected and can't be switched off by mistake.

☒ Don't use extension cables to reach a distant socket or try to fix a cable from a lamp or adaptor.

BUY WISELY

Whatever type or make of smoke alarm you buy, make sure it meets British Standards and has the BS number BS 5446:Part 1 on it. If the smoke alarm has the Kite Mark on it too, so much the better.*



*There is also a British Standard Code of Practice covering the installation and servicing of fire detection and alarm systems in buildings – BS 5839:Part 1. This Code of Practice is mainly intended for hotels, factories and the like, but it can cover private houses as well. If your home is large (see page 3) or if you want your fire alarm system to contact the fire brigade automatically it is strongly recommended that you follow the Code of Practice.

IS ONE SMOKE ALARM ENOUGH?

In many ways this is a more important question than which kind of smoke alarm to buy. In order to do its job properly a smoke alarm needs to be close enough to the fire to respond quickly but in a position where its alarm can be heard throughout your home and is able to wake you and your family – **in time for you all to escape**. A single smoke alarm will give some protection if it is properly installed (see the next section on where to place your smoke alarms) but obviously two or more offer more reliable early warning than one and are more likely to provide an adequate amount of time for you all to escape. **For maximum protection** you should put individual smoke alarms in all the rooms where fire is most likely to break out.

If you can afford only one or two smoke alarms, try this simple test. Decide on the quickest and safest route you and your family would use to escape through the house from a fire which started in your living room at night. Now get someone to stand holding a smoke alarm on that route as close to the living room door as possible but not more than ten paces away from any other door to living accommodation or the kitchen. Ask them to wait for a few minutes and then start the alarm (the maker's instructions should tell you how to do this). In the meantime close your bedroom door, set a radio to a reasonably loud conversation level and lie on your bed. Can you hear the alarm? If you can't hear it over your radio the chances are that it wouldn't wake you. To make sure you are woken up you need extra detection and alarm facilities and the simplest way of doing this is to link another smoke alarm to the first, putting one in the best position to detect the fire and the other in the best position to be heard. In this way if one smoke alarm senses smoke both will sound an alarm and provide a louder warning. Linking a battery model should be a simple operation for an electrician or reasonably competent DIY householder but the maker's instructions should be followed carefully.

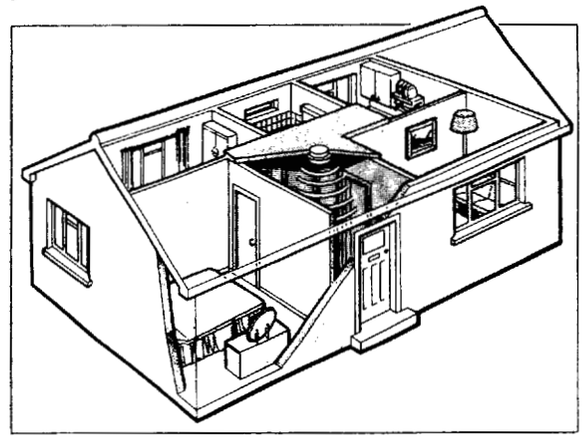
Even if you install only one smoke alarm to start with, it is worth thinking about buying a model which can be linked to others. Then, when you can afford to buy more smoke alarms or when circumstances change, such as the addition of young children to the family, more smoke alarms can easily be added and linked to the first.

NOTE: Not all self-contained smoke alarms are suitable for linking with others and you should check with your supplier that the one you are buying is suitable for linking in this way.

WHERE IS THE BEST PLACE FOR SMOKE ALARMS?

This depends on the size and layout of your home and where you and your family sleep. The most critical requirement for the positioning of a **single** smoke alarm is to choose a spot between the sleeping area(s) and the most likely sources of fire (living room or kitchen). But it shouldn't be more than about 10 paces (seven metres) from the door to any room where a fire might start and block your escape from the house.

If your home is on one level (a bungalow or mobile home for example) you should put your smoke alarm in a corridor or hallway between the sleeping and living accommodation. Place it as near to the living accommodation as possible but make sure you can hear it loudly enough to wake you in the bedroom.



Where there are rooms (other than a bathroom or WC) on either side of a bedroom, a single smoke alarm should be sited on the ceiling in the hall or corridor midway between the doors to those rooms.

NOTE: If your bungalow is very large and the corridor or hallway is more than, say, 22 paces (15 metres) long, one smoke alarm may not be enough and you should consult your local fire brigade.

If your home is on more than one level the best place for a **single** smoke alarm is in the hallway above the bottom of the staircase. This is because smoke is likely to be detectable in the hallway before it reaches the upstairs landing and bedrooms. But if you can't hear the alarm properly in the bedrooms (try the test described earlier) you'll need to link another smoke alarm

on the landing. It is a good idea to do this anyway because smoke from a fire **in a bedroom upstairs** is unlikely to be detected by a smoke alarm downstairs.

If you're putting in several smoke alarms and you've put one (or two) between the sleeping area(s) and living accommodation as described above, you should put the other smoke alarms in the individual rooms where fire is most likely to occur. The living room is the most likely place for a fire to start at night, then the kitchen (although it's **not** recommended to put smoke alarms in kitchens – put one outside the cooking area instead) and lastly the dining room. You should also consider putting smoke alarms in any bedrooms where fires might be likely to start, for instance, where there is an electrical appliance such as an electric blanket or an electric heater, or where the occupant is a smoker. You could also consider putting smoke alarms in any rooms where the occupant may not be able to respond very well to a fire starting in the room, such as an elderly or sick person or a very young child.

SOME DOs AND DON'Ts ON POSITIONING SMOKE ALARMS

✔ Do make sure your smoke alarm is fixed on the ceiling at least 30 cm (12 inches) from any wall or light fitting. A central position is best. If it's designed for wall mounting, put it between 15 and 30 cm (6 and 12 inches) below the ceiling.

✔ Do put your smoke alarm where you will be able to reach it fairly easily – and safely – for regular testing and maintenance; not above stairwells, for example.

✘ Don't put your smoke alarm in any room which tends to get very hot (a boiler room for example) or very cold (an unheated outhouse).

✘ Don't put your smoke alarm in bathrooms, shower rooms or in cooking areas or garages where the smoke alarm may be triggered by steam, condensation or fumes.

✘ Don't put your smoke alarm next to or directly above heaters or air conditioning vents.

✘ Don't fix your smoke alarm to surfaces which are normally much warmer or colder than the rest of the room. These can include uninsulated exterior walls and ceilings (temperature differences might stop smoke from reaching it).

LOOKING AFTER YOUR SMOKE ALARM

All smoke alarms need to be checked regularly to make sure they are in good working order. First you should make sure that the smoke alarm is powered (see under "Choosing a smoke alarm"). Then you need to make sure that your smoke alarm will sense smoke properly. A smoke alarm which has been made to the British Standard should come with instructions on how to do this. One test is to allow the smoke from a joss-stick or newly-extinguished taper to drift up to the smoke alarm from immediately below it. As soon as the alarm sounds, fan the smoke away vigorously to silence it. You should give your smoke alarm a proper test once a month.

For periodic maintenance and servicing, follow the maker's instructions.

BE PREPARED

If you have followed the advice in this booklet you should have a smoke alarm system which is capable of giving you and your family warning of a fire before it spreads. This will give you a better chance of escaping unharmed. The amount of warning will obviously depend on the fire, the equipment you have chosen and how well you have looked after it. However, you may only have a few minutes to escape so it pays to have made an escape plan in advance. Everyone, including children, should know what to do in case of a real fire.

- Practise walking along your main escape route with your family. You may all have to do it **in the dark** under very unpleasant conditions.
- Plan other **safe** ways of escaping from your home if your main route was blocked by fire or smoke.

WHAT TO DO WHEN THE ALARM GOES OFF...

- Alert the household and get everyone out by the safest route. If you have to go through a smoke-filled area crawl with your head low.
- If it's safe to do so, shut doors and windows to help reduce draughts that could fan the fire. Feel each door before opening it – if it is warm or if smoke is coming through **don't open it** – it could be protecting you from a dangerous smouldering fire.
- Alert the neighbours and call the fire brigade as soon as possible (don't leave it to somebody else) giving the full address of the fire.
- Make sure everyone stays outside the house until the fire brigade arrives and tells you it's safe to go back in. Possessions are replaceable – people are not.

WHAT ABOUT FALSE ALARMS?

If, when the alarm goes off, there is no sign of smoke or heat or noise to indicate that there is a fire you should get your family into a place from where escape is easy **before you start investigating**. If you feel any signs of heat at the top of any door **don't open it**. If the alarm has gone off without apparent cause it may be an indication that the battery in the smoke alarm needs replacing. Other causes of false alarms are fumes, steam, dust and even small insects inside the detector chamber.

NOW. . .

Read the booklet *Your Home Fire Safety Guide* (available from your local fire brigade). It contains a lot of useful information on how to prevent fires happening. Make sure in particular that every member of your family understands the need to keep downstairs doors shut at night. There is also a companion booklet *Fire Extinguishers for the Home* available.

Appendix J. Guide to recommendations applicable to specific types of system

J.1 General

Most of the recommendations of this Part of BS 5839 are relevant to all types of system. This appendix is intended to provide a guide to those recommendations which are appropriate only to certain types of system.

The following clauses are relevant to the design and installation of all types of system:

(a) scope (clause **1**);
(b) definitions (clause **2**);
(c) exchange of information (clause **4**);
(d) planning schedule (clause **5**);
(e) zones (clause **7**);
(f) communications with the fire brigade (clause **8**);
(g) manual call points (clause **10**);
(h) types of detector (clause **11**);
(i) false alarms (clause **14**);
(j) control and indicating equipment (clause **15**);
(k) cables, wiring and other interconnections (clause **17**);
(l) radio-linked systems (clause **18**);
(m) ancillary services (clause **19**);
(n) radio and electrical interference (clause **20**);
(o) workmanship, installation and commissioning (clauses **21** to **27**);
(p) user responsibilities (clauses **28** and **29**).

The following clauses are applicable to only some types of system, or are divided into subclauses applicable to only some types of system:

(1) types of system (clause **3**);
(2) general design considerations (clause **6**);
(3) audible and visual alarms (clause **9**);
(4) application, choice and siting of detectors (clauses **12** and **13**);
(5) power supplies (clause **16**).

J.2 Systems for property protection (type P)

In addition to the clauses common to all types of system, the following clauses and subclauses are applicable to systems for property protection:

(a) type of system: see **3.2**;
(b) general design considerations: see **6.2**;
(c) audible and visual alarms: see **9.2**;
(d) detector spacing and siting: see clause **12**;
(e) power supplies: see **16.5.2**.

J.3 Systems for the protection of life (type L)

In addition to the clauses common to all types of system, the following clauses and subclauses are applicable to systems for the protection of life:

(a) type of system: see **3.3**;
(b) general design considerations: see **6.3**;
(c) audible and visual alarms: see **9.3**;
(d) detector spacing and siting: see clause **13**;
(e) power supplies: see **16.5.1**.

J.4 Manual alarm systems (type M)

In addition to the clauses common to all types of system, the following subclauses are applicable to manual alarm systems:

(a) type of system: see **3.3**;
(b) general design considerations: see **6.3**;
(c) audible and visual alarms: see **9.3**;
(d) control equipment: see **15.2.2** and appendix G;
(e) power supplies: see **16.6**.

J.5 Multi-occupancy buildings (X)

In addition to the clauses common to all types of system, the following subclauses are applicable to multi-occupancy buildings:

(a) type of system: see **3.5**;
(b) exchange of information: see **4.4**;
(c) siting of control equipment: see **15.3.6**;
(d) power supplies: see **16.7.3**.

The following subclauses include recommendations for systems which are to be installed in buildings in multiple occupation:

(1) communication with the fire brigade: see **8.1**;
(2) audible and visual alarms: see **9.1**.

K.1 Staged alarms and phased evacuation

In the past, the terms 'staged alarms' and 'phased evacuation (particularly 'two-stage alarm' and 'two-phase evacuation') have frequently been confused. In the context of this standard, 'staged alarms' refer to the stages of alarm (hidden staff alarm, general alert signal, evacuation alarm, etc.) which can be given in a particular area, and 'phased evacuation' refers to the evacuation of the premises in a controlled sequence of phases. 1

Although staged alarms are usually given by alarm devices of various types (e.g. coloured lights or 'bleepers' for a staff alarm, intermittent sounds for an alert signal and continuous

sounds for the evacuation signal), it is possible for the same functions to be performed by a public address system. In this case the staff alarm could be given by a 'coded' message and the alert and evacuation signals could be given as 'plain language' messages. In some cases the use of voice messages may be considered as giving a greater degree of control while simultaneously allowing the transfer of better information.

The use of phased evacuation implies at least one phase in which people near the fire are warned to evacuate their area while people further from the fire are only alerted. Thus in the simplest type of phased evacuation the first phase is of movement only of people at immediate risk, while the second phase is of evacuation of the remainder of the premises. Such a type has sometimes been referred to as a 'two-stage system', but this is now deprecated because of the possible confusion with 'two-stage alarms'. A more complex type of phased evacuation (common in large office buildings) involves a greater number of phases of evacuation, possibly depending on the height of the building, the available stairs and the fire separation within the building.

K.2 Conditions in which staged alarm systems can be used

Staged alarm systems may be found convenient in a wide range of applications. Four such applications are as follows.

(a) Premises in which only a restricted part will be at risk from a fire, although alert signals or staff alarms may be necessary in some other parts. For example, the premises could consist of a range of separate buildings using a common alarm system; an evacuation signal could be given in one building while staff alarms in other buildings alert a works fire brigade.

(b) Premises in which phased evacuation is to be used.

(c) Premises in which staff away from the fire area are required to perform certain functions (such as shut-down procedures) before leaving the building.

(d) Premises in which the fire procedure allows for the investigation of alarms from automatic fire detectors prior to the initiation of evacuation. In some premises the increased risk due to the delays associated with such a procedure might be acceptable in return for a reduction in the inconvenience due to an unduly high frequency of false alarms (see 14.6).'

3

Publications referred to

BS 476 Fire tests on building materials and structures
BS 800 Specification for limits and methods of measurement of radio interference characteristics of household electrical appliances, portable tools and similar electrical apparatus
BS 1635 Graphical symbols and abbreviations for fire protection drawings
BS 2316 Specification for radio-frequency cables
Part 3 Cable data sheets (metric and imperial units)
BS 3116 Specification for automatic fire alarm systems in buildings
*Part 4 Control and indicating equipment
BS 4678 Cable trunking
Part 4 Specification for cable trunking made of insulating material
BS 4683 Specification for electrical apparatus for explosive atmospheres
BS 5306 Fire extinguishing installations and equipment on premises
Part 1 Hydrant systems, hose reels and foam inlets
Part 3 Code of practice for selection, installation and maintenance of portable fire extinguishers
BS 5345 Code of practice for the selection, installation and maintenance of electrical apparatus for use in potentially explosive atmospheres (other than mining applications or explosive processing and manufacture)
BS 5445 Components of automatic fire detection systems
Part 5 Heat sensitive detectors — point detectors containing a static element
Part 7 Specification for point-type smoke detectors using scattered light, transmitted light or ionization
Part 8 Specification for high temperature heat detectors
BS 5446 Specification for components of automatic fire alarm systems for residential premises
Part 1 Point-type smoke detectors
BS 5467 Specification for cables with thermosetting insulation for electricity supply for rated voltages of up to and including 600/1000 V and up to and including 1900/3300 V
BS 5501 Electrical apparatus for potentially explosive atmospheres
BS 5588 Fire precautions in the design and construction of buildings
BS 5750 Quality systems
BS 5839 Fire detection and alarm systems for buildings
Part 2 Specification for manual call points
†Part 3 Specification for automatic release mechanisms for certain fire protection equipment
Part 4 Specification for control and indicating equipment
Part 5 Specification for optical beam smoke detectors
BS 5969 Specification for sound level meters
BS 6004 Specification for PVC-insulated cables (non-armoured) for electric power and lighting
BS 6007 Specification for rubber-insulated cables for electric power and lighting
BS 6099 Conduits for electrical installations
Section 2.2 Specification for rigid plain conduits of insulating material
BS 6132 Code of practice for safe operation of alkaline secondary cells and batteries
BS 6133 Code of practice for safe operation of lead-acid stationary cells and batteries
BS 6207 Specification for mineral-insulated copper sheathed cables with copper conductors
BS 6231 Specification for PVC-insulated cables for switchgear and controlgear wiring
BS 6259 Code of practice for planning and installation of sound systems
BS 6266 Code of practice for fire protection of electronic data processing installations
BS 6346 Specification for PVC-insulated cables for electricity supply
BS 6387 Specification for performance requirements for cables required to maintain circuit integrity under fire conditions
BS 6467 Electrical apparatus with protection by enclosure for use in the presence of combustible dusts
BS 6651 Code of practice for protection of structures against lightning
BS 6701 Code of practice for installation of apparatus intended for connection to certain telecommunications systems
Part 1 General recommendations
BS 6724 Specification for armoured cables for electricity supply having thermosetting insulation with low emission of smoke and corrosive gases when affected by fire
BS 6746 Specification for PVC insulation and sheath of electric cables
BS 7629 Specification for thermosetting insulated cables with limited circuit integrity when affected by fire
BS 8313 Code of practice for accommodation of building services in ducts
CP 1003 Electrical apparatus and associated equipment for use in explosive atmospheres of gas or vapour other than mining applications

§ IEE Wiring Regulations, Regulations for electrical installations, Institution of Electrical Engineers

* Withdrawn, superseded by BS 5839 : Part 4.

† Referred to in the foreword only.

‡ Referred to in the foreword only. Under revision, to be published as BS 5588 : Section 1.2.

§ Obtainable from the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London WC2R 0BL.

Issue 2, August 1996

BS 5839 : Part 1 : 1988

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Third revision May 1988

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Committees responsible for this British Standard

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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
Department of Health and Social Security
Department of the Environment (Building Research Establishment, Fire Research Station)
Department of the Environment (Property Services Agency)
Department of Transport (Marine Directorate)
Electrical Contractors' Association
Electrical Installation Equipment Manufacturers' Association (BEAMA Ltd.)
Fire Insurers' Research and Testing Organization (FIRTO)
Fire Offices Committee
Fire Protection Association
Home Office
Institution of Electrical Engineers
Institution of Fire Engineers
Ministry of Defence
National Inspection Council for Electrical Installation Contracting
Royal Institute of British Architects
Society of Fire Protection Engineers
Trades Union Congress

Amendments issued since publication

Amd. No.	Date of issue	Text affected
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6874	May 1992	Indicated by a line in the margin
9257	August 1996	Indicated by a double line in the margin -Skwg Forward-ti 6-9-96

British Standards Institution · 2 Park Street London W1A 2BS · Telephone 071-629 9000 · Telex 266933

BSI

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to BS 5839 : Part 1 : 1988

Fire detection and alarm systems for buildings
Part 1. Code of practice for system design, installation and servicing

Revised text

AMD 6317
January 1991

Foreword

In item (h), line 2, delete 'will be' and substitute 'is further'.

After item (j), insert the following new item.

'(k) The effect on manual call points of the removal of detectors from their bases is included.'

In paragraph 7, line 8, delete 'and to CP 3 : Chapter IV : Part 1'.

AMD 6317
January 1991

New definitions 2.21, 2.22, 2.23 and 2.24

After **2.20** insert the following four new definitions.

'**2.21 condition.** The condition of a control equipment.

NOTE. For example, the control equipment may be in the normal condition, the fault condition, the alarm condition, etc.

2.22 phased evacuation. A system of evacuation in which different parts of the premises are evacuated in a controlled sequence of phases, those parts of the premises expected to be at greatest risk being evacuated first. (See appendix K.)

NOTE. A phased evacuation will normally require at least a two-stage alarm system.

2.23 staged alarm system. An alarm system in which two or more stages of alarm can be given within a given area. (See appendix K.)

NOTE 1. Examples of staged alarm systems are a two-stage system capable of giving 'alert' or 'evacuate' signals, or a three-stage alarm system capable of giving 'staff alarm', 'alert' or 'evacuate' signals.

NOTE 2. The normal condition, under which no alarm is given, is not counted as a stage of alarm.

NOTE 3. In this standard, in order to avoid confusion:

(a) the term 'stage' is used to describe the different stages of alarm in one area of the premises;

(b) the term 'phase' is used in describing the sequence of phases of evacuation of different areas of the premises.

2.24 state. The outputs of a detector.'

AMD 6317
January 1991

Clause 4.2 Action in the event of an alarm of fire

After paragraph 1, insert the following new paragraph.

'In particular, if the preferred mode of evacuation of the building is such that different actions may be required in different areas of the building, then the alarm system should be so designed that the necessary commands, messages or signals can be distributed easily. In many cases proper control of evacuation will require a system capable of giving speech

messages (see 9.12). The area in which the fire is first detected will usually determine the initial distribution of alarm signals. The relationship between the location of the fire and the alarm distribution should be carefully defined and specified prior to the design of the system, since it may reflect strongly on the facilities required in the control equipment and on the wiring arrangement. For example, a high building using a phased evacuation scheme could require an evacuation signal in some areas, while in others only an alert signal would be given initially, and it is essential that the control equipment and the sounder distribution network is capable of providing this differentiation. Particular care should be taken in parts of the building where signals relating to more than one area may be audible (such as stair enclosures). This code is concerned only with the design of the fire alarm system; the requirements for the evacuation scheme should be determined in consultation with the relevant authorities (see also the relevant Part of BS 5588).'

AMD 6317
January 1991

Clause 6.6.2 Circuits containing fire detectors

In paragraph 5 delete entirely the first three lines and substitute the following.

'Where detectors are designed to be removable from their bases, with or without locking devices, removal of any detector(s) from the circuit should not affect the operation of any manual call point.'

In paragraph 5, line 4, delete 'during' and substitute 'During'.

AMD 6317
January 1991

Clause 6.6.3 Circuits containing fire alarm sounders

Delete entirely the existing clause and substitute the following.

'6.6.3 *Circuits containing fire alarm sounders.* If alarm sounders use the same wiring as detectors, then no alarm sounder should be affected by the removal of any detector. Any sounder that is necessary in order to reach the audibility levels recommended in clause 9 should be capable of electrical disconnection from the alarm sounder circuit only by the use of a special tool and the disconnection should generate a fault warning at the control and indicating equipment. If such alarm sounders are located so that they are easily accessible, consideration should be given to the effects of malicious interference.'

AMD 6317
January 1991

Clause 6.9 Program controlled systems

In paragraph 1, line 5, delete 'of the remainder'.

AMD 6317
January 1991

New clause 6.11

After 6.10 insert the following new clause.

'6.11 *Deviations from the recommendations of the code*

The recommendations of this code are intended to be suitable for the majority of normal applications. There will, however, be a few applications in which the recommendations may be unsuitable, and in which deviations from the code may be necessary. Before agreement of any deviation by interested parties (see 4.3), consideration should be made of at least the following factors:

(a) the quantity and type of contents, including the ease of ignition, heat release rate, and probable rate of fire growth and spread;

(b) the probable false alarm rates of different types of detector;

(c) the method of transmission of fire products from the fire to the detector, including any possible adverse environmental effects;

(d) the type of occupant, including discipline, fitness and training;

(e) the attendance time of fire-fighting forces (including both the local authority fire brigade and any industrial fire brigade);

(f) the degree of fire protection given by other methods (such as partial sprinkler protection);

(g) any needs for special facilities for control or indication;

(h) any special provisions (either already existing or likely to be needed) for maintained power supplies;

(i) the type of work carried out in the building (for example, hot, smoky or dusty operations may need special detection provision);

(j) any special requirements for alarm devices, either due to the type of occupant or to the sound environment in the building;

(k) the fire routine for the building.

NOTE. All deviations should be listed in the installation and commissioning certificate (see appendix B).'

AMD 6317
January 1991

Clause 7.2 Recommendations for the size and number of zones

After item (h), insert the following new item.

'(i) In premises having phased evacuation schemes, the zoning of fire detectors should be compatible with the evacuation procedures.

Particular care should be taken in enclosures common to more than one floor, such as stairways and atria (see also 4.2).'

AMD 6317
January 1991

New clause 7.4

After **7.3** insert the following new clause.

'**7.4 Zoning of fire detectors**

Zoning of fire detectors should be such that upon activation of any device the fire alarm system will respond in the correct manner. This is particularly important where phased evacuation is involved, as evacuation procedures could be adversely affected if incorrect alarm signals were given.

For example, careful consideration should be given to the type of alarm that should result from the operation of fire detectors located in positions which may not be related directly to that of the fire incident, such as in atria, stair enclosures, shafts, ducts, etc.'

AMD 6317
January 1991

New clause 9.4.6

After **9.4.5** insert the following new clause.

'**9.4.6** *Intelligibility.* Any speech message carrying information or instructions relevant to fire action should be intelligible above the background noise in any part of the building to which the message is addressed. Where the level of sound of this message falls below that recommended in **9.4.1**, the message should be preceded for at least 6 s by an attention-drawing signal, having at least the loudness recommended by **9.4.1** and which is used only as a fire warning signal. Where the fire action in the building depends on the reception of verbal messages, the attention-drawing signal should not normally last for more than 10 s.

NOTE. Advice on planning and installation of such systems is given in BS 6259.'

AMD 6317
January 1991

Clause 9.5 Grouping of fire alarm sounders

At the end of the existing text insert the following new paragraph.

'Where fire alarm sounders are grouped, the control equipment should have facilities both for controlling each group individually and for sounding an alarm (either alert or evacuate) in all groups simultaneously. The wiring should be so arranged that failure of a sounder or of sounder wiring in one group will not cause the failure of any other group.'

AMD 6317
January 1991

Clause 9.12 Audible alarms by intercommunication or public address equipment

In item (e), line 2, after 'clause **17**' insert 'and are monitored in accordance with **6.6**'.

After item (g), insert the following new item.

'(h) That where the fire action in the building depends on a continuing ability to give signals over the public address system, consideration should be given to the consequences of failure of amplifiers, tone generators, synthesizers, pre-recorded tapes, etc., and to any consequential need for duplication. In general, systems using moving parts (such as tapes) should be considered as less reliable than other systems.'

Delete entirely item (3) and substitute the following.

'(3) That during fire alarm conditions all audio input sources are automatically disconnected except the speech modules (or equivalent message generators) which give the warning, or those microphones designated as fire microphones. These should be retained in circuit so that announcements and instructions relating to the emergency can be given.

At least one fire microphone should normally be sited near to the control equipment. It may be necessary for additional fire microphone positions to be provided at places well separated from the first. In such cases the system should be so designed that it is not possible for messages from more than one microphone, speech module or message generator to be broadcast simultaneously.'

AMD 6317
January 1991

Clause 9.14 Use of the fire alarm sound for other purposes

Delete entirely the first sentence and substitute the following.

'In general, fire alarm sounds should be used for other purposes only if the response required is identical to that which would be required in a fire, i.e. immediate evacuation of the area in which the alarm is sounding by the use of any route designated as a fire exit. If any other response is required then fire alarm sounds should not be used unless accompanied by other information.'

AMD 6317
January 1991

Clause 10.1 General

In paragraph 3, line 4, delete '8 s' and substitute '3 s'.

Delete entirely the existing note and substitute the following.

'NOTE. A maximum delay of 8 s applied to systems installed before 1 January 1990.'

AMD 6317
January 1991

Clause 10.2 Siting

Between the first and second sentences, insert the following.

'(Special consideration may need to be given for staged alarm systems (see **7.3** and **9.9**).)'

AMD 6317
January 1991

Clause 13.2.2 Protection of escape routes

In the final line, delete 'adjacent' and substitute 'adjoining'.

AMD 6317
January 1991

Clause 13.3.2 Smoke-sensitive detectors

Delete the existing clause title and substitute *'Point and beam type smoke-sensitive detectors.'*

In line 2, between 'with' and 'BS 5445 : Part 7', insert 'BS 5839 : Part 5,'.

AMD 6317
January 1991

Clause 13.4 Siting and spacing

In line 6, delete 'adjoining rooms' and substitute 'rooms opening onto the corridors'.

AMD 6317
January 1991

Clause 13.5.1 General

In the final line, delete 'adjoining rooms' and substitute 'rooms opening onto the escape routes'.

AMD 6317
January 1991

Clause 14.2 Heat detectors

In paragraph 2, line 5, delete the semi-colon and substitute a colon.

AMD 6317
January 1991

Clause 14.6 Time related systems

Delete entirely items (1) to (4) and substitute the following.

'(1) In an analogue detector system it might be possible to increase the alarm thresholds (i.e. decrease the sensitivity of the system to fire) during working hours. Outside working hours the threshold might be reduced (i.e. the sensitivity increased).

(2) Heat detectors employed during working hours could be supplemented by smoke detectors outside working hours.

(3) During working hours the system could be so arranged that initiation of the alarm condition by automatic detectors does not immediately result in the sounding of the alarm of fire: a responsible person would be alerted to investigate the alarm, although the alarm sounders might be automatically sounded after a preset period. However, the sounders should sound immediately in response to any manual operation.

(4) As a last resort, the system could be switched to manual detection during working hours, and be switched back to automatic detection outside working hours.'

AMD 6317
January 1991

Clause 14.7 Transmission delay units

In item (b), line 4, after '2 min' insert 'unless agreement has been reached to delay the sounding of the fire alarm on initiation of the fire condition by automatic detectors (see item (3) of **14.6**)'.

In item (d), line 1, delete 'either' and substitute 'any', and in line 4, after 'immediate transmission of the alarm' insert 'and should sound the fire alarm if not sounded immediately on initiation of the alarm condition (see item (b))'.

AMD 6317
January 1991

New clause 15.2.3

After **15.2.2** insert the following new clause.

'**15.2.3** *Facilities.* The facilities provided by the control equipment should meet any special requirements for the premises; in particular, they should satisfy the requirements defined in **4.2** for action in the event of an alarm of fire.'

AMD 6317
January 1991

Clause 17.2 Applications

In item (a), in the penultimate line, delete 'two-state' and substitute 'two-stage'.

AMD 6317
January 1991

Clause 17.3 Recommended cable types

In item (b), line 2, delete 'AWS' and substitute 'AWX'.

AMD 6317
January 1991

Clause 17.4.2 Applications requiring prolonged operation during a fire

In line 6 delete 'direct', and between item (b) (3) and the final paragraph insert the following note.

'NOTE. The mechanical protection of cables by conduit, ducting or trunking should not be considered to give protection against fire.'

AMD 6317
January 1991

Clause 17.10 Segregation of wiring

In item (d), line 3, delete 'the BASEC scheme' and substitute 'any scheme (such as the BASEC scheme)'.

AMD 6317
January 1991

Clause 29.2.1 General

At the end of the existing text, insert the following new paragraph.

'In some cases it may be desirable for special facilities to be incorporated in the system to assist in servicing, e.g. a low-level 'pip tone' can be used in some sounder systems to enable the sounders to be checked without undue disturbance of the occupants. Where synthesized or recorded speech messages are used, a monitor speaker near the control equipment may enable the message to be checked without operating the main sounders.'

AMD 6317
January 1991

Clause 29.2.4 Weekly attention by the user

In item (a), in lines 2, 5, 6, 9 and 10, delete 'circuit' and substitute 'zone'.

AMD 6317
January 1991

New appendix K

After appendix J, insert the following new appendix.

'Appendix K. The uses of staged alarm systems

K.1 Staged alarms and phased evacuation

In the past, the terms 'staged alarms' and 'phased evacuation' (particularly 'two-stage alarm' and 'two-phase evacuation') have frequently been confused. In the context of this standard, 'staged alarms' refer to the stages of alarm (hidden staff alarm, general alert signal, evacuation alarm, etc.) which can be given in a particular area, and 'phased evacuation' refers to the evacuation of the premises in a controlled sequence of phases.

Although staged alarms are usually given by alarm devices of various types (e.g. coloured lights or 'bleepers' for a staff alarm, intermittent sounds for an alert signal and continuous sounds for the evacuation signal), it is possible for the same functions to be performed by a public address system. In this case the staff alarm could be given by a 'coded' message and the alert and evacuation signals could be given as 'plain language' messages. In some cases the use of voice messages may be considered as giving a greater degree of control while simultaneously allowing the transfer of better information.

The use of phased evacuation implies at least one phase in which people near the fire are warned to evacuate their area while people further from the fire are only alerted. Thus in the simplest type of phased evacuation the first phase is of movement only of people at immediate risk, while the second phase is of evacuation of the remainder of the premises. Such a type has sometimes been referred to as a 'two-stage system', but this is now deprecated because of the possible confusion with 'two-stage alarms'. A more complex type of phased evacuation (common in large office buildings) involves a greater number of phases of evacuation, possibly depending on the height of the building, the available stairs and the fire separation within the building.

K.2 Conditions in which staged alarm systems can be used

Staged alarm systems may be found convenient in a wide range of applications. Four such applications are as follows.

(a) Premises in which only a restricted part will be at risk from a fire, although alert signals or staff alarms may be necessary in some other parts. For example, the premises could consist of a range of separate buildings using a common alarm system; an evacuation signal could be given in one building while staff alarms in other buildings alert a works fire brigade.

(b) Premises in which phased evacuation is to be used.

(c) Premises in which staff away from the fire area are required to perform certain functions (such as shut-down procedures) before leaving the building.

(d) Premises in which the fire procedure allows for the investigation of alarms from automatic fire detectors prior to the initiation of evacuation. In some premises the increased risk due to the delays associated with such a procedure might be acceptable in return for a reduction in the inconvenience due to an unduly high frequency of false alarms (see **14.6**).'

AMD 6317
January 1991

Publications referred to

Delete entirely the entry for BS 800 and substitute the following.

'BS 800 Specification for limits and methods of measurement of radio interference characteristics of household electrical appliances, portable tools and similar electrical apparatus'

In the entry for BS 5446, line 1, delete 'purposes' and substitute 'premises'.

Delete entirely the entry for BS 5467 and substitute the following.

'BS 5467 Specification for cables with thermosetting insulation for electricity supply for rated voltages of up to and including 600/1000 V and up to and including 1900/3300 V'

In the entry for BS 5588, delete the footnote mark.

Insert the following new entry in the correct numerical order.

'BS 6259 : 1982 Code of practice for planning and installation of sound systems'

Delete entirely the reference to CP3 : Chapter IV : Part 1.

AMD 6874

Amendment No. 2
published and effective from 1 May 1992
to BS 5839 : Part 1 : 1988

Fire detection and alarm systems for buildings
Part 1. Code of practice for system design, installation and servicing

Revised text

AMD 6874
May 1992

Clause 6.6.2 Circuits containing fire detectors (as amended by Amendment No. 1)

Delete paragraphs 1, 2 and 3 and substitute the following.

'**6.6.2** *Circuits containing fire detectors.* The wiring arrangement of the system should be such that:

(1) if separate circuits are used for each zone, then a fault or faults on one circuit cannot affect any other circuit;

(2) if any circuit is used for more than one zone, then a single fault on that circuit cannot remove protection from an area greater than that allowed under **7.2**(a) to (d) for a single zone;

(3) if a circuit is used for more than one zone and multiple faults within one fire compartment could remove protection from an area greater than that allowed under **7.2**(a) to (d) for a zone, then the circuit within that compartment is suitably protected (see **17.15**);

(4) two simultaneous faults should not remove protection from an area greater than 10 000 m^2.'

AMD 6874
May 1992

Clause 6.6.3 Circuits containing fire alarm sounders (as amended by Amendment No. 1)

NOTE. The purpose of the amendment to this clause is to correct an error introduced by Amendment No. 1.

At the end of the existing text insert the following.

'The wiring of sounder circuits should be so arranged that, in the event of a short circuit developing in any part of the wiring of sounder circuits during a fire, a minimum of one alarm sounder will continue to sound. This minimum provision should ensure that a general alarm can be given at the start of a fire and for a significant period thereafter, and that in the event of the fire burning through a sounder cable, the alarm will be maintained at at least one point in the building, usually near the control equipment.

The minimum sounder circuit provision does not ensure that the reduced alarm is audible throughout the building. In some installations the minimum provision against loss of signal may not be sufficient. If audibility of the alarm throughout the building is required to be maintained even in the event of attack by fire on the sounder cables, then either:

(a) cables likely to resist fire for a considerable time should be used; or

(b) a greater number of separate sounder circuits should be provided; or

(c) sounder cables protected against cable faults (see **6.6.5**) should be used.'

AMD 6874
May 1992

Clause 9.12 Audible alarms by intercommunication or public address equipment

In item (g), line 5, after 'ensured', insert 'and reference should be made to BS 7443'.

In item (2), line 4, change 'perods' to 'periods'.

AMD 6874
May 1992

Appendix B. Model certificate of installation and commissioning of a fire alarm system

In the paragraph commencing 'In accordance with BS 5839 : Part 1 : 1988, subclause 26.1,' insert a comma after 'supplied'.

AMD 9257

Amendment No. 3
published and effective from 15 August 1996
to BS 5839 : Part 1 : 1988

Fire detection and alarm systems for buildings

Part 1. Code of practice for system design, installation and servicing

Instructions for replacement of pages

Where only one of the two pages on each sheet has been updated, the other page has been reprinted.

Front cover and inside front cover	Replace the pages
a and b	Insert the pages immediately after the inside front cover
17 and 18	Replace the pages
35 and 36	Replace the pages
Inside back cover and back cover	Replace the pages

You may wish to retain the superseded pages, e.g. for reference purposes, if so please mark them 'Superseded by issue X', where 'X' is the appropriate issue number. If you do not wish to retain the superseded pages, please destroy them.

BRITISH STANDARD

BS 5839 :
Part 1 : 1988

Incorporating Amendment Nos. 1, 2 and 3

Fire detection and alarm systems for buildings

Part 1. Code of practice for system design, installation and servicing

Foreword

This Part of BS 5839 has been prepared under the direction of the Fire Standards Committee. It is a revision of BS 5839 : Part 1 : 1980, which is withdrawn.

In addition to the existing BS 5839 : Parts 2, 3, 4 and 5, a specification for line-type heat detectors is in preparation. Parts of EN 54 'Components of automatic fire detection systems' (in preparation by Technical Committee CEN/TC 72, Automatic fire detection systems, of the European Committee for Standardisation) will be published as Parts of BS 5445. Standards prepared by subcommittee ISO/TC 21/SC 3, Fire detection and alarm systems, (of Technical Committee TC 21, Equipment for fire protection and fire fighting, of the International Organization for Standardization) that are accepted as British Standards will be included in BS 5445 if adopted by CEN, and in BS 5839 if not.

As far as possible, this Part of BS 5839 takes account of the work of CEN/TC 72 and ISO/TC 21/SC 3.

The major part of this revision was updating the recommendations and important changes made are as follows.

(a) Classifications have been introduced to allow the specification of system type by principal purpose (i.e. life or property protection) and extent of protection provided (i.e. entire premises, areas of special risk only, or escape routes only).

(b) Recommendations have been included to cover systems utilizing recent advances in technology, e.g. the use of microprocessors, analogue detector signalling, multi-function indicators and radio-linked systems.

(c) Advances in technology have led to systems in which circuits serve more than a single zone: recommendations have been incorporated to restrict the effect of faults in such circuits.

(d) Recommendations on self-contained smoke alarms for domestic use are no longer included in the body of this Part of BS 5839.

(e) Consideration has been given to problems which might arise from the combination into one system of components from several manufacturers.

(f) Monitoring of circuits connecting detectors, sounders, call points, power supplies and control and indicating equipment is recommended.

(g) With the exception of control equipment for small manual systems, (see appendix G), all recommendations relating to the specification of control equipment have been transferred to BS 5839 : Part 4.

(h) The maximum delay in the response to the operation of manual call points has been altered to 8 s, and is further reduced to 3 s from 1 January 1990.

(i) Following recent research, the provision of detectors in rooms adjoining escape routes is now recommended, particularly for sleeping accommodation.

(j) More detailed recommendations on the avoidance of false alarms are included.

(k) The effect on manual call points of the removal of detectors from their bases is included.

Current legislation requires that an effective means of giving warning in case of fire be provided in certain premises. The fire authority and the Health and Safety Executive will advise on legislation that applies to any building. Consultation with the appropriate authority is advisable and may be obligatory.

The protection of property with a fire detection and alarm system may permit an insurance company to offer a reduced premium provided that the system is acceptable. Early consultation with the insurer is advisable.

Fire protection should not be confused with fire precautions, and the provision of a fire detection and alarm system should never be regarded as giving complete protection against fire. In particular, it should not be used as an excuse for reducing measures intended to prevent the occurrence of fire. For detailed recommendations on fire precautions in buildings, reference should be made to the relevant Parts of BS 5588

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.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

The following table identifies the current issue of each page. Issue 1 indicates that a page has been introduced for the first time by amendment. Subsequent issue numbers indicate an updated page. Double sidelining on replacement pages indicates the most recent changes (amendment, addition, deletion).

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Inside front cover	original	35	2
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b	blank	Inside back cover	2
1 to 16	original	Back cover	2
17	2		

Where the transmitted alarm is a voice message the following should be ensured and reference should be made to BS 7443.

(1) That a suitable alarm (either pre-recorded or synthesized) is immediately and automatically transmitted on the receipt of a fire signal; this transmission should not depend on the presence of an operator.

(2) That the time interval between successive messages does not exceed 30 s, and that 'fill-in' signals similar to those of conventional sounders are used wherever periods of silence might otherwise exceed 10 s.

(3) That during fire alarm conditions all audio input sources are automatically disconnected except the speech modules (or equivalent message generators) which give the warning, or those microphones designated as fire microphones. These should be retained in circuit so that announcements and instructions relating to the emergency can be given. At least one fire microphone should normally be sited near to the control equipment. It may be necessary for additional fire microphone positions to be provided at places well separated from the first. In such cases the system should be so designed that it is not possible for messages from more than one microphone, speech module or message generator to be broadcast simultaneously.

(4) That all voice messages are clear, short, unambiguous and, as far as practicable, preplanned.

(5) That the level of sound in the building complies with the recommendations of 9.2 for property protection systems, or 9.3 for life protection systems.

Where the transmitted alarm is not a voice message, its audibility should comply with the recommendations of 9.2 for property protection systems or 9.3 for life protection systems.

9.13 Limitation of alarm information

In some systems much information about both the state of the system and any fire condition is available. It is important that, in order to avoid confusion, the amount of information given is limited to that which is both necessary and sufficient.

9.14 Use of the fire alarm sound for other purposes

In general, fire alarm sounds should be used for other purposes only if the response required is identical to that which would be required in a fire, i.e. immediate evacuation of the area in which the alarm is sounding by the use of any route designated as a fire exit. If any other response is required then fire alarm sounds should not be used unless accompanied by other information. However, as an established exception, it may be permissible in schools to use a coded signal of short duration to indicate the start or finish of predetermined periods. The duration of the coded signal should not exceed 5 s. Where new systems are being installed, or where sounders are being replaced, the use of sounders capable of delivering several distinct sounds should be considered, with one of the sounds being reserved for fire alarm use.

10 Manual call points

10.1 General

Manual call points should comply with BS 5839 : Part 2.

It is important that manual call points are clearly identifiable and simple to use without the need for instructions as to their method of operation. The method of operation of all manual call points in an installation should be identical unless there is a special reason for differentiation. If necessary a striker should be provided adjacent to the call point to facilitate breaking the frangible cover.

A person operating a manual call point should not be left in doubt as to the success of the operation. The delay between operation of a call point and the giving of the general alarm should therefore not exceed 3 s.

NOTE. A maximum delay of 8 s applied to systems installed before 1 January 1990.

If the design of the system is such that the indication of the alarm could be unwittingly cancelled at the call point after the glass has first been broken, then the delay between operation of the call point and the giving of the general alarm should not exceed 1 s.

Requirements additional to those of BS 5839 : Part 2 may be necessary where call points are to be used in flammable or explosive atmospheres (see 6.5), or where frangible element fragments are objectionable, such as in food preparation areas.

10.2 Siting

Manual call points should be located on exit routes and in particular on the floor landings of stairways and at exits to the open air. (Special consideration may need to be given for staged alarm systems (see 7.3 and 9.9).) They should be so located that, to give the alarm, no person in the premises need travel more than 30 m. It may be necessary to have travel distances to a call point much less than 30 m where the expected occupants of the building are likely to be slow in movement, or where potentially hazardous conditions exist, e.g. in close proximity to cellulose spray booths. The action to be taken in the event of fire may make the provision of additional manual call points necessary.

In general, call points should be fixed at a height of 1.4 m above the floor, at easily accessible, well illuminated and conspicuous positions free from obstruction. Manual call points should be sited against a contrasting background to assist in easy recognition. They may be flush mounted in locations where they will be seen readily, 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.

10.3 Manual call points in automatic systems

If manual and automatic devices are to be installed in the same building for the purpose of providing a general alarm of fire, then they may be incorporated into a single system; zoning of such systems is covered in 7.3, and the connection of call points to circuits containing fire detectors is covered

in **6.6.2.** Where manual call points are incorporated in an automatic system the delay between the operation of the call point and the indications of alarm should comply with the recommendations of **10.1.**

11 Types of fire detector

11.1 General

Fire detectors are designed to detect one or more of three characteristics of a fire: smoke, heat and radiation (flame). No one type of detector is the most suitable for all applications and the final choice will depend on individual circumstances. It will often be useful to employ a mixture of different types of detector.

Most, if not all, fire detectors are affected not only by the level of the detected phenomena but also by the behaviour of the phenomena with time. In some cases this is deliberate, as with detectors responding to rate-of-change of phenomena; in others it is the effect, for instance, of delays in smoke entry or of thermal lags. In systems using analogue detectors, the time response of the system can often be controlled or modified by the processing software in the control equipment.

All fire detectors will respond to some extent to phenomena other than fire; reducing the incidence of such false alarms is covered in clause **14.**

11.2 Heat detectors

There are two main types of heat-sensitive detector. One is the 'point' type of detector responding to the temperature of the gases in the immediate vicinity of a single point. The other is the 'line' type of detector which responds to the temperature of the gases in the vicinity of a line (not necessarily straight). Line detectors can be integrating or non-integrating: in the integrating type the response to temperature at one point on the line is modified by the temperature of the remainder of the line, while in the non-integrating type the response to temperature at one point is independent of temperatures at other points on the line.

In both main types (point and line) there are two main subdivisions.

(a) *Fixed temperature (static) elements.* These are designed to operate when they reach a pre-selected threshold temperature.

(b) *Rate-of-rise of temperature elements.* These are designed to operate when their temperature rises abnormally quickly.

Point heat detectors should comply with BS 5445 : Part 5, except in high temperature areas (see **11.5.2** and **12.3.2**), where heat detectors complying with BS 5445 : Part 8 should be used.

Heat detectors complying with BS 5445 will 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. Reference in this clause to static and rate-of-rise elements should not be taken as requiring physically separate elements, but as requiring a detector response equivalent to that of a detector containing the separate elements. Particularly in analogue output detectors, the response of a single temperature sensor can be electrically modified to produce the desired detector response.

11.3 Smoke detectors

There are two commonly used classes of detectors for detecting smoke.

(a) *Ionization chamber smoke detectors.* These are based on the fact that the electric current flowing between electrodes in an ionization chamber is reduced when smoke particles enter the chamber.

(b) *Optical smoke detectors.* These operate by detecting the scattering or absorption of light by smoke particles.

There are 'point' type smoke detectors that detect smoke at one position and which may be based on optical or ionization chamber principles, aspirating smoke detectors in which air is taken from a number of positions to a central detector and 'beam' type smoke detectors working on the optical obscuration principle. Beam detectors are effectively line detectors since they can detect the presence of smoke in only 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 comply with BS 5445 : Part 7 or, for residential applications, BS 5446 : Part 1 (excluding self-contained smoke alarms). Smoke detectors (other than self-contained smoke alarms) complying with BS 5446 : Part 1 may also be suitable for an industrial or commercial environment that is similar to that present in residential premises. Optical beam smoke detectors should comply with BS 5839 : Part 5.

In an aspirating smoke detector, the tube from the protected space to the central detector may have one or more holes through which smoke may be drawn. Design of the system should take into account any dilution of smoke taken into one hole by clean air taken into others. The amount of air entering each hole is usually small, and should not be considered as modifying air or smoke flows within the protected space. In general, each hole may be considered as a separate point smoke detector, and siting of the holes may be based on the siting requirements for point smoke detectors. The system should be such that separate signals are obtained from each zone. The design and sizing of the tubing system should comply with the manufacturer's recommendations.

11.4 Flame detectors

Flame detectors detect ultraviolet and/or infra-red radiation. Both types use radiation-sensitive cells that 'see' the fire either directly or through built-in lenses or reflectors.

Infra-red flame detectors are intended to respond to the flickering radiation emitted by the diffusion type of flame normally found in fires. Because of the presence of other infra-red sources, such as the sun, infra-red flame detectors will usually have some method of discriminating between fire and non-fire radiation; flicker sensing or the use of one or more specific infra-red emission bands are common techniques.

or non-flame propagating trunking complying with BS 4678 : Part 4 should be used. It should be noted that the flame propagation test does not necessarily indicate the ability of the trunking to maintain the circuit integrity under fire conditions.

Other types of conduit, ducting or trunking may be used only if it can be shown that, in the application in which they are to be used, their resistance to ambient conditions including resistance to mechanical impact and abrasion is not less than that of the types specified as suitable for the application, and they are not prone to failure due to faulty assembly or installation.

17.9 Joints

All joints, except those in detectors, call points, sounders, control and indicating equipment or other similar system components, should be enclosed in suitable junction boxes labelled 'FIRE ALARM' to avoid confusion with other services. Jointing and termination methods should be chosen to minimize any reduction in reliability and resistance to fire below that of unjointed cable.

17.10 Segregation of wiring

Conductors carrying fire alarm power or signals should be separated from conductors used for other systems. The separation may be by one or more of the following:

(a) installation in conduit, ducting, trunking or a channel reserved for fire alarm conductors;

(b) a mechanically strong, rigid and continuous partition of non-combustible material;

(c) mounting at a distance of at least 300 mm from conductors of other systems;

(d) wiring in cables complying with BS 7629;

(e) wiring in mineral-insulated copper-sheathed cable (see 17.3(a)) with an insulating sheath or barrier. The exposed-to-touch rating of the IEE Wiring Regulations should not be exceeded.

If a cable which should be segregated from cables of other services is not enclosed in ducting, trunking or a channel reserved for fire alarm circuits, then it should be suitably marked or labelled at intervals not exceeding 2 m to indicate its function and the need for segregation. Ducting, trunking or a channel reserved for fire alarm circuits should be marked to indicate this reservation. The fire alarm cable should be completely enclosed when the cover of the ducting, trunking or channel is in place, and all covers should be securely fixed.

Segregation of the fire alarm power supply cables need not be applied on the supply side of the isolating protective device (see 16.2). Cables carrying power in excess of extra-low voltage should be separated from other fire alarm cables. In particular, the mains supply cable should not be brought in through the same cable entry as cables carrying extra-low voltage power or signals.

17.11 Telecommunication cables

Public telecommunications operator lines used for the transmission of alarms to the fire brigade should be mechanically protected (see 17.5.2) and should be considered as needed to give prolonged operation in a fire (see 17.4.2).

17.12 Overhead lines

Overhead lines should be avoided wherever possible for fire alarm system interconnections. If they are used, BS 6701 : Part 1 should be followed. If overhead lines cross or are installed in close proximity to electricity power lines, public telecommunications operator lines or other overhead lines, agreement relating to protection should be reached with the appropriate operator.

17.13 Damp, corrosive or underground locations

Cables intended for installation in damp, corrosive or underground locations, or in plasters or cements having a corrosive effect on metallic sheathing, should be PVC-sheathed overall. Where the environment may attack PVC, a suitable alternative sheath should be adopted. In some locations further protection may be necessary.

17.14 Ambient temperatures

Care should be taken that the combination of ambient temperature and temperature rise caused by load current does not result in a conductor temperature which exceeds the limit for the insulation.

Where high conductor temperatures are anticipated, cables having appropriate heat-resisting insulation should be used, such as:

(a) 85 °C rubber-insulated cable complying with table 1 or 5 of BS 6007 : 1983;

(b) 150 °C rubber-insulated cable complying with table 6 of BS 6007 : 1983;

(c) 85 °C rated PVC-insulated cables complying generally with BS 6004 but having type 4 or 5 insulation and sheath complying with BS 6746;

(d) 90 °C rated XLPE- or EPR-insulated cables complying with BS 5467 or BS 6724.

PVC conduit should not be used where the ambient temperature is likely to exceed 60 °C. Where temperatures below −5 °C for classification 405/1 of BS 6099 : Section 2.2 or −25 °C for classification 425/1 of BS 6099 : Section 2.2 are likely, suitable precautions should be taken to avoid physical damage.

17.15 Systems protected against cable failure

If circuits are protected against single cable faults (see 6.6.5) then a reduced standard of cable protection may be acceptable. If the design is such that a single fault on the interconnections between components will:

(a) at most have an effect on the components immediately adjacent to the fault;

(b) not affect the correct working of the remainder of the system;

(c) give a fault warning as recommended in **6.6.5**;

(d) indicate that section of the cabling affected by the fault;

then any of the cables described in **17.3** can generally be allowed for any application.

Care should be taken in the planning and siting of cable runs for such systems so that a fire restricted to a single fire compartment cannot so damage the cable as to prevent the correct operation of devices in any other compartment. If such siting cannot be avoided, then wiring able to withstand prolonged exposure to fire should be used within the critical compartment(s).

18 Radio-linked systems

18.1 General

18.1.1 *Radio links.* Some alarm systems are available in which some or all of the interconnections between components are made by radio links. Because of the special properties of radio signals, some of the recommendations applicable to wired systems, particularly those for power supplies and fault monitoring, are unsuitable for, or cannot be applied to, radio-linked systems. In such systems the recommendations of this clause should be followed.

18.1.2 *Choice of system.* Radio-linked systems have both advantages and disadvantages. Before adopting such a system for any specific application, the advantages and disadvantages should be carefully considered so that a correct choice of system can be made.

18.1.3 *Advantages of radio-linked systems.* The advantages of radio-linked systems include the following.

(a) Since, in general, no wiring is needed between system components, the system can be much easier, quicker and cheaper to install. The system can extend beyond a single building without inter-building wiring, provided that the buildings are in the same ownership and no third party is involved. Disruption of normal activities during installation is minimized, and the system can be easily modified or extended.

(b) The absence of wiring means that damage or disfigurement of existing surfaces is kept to a minimum. This can be particularly important in dealing with buildings having valuable or historic decoration.

(c) Individual identification of each detector or call point is a normal feature of radio-linked systems.

(d) Radio links will function without impairment in a fire, reducing the need for fire-protected cables.

(e) On some systems, radio-linked repeater indicator panels can be easily added as required elsewhere in the building.

(f) Short-term temporary cover of special risks can be easily arranged.

18.1.4 *Disadvantages of radio-linked systems.* The disadvantages of radio-linked systems include the following.

(a) Because limitations of allowed frequency spectrum can lead to interference between simultaneous signals, it is considered unwise to send monitoring signals at very frequent intervals. Hence for some (but not all) faults, there may be a significant delay (possibly several hours) between the occurrence of a fault and its indication on the control equipment.

(b) Radio links cannot transfer significant amounts of power. Each detector, call point or sounder has to be supplied with local power, either from local mains or from batteries.

(c) There is a possibility of the radio path being interrupted by temporary or permanent screening. This should be indicated as a fault, but in the interval before the fault is indicated (see **18.3**) the area could be unprotected. The problem becomes more important when screening affects several detectors in one area.

(d) The possibility exists that the receiver may be blocked by interfering signals from other sources. Radio alarm systems operate on frequencies which are not protected by the regulatory body from other interfering signals on those frequencies.

NOTE. The possibility of interference from other sources can be much reduced by proper receiver design, for instance by a suitably narrow receiver bandwidth, or by redundancy techniques in the transmission.

18.2 Power supplies

18.2.1 *Power supplies for control and indicating equipment.* Power supplies for control and indicating equipment (other than repeater panels) should comply with the recommendations of clause **16.**

18.2.2 *Power supplies for sounders and repeater indicator panels.* Power supplies for sounders and for repeater indicator panels should comply with the recommendations of clause **16**, except that the normal supply may be derived from the local mains supply, which need not have an isolating protective device (see **16.2**). Failure of the normal supply to a sounder or repeater panel should give a fault warning at the main control and indicating equipment.

18.2.3 *Power supplies for detectors and manual call points.* Power supplies for detectors and manual call points should be derived from either:

(a) the normal mains supply plus a reserve battery (primary or continuously charged secondary); or

(b) a primary battery plus a reserve second primary battery. The primary battery used for the normal supply should have an operational life of at least 1 year. If intended to be replaceable by the user the battery should be of a type readily available from electrical suppliers.

Power supplies having one or more primary batteries should give at least 30 days warning of impending failure of any primary battery. This warning should be by a fault

Publications referred to

BS 476 Fire tests on building materials and structures
BS 800 Specification for limits and methods of measurement of radio interference characteristics of household electrical appliances, portable tools and similar electrical apparatus
BS 1635 Graphical symbols and abbreviations for fire protection drawings
BS 2316 Specification for radio-frequency cables
Part 3 Cable data sheets (metric and imperial units)
BS 3116 Specification for automatic fire alarm systems in buildings
*Part 4 Control and indicating equipment
BS 4678 Cable trunking
Part 4 Specification for cable trunking made of insulating material
BS 4683 Specification for electrical apparatus for explosive atmospheres
BS 5306 Fire extinguishing installations and equipment on premises
Part 1 Hydrant systems, hose reels and foam inlets
Part 3 Code of practice for selection, installation and maintenance of portable fire extinguishers
BS 5345 Code of practice for the selection, installation and maintenance of electrical apparatus for use in potentially explosive atmospheres (other than mining applications or explosive processing and manufacture)
BS 5445 Components of automatic fire detection systems
Part 5 Heat sensitive detectors — point detectors containing a static element
Part 7 Specification for point-type smoke detectors using scattered light, transmitted light or ionization
Part 8 Specification for high temperature heat detectors
BS 5446 Specification for components of automatic fire alarm systems for residential premises
Part 1 Point-type smoke detectors
BS 5467 Specification for cables with thermosetting insulation for electricity supply for rated voltages of up to and including 600/1000 V and up to and including 1900/3300 V
BS 5501 Electrical apparatus for potentially explosive atmospheres
BS 5588 Fire precautions in the design and construction of buildings
BS 5750 Quality systems
BS 5839 Fire detection and alarm systems for buildings
Part 2 Specification for manual call points
†Part 3 Specification for automatic release mechanisms for certain fire protection equipment
Part 4 Specification for control and indicating equipment
Part 5 Specification for optical beam smoke detectors
BS 5969 Specification for sound level meters
BS 6004 Specification for PVC-insulated cables (non-armoured) for electric power and lighting
BS 6007 Specification for rubber-insulated cables for electric power and lighting
BS 6099 Conduits for electrical installations
Section 2.2 Specification for rigid plain conduits of insulating material
BS 6132 Code of practice for safe operation of alkaline secondary cells and batteries
BS 6133 Code of practice for safe operation of lead-acid stationary cells and batteries
BS 6207 Specification for mineral-insulated copper sheathed cables with copper conductors
BS 6231 Specification for PVC-insulated cables for switchgear and controlgear wiring
BS 6259 Code of practice for planning and installation of sound systems
BS 6266 Code of practice for fire protection of electronic data processing installations
BS 6346 Specification for PVC-insulated cables for electricity supply
BS 6387 Specification for performance requirements for cables required to maintain circuit integrity under fire conditions
BS 6467 Electrical apparatus with protection by enclosure for use in the presence of combustible dusts
BS 6651 Code of practice for protection of structures against lightning
BS 6701 Code of practice for installation of apparatus intended for connection to certain telecommunications systems
Part 1 General recommendations
BS 6724 Specification for armoured cables for electricity supply having thermosetting insulation with low emission of smoke and corrosive gases when affected by fire
BS 6746 Specification for PVC insulation and sheath of electric cables
BS 7629 Specification for thermosetting insulated cables with limited circuit integrity when affected by fire
BS 8313 Code of practice for accommodation of building services in ducts
CP 1003 Electrical apparatus and associated equipment for use in explosive atmospheres of gas or vapour other than mining applications

§ IEE Wiring Regulations, Regulations for electrical installations, Institution of Electrical Engineers

* Withdrawn, superseded by BS 5839 : Part 4.

† Referred to in the foreword only.

‡ Referred to in the foreword only. Under revision, to be published as BS 5588 : Section 1.2.

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Department of the Environment (Property Services Agency)
Department of Transport (Marine Directorate)
Electrical Contractors' Association
Electrical Installation Equipment Manufacturers' Association (BEAMA Ltd.)
Fire Insurers' Research and Testing Organization (FIRTO)
Fire Offices Committee
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