

Fire detection and alarm systems for buildings —

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

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Fire Standards Committee (FSM/–) to Technical Committee FSM/12, upon which the following bodies were represented:

- 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

This British Standard, having been prepared under the direction of the Fire Standards Committee, was published under the authority of the Board of BSI and comes into effect on 31 May 1988

© BSI 10-1998
First published, as CP 327.404/402.501, September 1951
First revision, as CP 1019, May 1972
Second revision, as BS 5839-1, January 1980
Third revision May 1988

The following BSI references relate to the work on this standard:
Committee reference FSM/12
Draft for comment 86/36284 DC

ISBN 0 580 16559 0

Amendments issued since publication

Amd. No.	Date of issue	Comments
6317	January 1991	
6874	May 1992	
9257	August 1996	Indicated by a sideline in the margin

Contents

	Page
Committees responsible	Inside front cover
Foreword	ii
Section 1. General	
1 Scope	1
2 Definitions	1
3 Types of system	3
4 Exchange of information	5
5 Planning schedule	6
Section 2. Design considerations	
6 General	8
7 Zones	13
8 Communications with the fire brigade and other off site organizations	15
9 Audible and visual alarms	16
10 Manual call points	20
11 Types of fire detector	21
12 Detectors installed primarily for the protection of property (type P)	24
13 Detectors installed primarily for life safety (type L)	29
14 False alarms	32
15 Control equipment	35
16 Power supplies	37
17 Cables, wiring and other interconnections	40
18 Radio-linked systems	44
19 Ancillary services	46
20 Radio and electrical interference	46
Section 3. Workmanship, installation and commissioning	
21 Work off site	47
22 Work on site	47
23 Siting and accommodation	47
24 Installation of cables and wires	47
25 Installation of equipment	49
26 Inspection, initial testing, commissioning and certification of systems	49
27 Extensions and alterations to existing systems	50
Section 4. User responsibilities	
28 General	52
29 Servicing	53
Appendix A Automatic connection to the fire brigade	58
Appendix B Model certificate of installation and commissioning of a fire alarm system	60
Appendix C Model certificate of testing of a fire alarm system	61
Appendix D Model log book for fire alarm systems	62
Appendix E Ionization chamber smoke detectors	64
Appendix F Fire alarm systems integrated with other systems	64
Appendix G Control equipment and power supplies for small manual systems (type M)	65
Appendix H Smoke alarms in the home	67
Appendix J Guide to recommendations applicable to specific types of system	72
Appendix K The uses of staged alarm systems	73
Table 1 — Limits of ceiling heights	26
Publications referred to	74

Foreword

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

In addition to the existing BS 5839-2, BS 5839-3, BS 5839-4 and BS 5839-5, 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 5839-4.
- 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.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

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

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 74, an inside back cover and a back cover.

The BSI copyright notice displayed in this document indicates when the document was last issued.

Sidelining in this document indicates the most recent changes by amendment.

Section 1. 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 Departments¹⁾ 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 page 74.

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;

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

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

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.

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

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 2. 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 5306-1 and BS 5306-3) 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 5306-0.

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.

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 m².

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.

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**).

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.

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.

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 Programme 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 programme. 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).

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 procedures in the building will usually 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 m².
- 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 m² 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 m², then all zones should be restricted to a single storey, except that:
 - 1) if the total floor area of a fire compartment is 300 m² 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.
- 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 sub-divided 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 m² 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 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 attenuation.

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.