
Fire detection and alarm systems in buildings

Part 1. Code of practice for installation and servicing

(Formerly CP 1019)

Systèmes de détection d'incendie et d'alarme dans les bâtiments
Partie 1. Code de bonne pratique pour l'installation et l'entretien

Feuermelde- und alarmsysteme in Gebäuden
Teil 1. Richtlinie für Einbau und Wartung

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Foreword

This code was first published in 1951 as CP 327/404/402.501 'Electrical fire alarms', one of a series of codes on electrical installations in buildings. The first revision was published in 1972 as CP 1019 'The installation and servicing of electrical fire alarm systems'. This second revision, prepared under the direction of the Fire Standards Committee, supersedes CP 1019 which will be withdrawn on publication of this second revision.

This second revision is published as Part 1 of BS 5839, and further Parts will comprise any future revisions of BS 3116 : Part 4, BS 5364 : Part 1 and BS 5446 : Part 1 together with any new standards that may be prepared, except that any 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 Standardization) that are accepted as British Standards 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 code takes account of the work of CEN/TC 72 and ISO/TC 21/SC 3. The two published Parts of EN 54 have been published as BS 5445 : Parts 1 and 5.

The chief differences between this code and CP 1019 are as follows.

- (a) Attention is drawn to the different needs for the protection of life and the protection of property.
- (b) Detailed information on circuit design and the connection to the local authority fire brigade has been eliminated or reduced.
- (c) The differences between CP 1019 and the various British Standards specifications for components of fire detection and alarm systems have been reduced and will disappear with the revisions of the specifications, which will also remove recommendations from the specifications that are more suitable for a code of practice.

(d) Guidance on zones is included.

(e) Recommendations are made for the selection of detectors.

(f) Recommendations are made to cover the use of optical, optical beam, ultraviolet and infra-red beam detectors.

(g) The use of electromagnetic radiation in place of wiring for transmitting signals among components of a system has been accepted.

(h) The use of multiplex systems is recognized.

(i) The use of telephones for giving the fire alarm within a building is no longer recommended.

(j) Recommendations are made for installations in buildings in multiple occupancy.

(k) Attention is drawn to some legal aspects of the use and disposal of detectors containing radioactive material.

(l) Some guidance is given on the application of self-contained detectors (single-station smoke detectors) that consist, within one unit, of a detector, a power supply and an alarm sounder. More detailed recommendations are in course of preparation, but may be published in a separate document.

Current legislation requires that an effective means of giving warning in case of fire shall 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 installation 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. Reference should be made to CP 3 : Chapter IV : Parts 1, 2 and 3 and BS 5588 : Part 4.

'Amendment No. 2 draws attention to the precautions necessary if detectors and manual call points and perhaps alarm sounders are connected on common wiring, or if zones are isolated for test purposes, and if removal of one or more detectors might render other detectors, or call points or sounders inoperative. In addition the mounting of beam type detectors in close proximity to walls and partitions is permitted, but the mounting of point type detectors on walls remains under consideration.'



This code of practice represents a standard of good practice and therefore takes the form of recommendations. Compliance with it does not confer immunity from relevant statutory and legal requirements.



British Standard

Fire detection and alarm systems in buildings

Part 1. Code of practice for installation and servicing
(Revision of CP 1019)

Section one. General

1. Scope

This code of practice provides recommendations for the planning, installation and servicing of fire detection and alarm systems in and around buildings. It covers systems from simple installations with one or two manual call points to complex installations with automatic detectors, manual call points, control and indicating equipment, connection to the public fire service, etc. It covers systems capable of providing signals to initiate, in the event of 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. The systems covered in this code are referred to as fire alarm systems.

This code does not cover the installation of single or interconnected self-contained detectors having a power supply and alarm sounder within one unit, street fire alarms, the 999 emergency call system, automatic sprinkler installations and extinguishing systems whether or not they can give an alarm, nor manually or mechanically operated sounders.

This code of practice applies only to fire alarm systems for use in a temperate climate such as that of the United Kingdom.

Recommendations for fire detection and alarm systems in electronic data processing installations are given in CP 95*.

2. References

The titles of the standards publications referred to in this code of practice are listed on the inside back cover.

3. Definitions

For the purposes of this code of practice the definitions given in BS 4422 : Parts 1 to 5 apply, together with the following.

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

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

3.3 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.

*In course of revision.

3.4 monitored wiring. Wiring in which either an open circuit or a short circuit failure will result in a fault warning or an alarm of fire.

3.5 sector. A subdivision of the protected premises larger than a zone. A sector will normally contain several zones.

3.6 smoke. Particulate and aerosol products of combustion generated by fire, whether this be of the smouldering or open flame type. (In general the particle diameters range from 10 μm (visible smoke) to 1 nm (invisible smoke).)

3.7 trigger device. A device capable of being operated automatically or manually to initiate an alarm of fire, e.g. a detector, a manual call point, a pressure switch.

3.8 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.

4. Exchange of information

4.1 General. The requirements for the building should be ascertained as accurately as possible by consultation between the client and, as appropriate, the architect, the consultant, the fire detection and alarm system contractor, the local fire authority (the Home Office, for Crown premises), the fire insurer, the Health and Safety Executive, and any public authority concerned. On the basis of this consultation, documents should be prepared showing:

- (a) details of the installation proposed;
- (b) the accommodation required for the equipment that should be specified at an early stage;
- (c) chases, ducts, conduits, channel, trunking and other structural provision required for wiring.

4.2 Action in the event of fire. All management, staff, and in most cases, permanent residents should be instructed in the proper initiation of an alarm of fire. It is essential that in the event of fire a pre-planned and practised course of action should be taken to ensure the safety of occupants and to coordinate efforts to commence fire fighting promptly. The effectiveness of such action depends largely on the signalling facilities of the fire alarm system, and so that these can be suitably arranged, the form of action to be adopted should be the subject of early discussion.

4.3 Restricted access and multiple occupation. Where there is any area within or adjacent to the premises to which access is controlled by some person or authority other than the client, and from which fire could spread to the remainder of the premises or to the means of escape from

the premises, then the consent of that person or authority should be sought to allow the fire alarm system to extend to the area. For a building in multiple occupation, see 8.2, 9.4, 22.2 and 22.3.

4.4 Connection to the local authority fire brigade or a central (fire alarm) station. Where means other than the manually dialled 999 system are to be provided for the transmission of the alarm to the local authority fire brigade, there should be early consultation, where appropriate, with the chief fire officer or fire master, the fire alarm system contractor, the central station manager, the telephone manager and the fire insurer concerned. (See appendix A.)

4.5 Chases, conduits, ducts, channel, trunking, sleeves and segregation of wiring. Wiring drawings should be agreed in collaboration with those responsible for other services to enable necessary chases, conduits, ducts, etc. to be specified before building operations commence. The need for segregation of the fire alarm system wiring and equipment should be taken into account at this stage. (See 8.6, 9.13(f), 17.5, 17.8, clause 18, clause 21 and 25.3.1.)

4.6 Record drawings and operating instructions. On completion of the installation, adequate instructions on its use 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 code that may reflect on the use of the fire alarm system, in particular, those on false alarms (clause 14) and servicing (clause 29). The installer should supply the user with a logbook and a certificate of installation and commissioning (see 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. 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 the requirements of BS 1635 and should be updated to include any modifications or additions made to the system.

The purchasing specification may additionally require circuit diagrams of the fire alarm system and its components to be supplied in sufficient detail for the operation of the system to be understood by the technical staff of the user.

5. Time schedule

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

- (a) A survey of the building or examination of the plans, and an assessment of the usage of the building.
- (b) Consideration of the action to be taken in the event of fire.
- (c) System design for estimating purposes.
- (d) Quotation.
- (e) Consideration of proposals and price.
- (f) Ordering.
- (g) Agreement on the action to be taken in the event of fire.
- (h) Detailed system design for installation.

(i) Production and delivery.

(j) Wiring.

(k) Installation of equipment.

(l) Connecting up and testing, including audibility testing, required by the fire brigade.

(m) Acceptance by the client and other interested parties listed in 4.1.

It will be normal practice for all these stages to be included in the critical path chart for large building operations. Control and indicating equipment for large installations will almost certainly have to be specially manufactured and the importance of dealing with item (f) in good time is evident. Wiring should be carried out at times and stages of building or decorating work agreed with the main contractor and other contractors. Installation of equipment should be carefully integrated with the operations of other trades to minimize damage from damp, building and decorating wet processes, dust, etc. Temporary physical protection may be necessary.

The final connection and switching on of the fire alarm system should be made at a time agreed between the user and the contractor. There may however be an interim period of partial operation during partial occupation of the building or to provide protection against risks during construction. Such operation is a matter for agreement among interested parties.

Section two. Design considerations

6. General design considerations

6.1 Purposes of fire alarm systems. A fire alarm system may be required in a building for one or both of the following purposes.

- (a) To enhance the safety of the occupants, by enabling an alarm of fire to be given to persons in the building so that they may escape to safety and to enable other emergency actions to be taken. The provision of such a system may be a legislative requirement and the system may require the approval of the fire authority.
- (b) To reduce the loss of property in a fire by the early detection of fire and by summoning aid or activating fire-fighting resources. The provision of such a system may be related to the cost of insuring the property and would then require the insurer's approval.

6.2 Protection of life. Fire can kill or maim in many ways, e.g. by asphyxiation, irradiation, 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 loss of visibility on escape routes. It has been shown that people are unwilling to walk through smoke in which they cannot see further than about 10 m even though this in itself constitutes no great hazard. If escape routes are not used for this or any other reason, the occupants are trapped, perhaps to be killed later in one of the ways mentioned above. A satisfactory fire alarm system will sound an alarm of fire while sufficient time remains for extinction of the fire or escape of the occupants before the escape routes become unusable because of smoke or other combustion products.

Primary attention is paid in this code consequently to the protection of the escape routes by the provision of detectors both on the routes and in those areas from which the routes might be hazarded. An alarm of fire should be given before the visibility falls below about 20 m, in order for action to be taken before the escape routes become blocked by smoke. An important feature of the threat posed to human life by fire is that because of the strong convection movement produced by fire, the lethal combustion products may travel a long way from the seat of the fire to regions where people have not been alerted.

In premises in which normally active occupants can be expected to react to an emergency in a rational manner, a manual fire alarm system may be sufficient to meet the purposes outlined in 6.1(a). This applies particularly in premises not used for sleeping in, and where the distribution of the occupants provides a relatively high degree of supervision over all areas where fire may threaten life.

If a protected escape route is protected against smoke by pressurization, the provision of detectors may be affected by the method employed for a particular pressurization scheme. BS 5588 : Part 4 gives recommendations for smoke control in protected escape routes using pressurization.

6.3 Protection of property. A fire alarm system, although it can do nothing to reduce the incidence of fire, can help to reduce the resultant loss by reducing the delay between ignition and the start of effective fire-fighting action.

The longest delay is likely when no people are present in the early stages of the fire. For the reduction of property loss, therefore, automatic detection is essential, although manual call points should also be provided because when people are present they may give the first alarm of fire.

A fire may start virtually anywhere on premises, and if undetected may grow until extinction becomes difficult or impossible. For the best protection, therefore, all parts of the premises should be provided with detectors.

There may be premises in which areas of specially high risk can be identified, and a lower but still worthwhile degree of overall protection can then be obtained by the installation of detectors in the high risk areas only. Such an installation is unlikely to satisfy the requirements of fire insurers.

The usefulness of a fire alarm system in reducing property loss will depend also on the provision of satisfactory fire-fighting resources. Fire-fighting appliances such as buckets complying with the requirements of BS 1689 and BS 3184, fire extinguishers complying with the requirements of BS 5423 and hose reels complying with the requirements of BS 5274 should be provided (see CP 402 : Part 3* and BS 5306 : Part 1), and staff trained in their use (see CP 3 : Chapter IV : Parts 1, 2 and 3). 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 fire alarm systems are unlikely to give satisfactory protection where the attendance time exceeds 15 min, and an attendance time less than 10 min is preferred.

6.4 Installations in explosive or flammable atmospheres. If it is necessary to install fire alarm equipment or wiring in areas where there may be an explosive or flammable atmosphere, the appropriate recommendations of BS 5345 should be observed together with those of CP 1003.

6.5 Circuit design. Care should be taken to ensure compatibility of all components, which might not be ensured by compliance with relevant standards such as codes or specifications.

In the interests of reliability it is desirable that the number of circuit elements in the system on which the actuation of the alarm of fire depends should be kept to a minimum. The design of a fire alarm system should, in the simplest possible manner, provide facilities for transmission to the control and indicating equipment of the signals initiated when manual call points or detectors are operated and when specific faults occur. Also, any resultant signals need to be transmitted by the simplest possible means to sounders and other indicating equipment and to any equipment which is to be operated by the fire alarm system, e.g. fixed fire extinguishing systems, fire doors, ventilating systems, etc. (see clause 18).

Most detectors and call points have contacts or equivalent components such as solid state devices that, electrically, are either normally open or normally closed, the condition being reversed to signal an alarm. Simple circuit arrangements can use either the former connected in parallel (an 'open' circuit) or the latter connected in series (a 'closed' circuit). In either case the reliability of the system is largely dependent on the integrity of the cables. A short-circuit in the cable of the simple 'open' circuit would give a false alarm as would a cable disconnection in the simple 'closed' circuit. A cable disconnection in the simple 'open' circuit or a cable short-circuit in the simple 'closed' circuit would put out of service all devices beyond it in the cable run and the fault could remain unnoticed until revealed by routine testing.

With either arrangement the regularity of routine testing is important and the addition of an 'end-of-line' circuit element, e.g. a resistor, can allow the ready testing of the circuits from the control and indicating equipment using a common test circuit, but to provide for immediate and automatic indication of the cable fault that does not give a false alarm of fire requires also the addition of a fault relay or its equivalent to each detector/call point circuit.

A means of testing the wiring of each zone of a system should be provided. If this is a manually operated device, a manual call point may be used but in this case see 10.3.

Circuits can be arranged to indicate immediately any fault in the cables, whether disconnection or short-circuit, without giving a false alarm of fire, but are more complex. Each detector or call point has to contain an additional element and the reliability with which such systems transmit true alarms of fire can never be quite as high as that of simpler systems built to the same standard. Every additional component on which the alarm sequence depends and any reduction in operational margins will inevitably add some risk. Nevertheless, with care taken to minimize these risks, a fully discriminating system can be justified where there are extensive cable runs on industrial premises and the overall chance of cable damage is relatively high.

* In course of revision. To be revised as BS 5306 : Part 3.

If the system is such that the removal of a trigger device from the circuit could affect the operation of other trigger devices or manual call points:

- (a) a 'fault' signal should be generated at the control equipment (see 15.1.3.2 (d) and (e)) indicating the need to replace the missing trigger device as soon as possible; and
- (b) the operating instructions (4.6) should draw the user's attention to any adverse effects on the remainder of the system of the removal of one or more devices.

During the design stage, consideration should be given to the possibility of malicious removal of trigger devices. If such removal is considered likely, one or more precautions, such as (1), (2) and (3), should be taken. In some installations precautions may be necessary only for some trigger devices, but not all. Possible precautions may include:

- (1) the use of trigger devices wired on circuits separate from those containing manual call points;
- (2) special care to be taken in the routing of the wiring such that manual call points precede other trigger devices in the circuits;
- (3) the use of trigger devices of a type that can be removed only by the use of a special tool. 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 as various articles can be used as ordinary screwdrivers.

If alarm sounders use the same wiring as trigger devices, removal of a trigger device should not affect the operation of an alarm sounder.

The system should be designed to minimize any disruption during maintenance and testing. In particular it is desirable that provision should be made so that testing of individual detectors neither sounds an alarm nor requires the complete system to be disabled to prevent such an alarm.

Any provision for the isolation of trigger devices for maintenance or testing should be such as to allow the operation of alarm sounders in response to the operation of trigger devices that have not been isolated. (See 29.3.3.)

The wiring of sounder circuits should be arranged so as to avoid total loss of the audible signal in the event of a short circuit developing in any part of the wiring of sounder circuits during a fire (see 9.1): one of the two sounders mentioned in 9.1, or the control sounder of 9.3.1 if the same as the general alarm sounder(s), is the minimum that should continue to operate in the event of the failure of all other sounders.

In some installations the minimum provision against loss of signal may not be sufficient. The minimum provision should ensure that a general alarm will be given at the start of the fire, but that in the event of the fire subsequently burning through a sounder cable, the alarm will be maintained at at least one point in the building, usually near the control equipment. This minimum provision does not ensure that the reduced alarm is audible throughout the building. 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 cables likely to resist fire for an adequate time should be used or a greater number of separate sounder circuits should be provided.

7. Zones

The protected area should be divided into zones in order that a clear and unambiguous indication can be given of that part of the area from which the alarm has originated. Careful consideration is necessary in determining the arrangement of zones. Accessibility, size, the provisions for containment of smoke and fire, and the fire routine determined for the premises should all be taken into account.

It is important, particularly in occupied buildings, that each zone is readily accessible from the main circulation routes leading from the point where the control and indicating equipment is sited. It should preferably not be necessary to pass through any zone other than by a main circulation route in order to reach another zone.

A zone should be sufficiently limited in extent to enable the precise location of the origin of an alarm of fire to be quickly determined. Any delay will depend not only on the extent of the zone but also on the degree and complexity of its internal subdivision.

(a) A zone should not extend beyond a single fire compartment, defined by the main walls, floor and ceiling of the compartment.

(b) The floor area of a zone should not exceed 2000 m².

(c) A zone should normally cover only one storey, except that where detectors are fitted in stairwells, lightwells, liftshafts and other flue-like structures extending beyond one floor but within one fire compartment, the volume of the well or shaft may be considered as a separate zone. If the total floor area of the building is 300 m² or less, then the building may be considered as a single zone even though there may be more than one storey.

(d) The search distance is the distance necessarily travelled within a zone by a searcher in determining the position of a fire indicated as existing in that zone, and should not exceed 30 m. To meet this requirement in a zone subdivided into rooms it may be advisable to fit indicators external to the doors, to indicate whether a detector within the room has operated. Indicators may be helpful if doors are likely to be locked.

If manual call points are included within an area defined by item (a), they may be wired to the detector circuit for that fire zone. If manual call points have been sited, say,

on the staircase landings, it may be preferable for them either to be wired as a separate zone, or to be incorporated in the wiring of the zone described in item (c), because otherwise they may give a misleading indication of the position of the fire.

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

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

In very large systems, such as systems covering more than one building, it may be necessary to restrict the number of zones from which alarms may originate simultaneously or in succession. Such restrictions should only be applied after consultations among the interested parties listed in 4.1.

8. Communications with the local authority fire brigade

8.1 It is desirable that provision should be made for the transmission of alarms to the local authority fire brigade by the speediest and most certain means available (see appendix A). Consultation with the insurers is advisable.

8.2 If a building is divided into separate occupancies, tenants or occupiers should make reliable arrangements to avoid the unnecessary duplication of emergency calls and, more importantly, to prevent the possibility of failure to call the fire brigade.

8.3 If communication with the local authority 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. (See clause 9.)

8.4 If a special telephone is provided for emergency purposes, it should be arranged so that outgoing calls have priority or incoming calls are barred.

8.5 If the transmission of an alarm to the local authority fire brigade depends on a telephone operator on the premises making a call, consideration should be given to the possible effects of a fire on the operator.

8.6 If Post Office lines are used in the transmission of fire signals to the local authority fire brigade, it is desirable to limit the risk of such Post Office lines being damaged by fire before a fire alarm is initiated. Regard should therefore be given to the routing of the lines and to the provision of additional protection in exposed situations. Such lines should, wherever possible, be protected within the building to an extent not less than that recommended in clause 17. Lines for the transmission of fire alarm signals should be the subject of discussion with the manager of the telephone area, so that, where practicable, the use of overhead lines can be avoided in the vicinity of the building.

The lines and the equipment for transmitting and receiving the electrical signal should, if practicable, be monitored and in the event of a failure should indicate a fault. The subscriber should, if practicable, be informed of such failure so that arrangements can be made for the continued protection of the premises.

8.7 Where there can be a high incidence of false alarms it may be desirable to delay, pending investigation, the transmission of an alarm to the local authority fire brigade. Delays greater than those allowed by BS 3116 : Part 4 for the operation of the control equipment (10 s) will not generally be accepted by fire insurers. Greater delays should only be incorporated after discussion with the fire authority and/or fire insurer, and the mechanism for this purpose should be so designed that the period of delay cannot readily be altered. Any alteration to the delay period should first be referred to the local authority fire brigade and/or fire insurers, and a notice to this effect should be attached to the mechanism. It is essential that the delay allowable should be related to the attendance time of the local authority fire brigade and the action to be taken in the event of fire: in general delay times greater than 2 min should not be used.

9. Audible and visual alarms

9.1 Fire alarm sounders. The number of fire alarm sounders used inside a building should be sufficient to produce the sound level recommended in 9.6 and 9.7 but should in any case be at least two. Advice on

② the connection of sounder circuits is given in 6.5.

② Wiring for sounders should be in accordance with 17.2.
 'Removal of a trigger device should not affect the operation of an alarm sounder even if alarm sounders use the same wiring as trigger devices. (See 6.5.)'

A fire alarm system may be required to have a sounder outside a building primarily in order to guide the fire brigade to the desired entrance. The position of this sounder should be agreed with the fire brigade. The sounder or its case should be coloured red and marked 'FIRE ALARM'.

9.2 Grouping of fire alarm sounders. The control equipment contains the mechanism for the activation of the alarm sounders.

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, the system may be arranged so that the alarms sound initially in the zone of origin, or in that zone and in adjoining areas, or in that zone and in specially selected areas of high flammability or difficult egress.

The sounding of alarms can be arranged, particularly in smaller buildings, such that any alarm operates the sounders throughout the entire building.

It is essential that the grouping of fire alarm sounders depends on consideration of the fire routine of the building or individual premises and what action should be required of people in those areas if fire should occur. This grouping should be reflected in the fire instructions issued for the use of the occupants. (See also 9.10 and 9.11.)

9.3 Control sounders

9.3.1 A fire alarm control and indicating equipment should incorporate, or have located near it, an audible signalling means that sounds in the event of the operation of the first trigger device 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 trigger device in another zone operates.

9.3.2 The operation of a silencing switch either for the general fire alarm sounders or for the signal of 9.3.1 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, and 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 of 9.3.1.

9.3.3 The signals of 9.3.1 and 9.3.2 should not be so loud as to interfere with the making of calls to the local authority fire brigade.

9.4 Audibility of general alarms. The type, number and location of fire alarm sounders should be such that the alarm is distinct from the background noise in every part of the building. In buildings having multiple occupancy it may be necessary for an alarm of fire to be audible in premises other than the premises from which the alarm of fire is initiated. The note of the fire alarm sounders should be distinct from any other sounders likely to be heard. All fire alarm sounders having a particular meaning within a building should have similar sound characteristics, unless particular requirements such as an area of high background noise makes this impracticable in which case other types of fire alarm sounder may additionally be provided. (See also 9.7.)

9.5 General fire alarm sounder 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.

Fire alarm sounders are often situated in corridors and are expected to serve surrounding rooms. Dividing walls and partitions will attenuate sound. In general the higher the frequency of the sound the greater will be the attenuation. This suggests that the fire alarm sounder frequencies should ideally lie in the frequency range 500 Hz to 1000 Hz.

If a two-tone alarm is used, at least one of the major frequencies should lie within this frequency range of 500 Hz to 1000 Hz.

9.6 Level of sound of general alarms. A minimum sound level of either 65 dB(A), or 5 dB(A) above any background noise likely to persist for a period longer than 30 s, whichever is the greater, should be produced by the sounders at any occupiable point in a building. Sounders should be suitably distributed throughout the building giving regard to the attenuation of sound caused by walls, floors, ceilings and partitions. If the fire routine for the premises requires the audible alarm to arouse sleeping persons 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 75 dB(A) can reasonably be expected to wake a sleeping person in most circumstances.

A larger number of quieter sounders rather than a few very loud sounders may be preferable to prevent noise levels in some areas from becoming too loud. In siting sounders in corridors to serve surrounding rooms, account should be taken of the attenuation at the sounder frequency of any dividing elements. 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 sounder noise levels in a room will be satisfactory if more than one dividing wall or door separates it from the nearest sounder. At least one sounder per fire compartment will be necessary.

The level of sound provided should not be so high as to cause permanent damage to hearing.

9.7 Audible alarms in noisy areas. In parts of buildings where there are noisy machines powered by a mains electricity supply the sounders of the fire alarm system (primary sounders) may be reinforced to comply with the recommendations of 9.6 by secondary sounders actuated by the same mains electricity supply.

If this expedient is adopted, however, it should be ensured that:

- (a) when the machine noise ceases and the secondary sounders are out of service, the primary sounders are distinctly audible to meet the sound levels recommended in 9.6;
- (b) the primary sounders in all other parts of the premises are distinctly audible at all times when operated;
- (c) in the event of failure of the supply to the mains-operated sounders, but not to the machines, an audible and visible fault warning should be given at the control and indicating equipment.

9.8 Visual alarm signals. In general, visual signals should only be used to supplement audible alarms. Only in special cases (see 9.11) should visual signals be used in lieu of audible signals. The operation of a sounder should not be prevented by a defect in a visual signal or vice versa.

In areas where a normal type of alarm sounder may be ineffective, e.g. where the background noise is excessive or where the occupants are deaf, visual signals such as rotating beacon or gas discharge lamps should be used in addition. Where these are used it is important that there should be no possibility of confusion with two-stage alarms (see 9.10).

9.9 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 code signals on alarm sounders are liable to misinterpretations however well-drilled fire-fighting staff or occupants may be.

9.10 Two-stage general alarms. In certain large installations and in 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. 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. 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 continuous. The 'alert' signal should be intermittent, 1 ± 0.5 s on and 1 ± 0.5 s off.

Provision should be made for changing the 'alert' signal to the 'evacuate' signal in any area, either manually or, after a predetermined period, automatically. Consideration should be given to the communications that may be needed to control the evacuation.

9.11 Staff alarms. In certain installations subject to statutory or other requirements, it may be desired, in order to avoid unnecessary dislocation, to restrict the alarm in the first instance to the staff and to resort to the sounding of a general alarm either if a responsible person considers it desirable to do so, or automatically after a predetermined period. Such a restricted alarm system should always incorporate suitable means of summoning fire-fighting staff to the outbreak when the

alarm is given. Staff, including night staff, should be sufficient in number and fully trained in the action that they are to take in the event of fire.

A general alarm is undesirable where a panic might arise, e.g. in places of entertainment, departmental stores, dance halls or exhibitions, or where distress or disturbance might create additional problems for staff, e.g. hospitals. In such places it is desirable that the alarm system should be restricted to the provision of sounders or means of personal communication not noticeable to public, residents or patients. The sounders may be supplemented by an adequate number of visual signals throughout the premises for staff recognition only. The authorities concerned should be consulted very early in the design stage as to the best method of providing an appropriate system.

9.12 Silencing devices. It should be a principle of design that after an alarm has been given, it should continue until normal conditions have been restored, but manually operated silencing devices may be provided for transferring or limiting an alarm to a control sounder (see 9.3). The operation of a silencing device while an alarm condition exists should not cancel the visual indication of the alarm recommended in clause 15, nor should the operation of any silencing device prevent the proper receipt of alarms from any zone(s) not already providing an alarm.

Automatic silencing of alarms should not be used.

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.

9.13 Audible alarms provided by intercommunication or public address equipment. Where intercommunication or public address equipment is used in lieu of conventional sounders, it should be ensured that:

- (a) 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 (but see 9.11);
- (b) other signals, e.g. meal-break, start and stop work, are not at any time broadcast by the equipment in a manner that can be confused with fire alarm signals;
- (c) during fire alarm conditions all microphones are automatically disconnected, except one, designated 'fire microphone', that is retained in circuit so that it can be used for announcements and instructions relating to the fire;
- (d) the power supply equipment complies with the requirements of BS 3116 : Part 4. When the intercommunication or public address equipment shares the power supply of the electrical fire alarm system, the total standby and alarm condition loads of both systems should be considered when calculating the battery capacity (see clause 16);
- (e) the use of the intercommunication or public address equipment other than for giving the audible alarm of fire during a mains supply failure should not cause the standby power supply to fall below the capacity recommended in clause 16;
- (f) the cable and wiring of the system comply with the recommendations of clause 17;
- (g) the amplifier is constructed to meet the requirements of clause 5 of BS 3116 : Part 4 : 1974;

(h) where the fire alarm system does not include control and indicating equipment having control sounders the recommendations of 9.2 are met.

The system may then be used for other services, e.g. music replay, paging, etc.

9.14 Use of the fire alarm sounders for other purposes.

In general, fire alarm sounders should not be used for purposes other than giving the alarm of fire. 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.

10. Manual call points

10.1 General. Manual call points should comply with the requirements of BS 5364 : Part 1. Where glass fragments are objectionable, manual call points that do not release such fragments should be used.

10.2 Siting. Manual call points should be located on exit routes and in particular on the floor landings of staircases and at exits to the open air. Other manual call points may also be required depending on the action to be taken in the event of fire. Manual call points should be so located that no person need travel more than 30 m from any position within the premises in order to give an alarm. It may be necessary in some circumstances to have distances much less than 30 m where potentially hazardous conditions exist, e.g. in close proximity to cellulose spray booths.

Generally, 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. If necessary a striker should be provided adjacent to the call point to facilitate breaking the frangible cover. The method of operation of all manual call points in an installation should be identical unless there is a special reason for differentiation. Manual call points should be sited against a contrasting background to ensure easy recognition. They may be flush mounted in locations where they will be seen readily. However, 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 mm².

10.3 Combined systems. If manual and automatic devices are to be installed in the same building, it is not necessary for them to be connected in separate systems; manual call points may be incorporated in an automatic system (see 4.2).

 If the removal of a trigger device can render inoperative other parts of the system, reference should be made to 6.5.

If manual call points are incorporated in an automatic system the delay between the operation of the call point and the indication of alarm should not normally exceed 1 s. If delays longer than this are included for automatic devices (as allowed by BS 3116 : Part 4) then the design of the system should be such that the indication of the alarm cannot be cancelled at a manual call point.

NOTE The reason for the restriction of the delay to 1 s is to prevent confusion in the mind of an inexperienced operator.

11. Types of fire detectors

11.1 General. Fire detectors are designed to detect one or more of three characteristics of a fire: smoke, heat or radiation (flame). No one type of detector is the most suitable for all applications and the final choice will depend

on individual circumstances. In some premises it may be useful to combine different types of detectors or to install an extinguishing system either combined with or separate from an automatic alarm system.

All fire detectors will respond to some extent to phenomena other than fire: see clause 14.

11.2 Heat detectors. There are two main classes of heat-sensitive detector. One is the 'point' type of detector which is affected by the hot gas layer immediately adjacent to it. The other is the 'line' type of detector which is sensitive to the effect produced by heated gases along any portion of the detector line.

There are two main types of heat-sensitive element in each class.

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

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

All detectors complying with the requirements of BS 5445 : Part 5 or BS 5445 : Part 8* contain fixed-temperature (static) elements, and may additionally contain rate-of-rise elements.

Detectors containing only rate-of-rise elements do not comply with BS 5445 and should not be used.

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 current flowing through an ionization chamber reduces when smoke particles enter the chamber.

(b) *Optical detectors.* These detect the scattering or absorption of light by smoke particles in a light beam.

There are point-type detectors that detect smoke at one position and may be based on optical or ionization principles; sampling detectors in which air is taken from a number of positions to a point smoke sensor; and beam-type detectors that are effectively line detectors working on the optical obscuration principle. Some beam detectors can also detect thermal turbulence by refraction of the beam at turbulent interfaces between hot and cold air. Smoke detectors for residential applications should comply with the requirements of BS 5446 : Part 1 and for industrial and commercial applications should comply with the requirements of BS 5445 : Part 7*. Detectors complying with the requirements of BS 5446 : Part 1 may also be suitable for an industrial or commercial environment that is similar to that present in residential premises.

Pending the publication of a standard for optical beam-type smoke detectors, detectors of this type approved by a recognized approval body may be suitable for use in residential, commercial and industrial premises for the protection of both property and life.

11.4 Radiation (flame) detectors. Radiation (flame) detectors detect either ultraviolet radiation or infra-red radiation. Both types employ radiation-sensitive cells that 'see' the fire either directly or when radiation is reflected onto them by mirrors.

Infra-red radiation (flame) detectors usually respond to infra-red radiation that has the flicker frequency, usually

between 5 Hz and 50 Hz, characteristic of a diffusion flame that is typical of fires. They do not respond to flames from pre-mixed gas/oxygen mixtures, but gas appliance flames may cause alarms if the gases are not well mixed, or if particles or impurities enter the flames.

Ultraviolet radiation (flame) detectors detect the ultraviolet radiation emitted from flames, and normally operate in the range of wavelengths from 220 nm to 270 nm. Solar radiation in this range is absorbed by the high altitude ozone layer, and therefore ultraviolet detectors do not normally respond to sunlight.

11.5 Choice of fire detectors. In any automatic fire detection system, the 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 building, the processes taking place 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 are suitable for use in most buildings. Radiation (flame) detectors are mainly suitable for supplementing heat and smoke detectors in high compartments, provided that an unobstructed view is possible, and for special applications such as outdoor storage and chemical processes employing flammable liquids.

The choice of fire 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 other types have.

11.5.1 Heat detectors. Fixed-temperature heat detectors are less suitable where ambient temperatures are low or may vary slowly over a wide range. Combined fixed-temperature and rate-of-rise heat detectors are less suitable where the ambient temperature may vary rapidly over short periods. Where very high temperatures (see 12.4.4) are likely to be encountered, heat detectors complying with the requirements of BS 5445 : Part 8 should be used.

Heat detectors are not usually suitable for the protection of places where large losses could be caused by small fires, e.g. computer rooms. Before final selection of a detector, an estimate should be made of the likely extent of the damage caused before operation of the heat detector.

11.5.2 Smoke detectors. Ionization chamber smoke detectors respond quickly to smoke containing small particles normally produced in clean burning fires, but may respond slowly to optically dense smoke which may be produced by smouldering materials. Certain materials, e.g. PVC, when overheated produce mainly large particles to which ionization detectors are less sensitive. Optical smoke detectors respond quickly to smoke that is optically dense.

Both types of detector have a sufficiently wide range of response to be of general use.

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 detectors under these conditions.

Smoke detectors other than those incorporating thermal turbulence detectors do not detect fumes from burning alcohol and other clean burning liquids which do not produce smoke particles. This is not a serious disadvantage because a fire will normally involve other combustible materials at an early stage. Combined optical beam smoke detectors and thermal turbulence detectors are particularly suitable for such risks.

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

Where there are production or other processes that produce smoke or fumes that would operate smoke detectors, an alternative type of detector should be used.

11.5.3 Radiation (flame) detectors. Radiation (flame) detectors are suitable for use in special applications such as the general surveillance of large open areas in warehouses or timber yards or the local surveillance of critical areas where fire may spread very rapidly, e.g. at pumps, valves, pipework containing flammable liquids.

12. Detectors installed primarily for the protection of property

12.1 Application. The installation of fire detectors may enable a fire to be detected sufficiently early to be easily extinguished without large property damage. In general, people form the most sensitive fire detectors but they are not always present or alert; there may be parts of the premises that are not attended during normal working hours, and during non-working hours there may be no-one on the premises. When fires start in unoccupied areas they may grow, if undetected, to a stage where they cannot be easily extinguished: because any area may be unoccupied at some time total coverage of the premises by detectors should be provided. The use of detectors can then significantly reduce the property loss, provided that suitable provision has been made for the necessary subsequent action.

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

12.2 General considerations for the siting of fire detectors

12.2.1 Every portion of the building(s) should be suitably protected and each effectively enclosed space should be considered separately for this purpose in accordance with the recommended limits of spacing for the type(s) of detectors concerned. Voids not more than 800 mm in height need not necessarily have independent coverage (see 12.2.7) unless the void is such that the spread of fire or fire products between rooms or compartments can take place through it.

Lavatories and water closets need not have independent coverage but may rely upon that provided in a lobby common thereto.

12.2.2 Where rooms are divided into sections by walls,