Consultants Guide

Design & Specification
of Fire Systems

fire systems

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About This Manual

Purpose

The code of practice for fire detection and alarm systems for commercial buildings † (BS 5839: Pt 1: 1988) is a detailed and comprehensive document which requires considerable study before it can be fully understood. Even when it is understood, many users still find it difficult to understand why certain clauses, relating to the recommendations and options offered, are included in the code.

The purpose of this manual is to provide a step-by-step approach to the necessary guidelines described in BS 5839: Pt1: 1988 so that users can achieve maximum benefit from the recommendations. This should assist in the task of choosing the best options, help in preparing the specification of the fire protection system, and assist architects, designers and electrical engineers in providing the most cost effective system that meets the needs of the user.

This manual is a consultants guide to the contents and usage of the British Standard code for the design, installation and servicing of fire detection and alarm systems for commercial buildings, BS 5839: Pt 1: 1988. Throughout the manual where it was necessary to reference this long title, we will simply refer to it as **the code** .

The code is divided into four sections. The first section is intended to be of general interest to all users, the second is intended to be of interest to the system designer, architect or electrical engineer, the third section is for the installer and the fourth is for the user. Because the code is sectionalised in this way, it has resulted in much duplication and cross-referencing of information within. This makes it quite difficult to follow because you have to constantly go back and forth in order to interpret its full meaning.

In practice one organisation or company is usually responsible for both the design of the system and its installation. Furthermore, the code recognises that, in most cases, the user is unlikely to go out and buy a copy of the code in order to learn about his responsibilities. In fact, the code recommends that the installer should instruct the user on his responsibilities.

Considering the points described above, its clear that the organisation (often one person) needs to be familiar with all aspects of the code. In this manual therefore we basically follow through the design phase, the installation phase and use of the system phase without strictly following the code as sectionalised.

This manual is a guideline to the code only, and as such it is important therefore to read this manual in conjunction with the code so that all aspects can be fully understood. This manual is not a replacement for the code.

The manual consists of two parts.

Part 1 Guide to design of Fire Systems

This part contains information taken from the planning and design guidelines described in BS 5839: Pt1: 1988. It also contains extracts from the publication titled “Fire Detection and Alarm Systems” by Peter Bury (published by Paramount Publishing Ltd.). Peter Burry was a member of the Technical Committee responsible for producing the code of practice. He was also an active member of the Working Party in which many technical discussions took place.

Part 2 Specification for an Analogue Addressable Fire System

This part contains a sample specification for an Analogue Addressable Fire System. The information in the specification may be edited and used in specifications for Fire System designs as appropriate. A file containing the text of the specification is provided on the diskette included with this manual (see **The Diskette** section below for further details). By using the sample specification included on the diskette, you can save yourself a considerable amount of time and effort because much of what is contained in the sample specification is applicable to almost all fire protection system designs.

† The code of practice for fire detection and alarm systems for dwellings, i.e. domestic buildings, is covered in BS 5839: Pt 6.

Basically, all you have to do is call up the specification file on your favourite word processing package and edit it to reflect the specification of your system design. Although the sample specification describes the most common elements of an analogue addressable fire system design, you will obviously have to delete some existing clauses and add new clauses as appropriate in order to produce a definitive specification of your design.

Readership

This manual has been prepared for use by architects, designers and electrical engineers responsible for the design, specification and installation of fire protection and alarm systems intended for use in medium to large size buildings, for example, schools, hotels, hospitals, office complexes, shopping precincts, super market stores, airports, warehouses, etc.

The information provided herein is intended specifically for the use of '*appropriately qualified and experienced persons* as stipulated in the Foreword to BS 5839: Pt 1: 1988.

The Diskette

Included with this manual you will find a 3.5" floppy disk. This disk contains the text of the sample specification for an Analogue Addressable Fire System printed in Part 2 of this manual. To satisfy the requirements of most PC users, the file has been saved to the disk in seven word-processing formats, as follows:

Filename	Word-processing Format
FAS-MSW6.DOC	Microsoft Word 6/7 for Windows
FAS-WP50.DOC	WordPerfect 5.0
FAS-WP51.DOC	WordPerfect 5.1 for DOS
FAS-WP5X.DOC	WordPerfect 5.x for Windows
FAS-WS70.WS7	WordStar 7.0
FAS-WMAC.MCW	Word 5.1 for Macintosh
FAS-ASCI.TXT	ASCII Text (with line breaks)

If you decide to use one of the files containing the text of the sample specification, we recommend you first make a copy of the file and work with the copy rather than the original file. By adopting this procedure, should your copy of the file become corrupt or damaged in any way, then you will always have the original file to fall back on.

Note: Throughout this manual, references in square brackets, for example [12.2.11], refer to the relevant section of the BS 5839: Pt 1: 1988 code of practice which describes the associated topic in greater detail.

Acknowledgments

Thorn Security Limited gratefully acknowledge the use of extracts taken from Peter Burry's publication titled "Fire Detection and Alarm Systems" (ISBN 0 947665 11 0) published by Paramount Publishing Limited, Paramount House, 17/21 Shenley Road, Borehamwood, Herts. WD6 1RT.

Company Background

Thorn Security is one of the longest established names within the fire detection and emergency lighting industry. By investing millions of pounds on research and development, Thorn Security are at the forefront of fire detection and emergency lighting technology.

With an increasing local office network, Thorn Fire & Security has an unprecedented reputation for quality, reliability and service. A comprehensive range of products, built up over a number of years, has positioned the company as the leader of the fire and security market. Thousands of customers all over the world have chosen the company for their fire detection, security and building management systems

Following Thorn Security's successful management buyout from Thorn EMI Plc, the company has increased its turnover from that predicted, to approaching £200 million. With its headquarters at Sunbury near London, the company operates from 30 offices in the UK and from nine other major centres around the world including Cleveland Ohio, Kuala Lumpur, Hong Kong and Singapore. In addition, it has manufacturing facilities in Walthamstow in the UK and Ohio in the USA; R&D in the UK and USA; alarm monitoring facilities in the UK, USA and Singapore, and employs over 3,300 people world-wide.

The Company has exceptional capabilities in systems integrating fire protection, security, environmental control and energy management technologies as well as providing stand-alone products and services in all of its core business areas.

Fire Protection

Thorn Security designs, installs and services fire protection systems for every type and size of building or installation. Systems can incorporate automatic detectors, manual call points, control panels, alarm sounders and extinguishing systems.

Security

The Company provides security systems to cover a wide variety of risks. These include the following:

- Intruder detection and alarm systems
- Closed-circuit television (CCTV) and slow-scan TV for remote central surveillance of multiple sites
- High security systems for banks and other high risk buildings
- A versatile range of access control systems and manned guarding services.

Alarm Communications

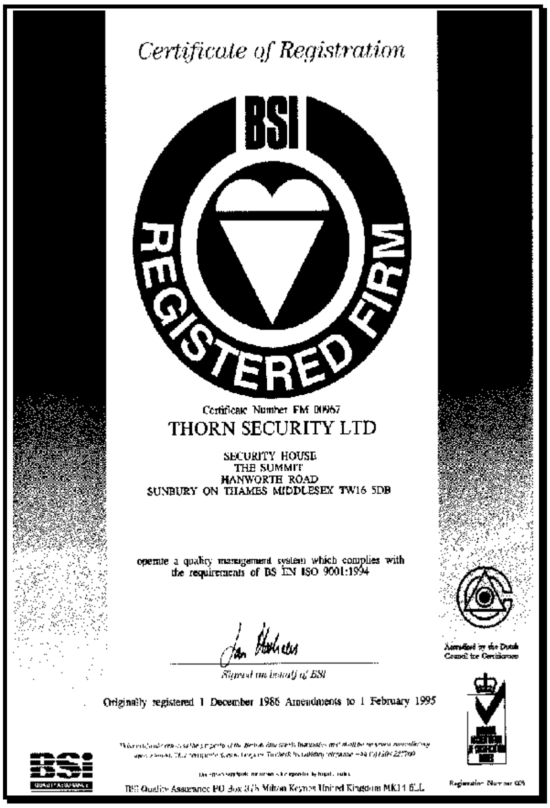
A network of manned central stations provides around-the-clock monitoring of customers premises ensuring that all alarm signals are immediately actioned and recorded. Central station staff ensure that the relevant emergency services are informed and, if necessary, arrange for a duty service engineer to call.

Service and Maintenance

The Company offers a nationwide planned maintenance contract service to ensure that products and systems are kept in good working order. A 24 hour, 365 days a year (holidays included) breakdown service is operated to ensure that any problems are speedily attended to by our expert staff.

Our Service Bureau is registered to BS EN ISO 9001 and is an approved service assessor for National Vocational Qualifications (NVQ). We are the only professional organisation within the industry to achieve the prestigious Investor in People Award for service excellence.

BS EN ISO 9001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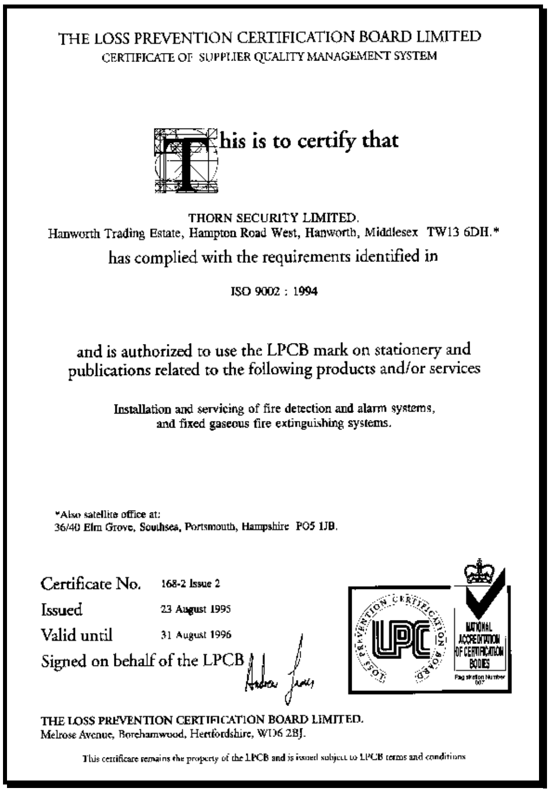
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Manchester, Carlisle	168-7
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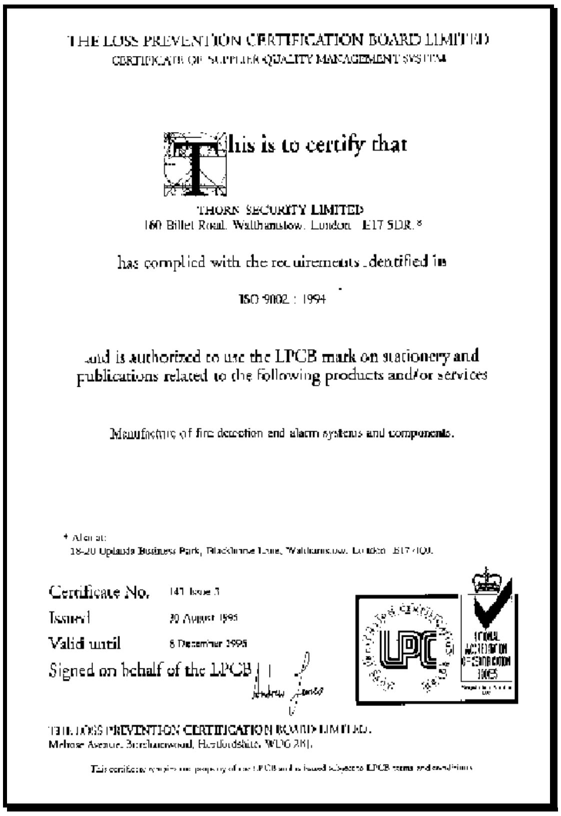
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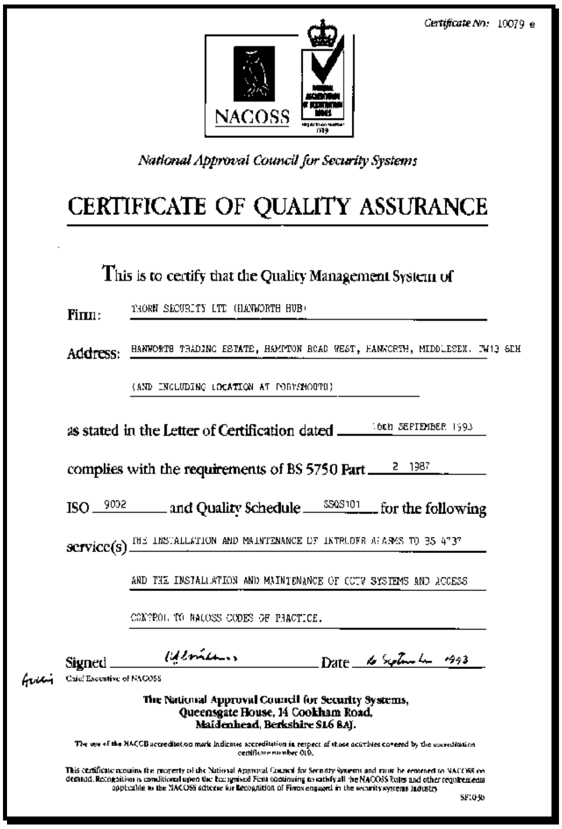
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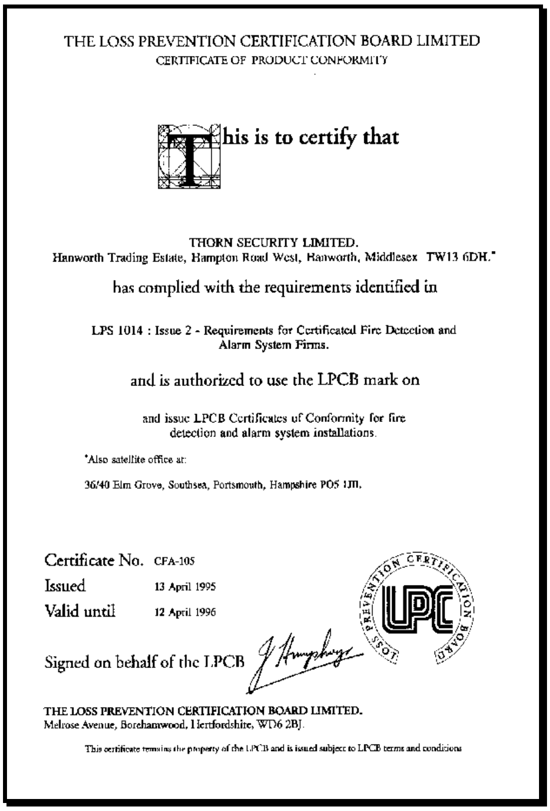
LPS 1014



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Thorn Security have a **Consultants Communication Programme** which was specifically designed to increase consultants' awareness of Thorn Security Limited, its services and its products, and to provide useful, accessible and up-to-date information on a regular basis. It also ensures that all queries are responded to as quickly and efficiently as possible.

The Consultants Communication Programme consists of:

1. **The consultants file and guide**

   Each consultant on our distribution list is sent a copy of the Thorn file which is designed for you to keep information about Thorn Security. Regular updates to this consultants guide, together with industry information bulletins will also be sent through.

2. **Newsletter and other information**

   On a bi-annual basis you will also be sent copies of our customer newsletter "Monitor". This provides general information on new products from Thorn Security, together with news on projects worldwide and profiles on people and customers of Thorn Security.

3. **Presentations**

   Presentations on a specific topic or interest can be made to consultants on request. These will be supplemented by 35mm slides, which can be made available to consultants for their own use if required.

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PART 1

Guide to Design of Fire Systems

1. Introduction

Fire detection and alarm systems are designed to provide warning of the outbreak of fire and allow appropriate fire fighting action to be taken before the situation gets out of control. As all systems are designed primarily to protect life and property, this places a great responsibility on the designer because each building will present a different set of problems in relation to the risk of fire and fire spread. Each fire detection and alarm system therefore must be specifically designed to meet the requirements for each building.

In designing a system, particular consideration must be given to the type of building, its construction and the purpose for which it is being used, so that in the event of a fire, the fire detection system, combined with appropriate fire prevention procedures, will keep risk to both personnel and property to a minimum.

With Thorn Security being at the forefront in planning and designing fire detection and alarm systems for many years, the techniques and procedures described in this manual are based on knowledge and experience gained over that time.

The information provided herein is intended to help and enable appropriately qualified designers to plan and design fire systems suitable for use in any type of building or installation.

As mentioned above, the designer of fire detection and alarm systems bears a great responsibility because the safety of personnel and property rests with him. Occasionally, particular problems may occur which are not covered in this manual. In such cases it is most important that you seek specialist advice at an early stage. Should you need help in resolving a system design problem, you can always contact our design specialists for assistance by calling our **HELPLINE** on **01932 74 3333**.

When designing a fire detection and alarm system, in addition to deciding the type of controller, detectors, call points and sounders to be used etc., there are also other aspects which need to be considered, for example, method of installation, materials required during installation, operator training, routine maintenance procedures, and service agreement. For any system to function reliably and provide problem free service throughout the life of the system, all of these aspects must be considered in the overall system design and plan.

As Thorn Security is an LPS 1014 Certificated company, you can be sure that any fire detection and alarm systems we design, install, commission, service and maintain not only complies with the requirements of BS 5389: Pt 1: 1988 but also fully complies with the requirements of LPS 1014.

What is LPS 1014?

LPS 1014 is a standard against which the Loss Prevention Certification Board ([†] LPCB) assesses the ability of companies to design, install, commission and service fire detection and alarm systems.

With technology advancing at an ever increasing rate, fire detection products and systems have likewise become more sophisticated and complex. Thus the choice of a competent installer to ensure satisfactory installation and maintenance of fire detection and alarm systems has become all the more important.

[†] The LPCB is an internationally recognised and independent certification body accredited by the Department of Trade and Industry's National Accreditation Council for Certification Bodies (NACCB) and has an independent board made up from representatives from industry, insurers, trade associations and CACFOA (Chief and Assistant Chief Fire Officers Association), with observers from the Department of the Environment, the Home Office and the Health and Safety Executive.

By specifying a company which is certificated to LPS 1014, you can be confident that your fire detection and alarm system will be installed competently to the codes of practice that you specify (e.g. BS 5839: Pt 1: 1988) and that the company can provide the necessary maintenance service required to maintain a valid LPS 1014 Certificate of Conformity.

For a company to be LPS 1014 Certificated it must fulfil the following requirements:

- have a several years experience in design, installation, commissioning and servicing of systems.
- have randomly selected installations inspected by the LPCB every six months against the specified contract requirements. Certificates must reliably identify any deviations from the Installation Rules applied.
- have the resources to support systems in case of a break down with 8-hour emergency call out service.
- be competently capable of performing the planned servicing of installations.
- have suitably trained and experienced staff.
- operate a BS EN ISO 9000 quality system.

When an LPS 1014 approved company completes each installation contract, the client is issued with a Certificate of Conformity. Copies of these certificates are also forwarded to the LPCB. The LPCB use their copies of the certificates to randomly choose which installations to inspect.

To be sure that the company you employ to install, service and maintain your fire alarm system is competent, and that the installation will be likely to meet the statutory requirements of the fire brigade and satisfy your insurance company, you should use a company which is LPCB Certificated to LPS 1014.

1.1 Planning the System

This task is probably the most important of all because mistakes made here may have a fundamental effect on the type and operation of fire system. The specification and associated documentation which form the invitation to tender will indicate any weaknesses, errors or omissions in the design. The specification of the system therefore should be prepared with great care, thus ensuring that all requirements of the system are covered.

[Clause 4] of the code gives details of the sort of documentation which is required, and also talks of consultations which should be held with third parties. [Clause 5] of the code suggests a typical list of events which should to be taken into consideration when preparing a planning schedule; many of these activities are also important in preparing the specification of the system.

Taking a broad view of [clause 4] and [clause 5] of the code, the suggested sequence of events which need to be considered is as follows:

1. How big is the building, what shape is it and how is it used?
2. What type of system is proposed (conventional or analogue addressable), and what is the required coverage, both initially and for the future?
3. What action is the system expected to initiate in the event of fire?
4. Will the system affect other occupants of the building?

These questions need to be answered before the next stage.

In [clause 5] there are two important aspects which should always be considered in every design, these are servicing arrangements, and the action to be taken in the event of fire.

Servicing Arrangements

Servicing arrangements are important because they represent a hidden cost to the user. Some systems may require regular attendance by a service engineer in order to maintain the system at a high efficiency level. Not only does the engineer have to be paid for, but his presence may also cause disruption to the day-to-day operation of the business. The latter element may actually be much more important to the end user than the service cost.

[Clause 29] of the code in fact specifies a routine for servicing. This can vary from daily through weekly, monthly, quarterly and annually to a special wiring check every five years. It also states [29.2.1], if some of the functions are tested automatically then the manufacturer can specify an increased interval between manual testing of those functions. This can pay off in servicing requirements [clause 5, h] since the end user can see the financial advantages of such a system. It should be noted that if servicing requirements is included, it means that the quotation should also include the costs of the recommended system maintenance.

The Action to be Taken in the Event of Fire

As the action to be taken in the event of fire is covered in [clause 5, c], why do we need to consider it? Well, we know that the fire alarm will initiate, and to some extent control, this action, therefore the two are intimately connected. It may be that the alarm system could be varied from that specified in order to enable the action to be carried out more effectively, or that the survey has identified problems in the proposed action. In either case, this is the stage at which the design should be considered so that any effect on the cost can be taken into account before ordering the system.

1.1.1 Refining the Design

The code recommends that the customer’s specification and the installer’s final design should proceed hand-in-hand, each being gradually refined. Where a design consultant prepares a design against which the installers are to tender, this can lead to difficulties. In such cases the consultant may need to leave some flexibility for variation of the design to suit the particular system being ordered.

1.1.2 Design Variations

In many systems being designed today, variations are made, particularly to the control equipment, to suit each installation. These variations may be in the software, or they may include such items as mimic diagrams. This development time is not mentioned in [clause 5] although it could be said that it is included under production in [m]. Whether allowed for or not in the planning schedule, it should be allowed for in any quoted delivery time.

1.1.3 Using a Flowchart

To assist with designing and specifying a typical fire alarm system the design flowchart shown in Figure 1 overleaf has been produced to provide a logical guide. This flowchart maps the main activities which should be considered when planning and designing a fire system. The call out text added to certain activity boxes are included for the purpose of directing the reader to relevant sections of this manual where further detailed information can be found.

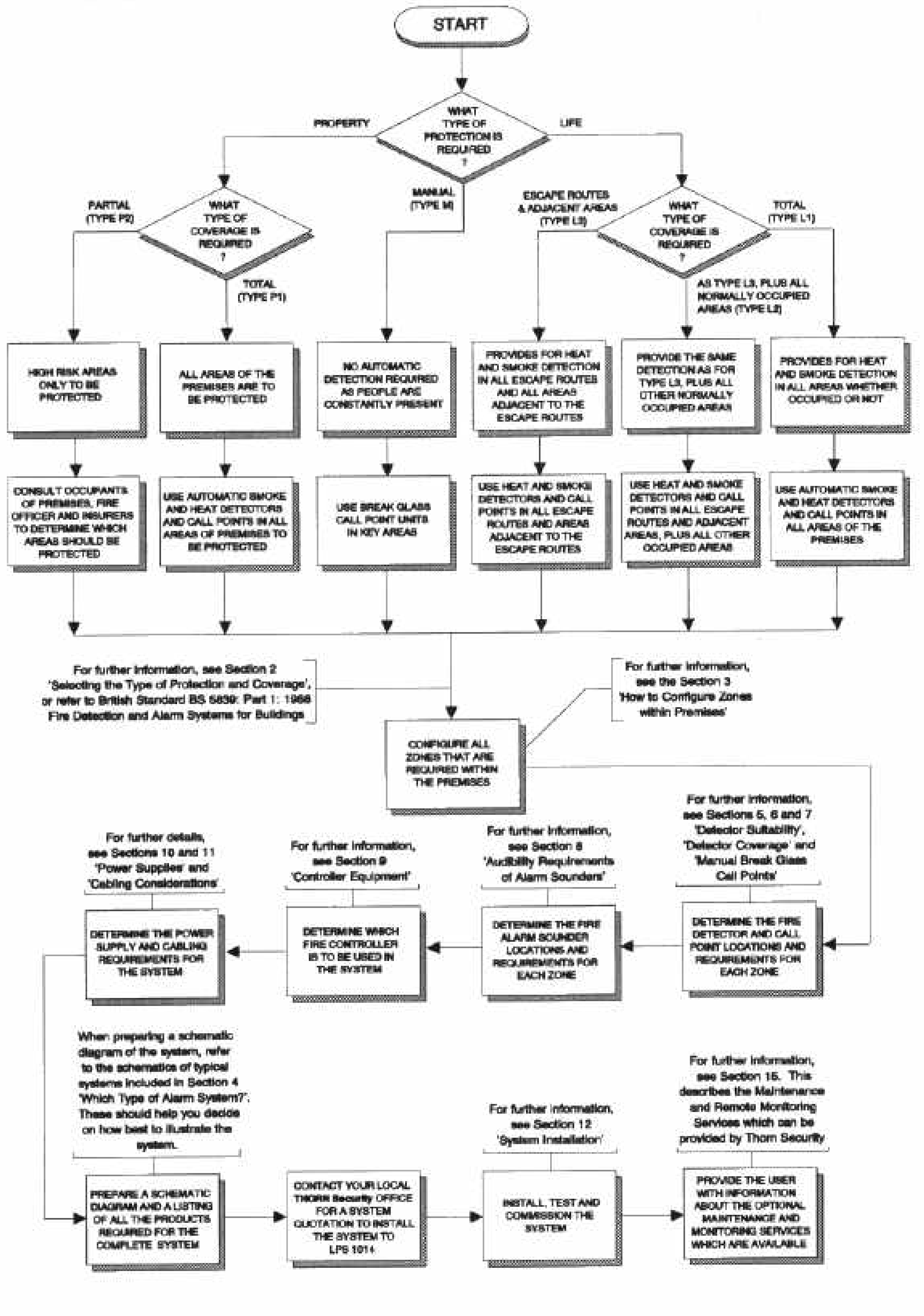


Fig. 1 Fire Planning and Design Flowchart

2. Selecting the Type of Protection and Coverage

After initially consulting with all interested parties, the first decision to be made when designing a fire detection and alarm system is a simple choice of establishing the purpose of the system, that is whether it is for protecting the building and its contents (Property Protection) or enhancing the safety of the occupants (Life Protection). British Standard BS 5839: Pt 1: 1988 provides a classification coding system which allows fire detection and alarm system designs to be specified according to purpose and the extent of protection to be afforded.

If it is desirable that there should be no automatic detection in view of the continuous presence of occupants in the building, a much simpler system will suffice comprising of sounders and break glass call point units alone. This type of system is classified as providing Manual (**Type M**) protection.

- **Manual (Type M)**

  Type M A system which provides manual alarm only.

[Section 6] of the code further divides the level of protection required for Life (**Type L**) and Property (**Type P**) systems in terms of the extent of coverage. The question to be asked is; what degree of coverage should be provided?

- **Life Protection (Type L)**

  This classification provides for the protection of life, that is the safety of the occupants. It caters for the detection of a fire, initiates an alarm of fire, and provides sufficient time for the occupants to escape from the building.

  Type L3 Covers escape routes and adjoining rooms (detectors should be situated adjacent to the door onto the escape route).

  Type L2 Covers escape routes, adjacent rooms and any other areas where it is considered the occupants are vulnerable.

  Type L1 Total Coverage,

- **Property Protection (Type P)**

  This classification provides for the protection of property and its contents. It caters for the automatic detection of a fire, initiates an alarm of fire, and indicates the location of the fire within the premises.

  Type P2 Covers all high risk areas.

  Type P1 Total Coverage.

2.1 Type M - Manual

This is the simplest form of fire protection coverage system available. It provides for basic cover comprises break glass call points and sounders only. As this type of system has no automatic detection devices, in the event of fire, it has to be manually initiated by activating a call point.

2.2 Type L3 - Life

Provides for smoke detector coverage in all escape routes and areas adjacent to the escape routes. Protection for **Type L3** systems is based purely on people being able to leave the scene of the fire and being given a warning so that they can vacate the building before the escape routes become blocked by fire or smoke.

The philosophy behind protecting escape routes and all areas adjacent to the escape routes is that people are unwilling to travel through a corridor if their visibility is impaired by smoke. The reasoning behind the protection of adjacent rooms is that smoke moving through a door crack from a rapidly burning fire may be cool and dense. Thus the escape corridor could become smoke-logged at low levels before reaching the corridor smoke detectors [13.5].

If a person in an enclosed office has to travel through another area in order to reach an escape route corridor then that area adjacent to the corridor shall be considered as part of the escape route for the enclosed office and therefore should be protected by a smoke detector.

2.3 Type L2 - Life

Type L2 systems must fulfil all the requirements of **Type L3** coverage with such additional cover as needed. The questions to be asked are:

- **Where is the additional cover needed?**

  It may also be useful to ask the following questions:

- **Are people able-bodied and alert?**

  This may not be the case in hospitals or day-care centres with infants, handicapped persons or senior citizens.

- **Are the premises residential where many people are asleep at varying times of the day?**

  If they are spread over the whole building then it can be argued that detection (by sight, or smell) would be quicker.

- **Are there people concentrated in one particular area?**

  These people could be at risk from fire breaking out in unoccupied areas.

- **Are the contents highly combustible?**

  Rapid smoke spread must be detected prior to blocking escape routes.

If protection is required for occupants, then smoke detectors must be placed in all these areas for a **Type L2** system. Smoke detection coverage should therefore be given to all areas which are normally occupied.

2.4 Type L1 - Life

Type L1 systems must fulfil all the requirements of the **Type L2** and **Type L3** systems to provide total cover wherever human activity prevails. Protection by automatic detection shall therefore be given to all areas where occupation is likely or threatened.

2.5 Type P2 - Property

In certain circumstances it is possible that partial coverage may be sufficient in which case only high risk areas are protected. To determine which areas should be covered, consultation with the occupants, fire officer and fire insurers is required and the following questions should be asked [3.1]:

- **How probable is the likelihood of human detection?**

- **How combustible are the contents?**

- **How valuable (and thereby replaceable) are the contents?**
- **What is the likelihood of fire spreading from unprotected parts to highly combustible areas?**
- **What are the costs of extending the system protection to all parts?**

The answers to these questions will determine whether a particular area within a premises is to be protected or not, since the code does not give exact guidelines.

The fundamental fire engineering principle of the danger of fire is whether there is an expectation of damage, and whether the contents are combustible.

With regard to life and property, if there can be no significant damage incurred in the event of a fire then there is no need for protection. Likewise, in respect to contents, no matter what the value, if there is no possibility of ignition then there is no need for protection. These two extreme cases rarely occur and in real life situations there is usually some degree of damage incurred and no site contains completely fire proof contents. The dividing line is difficult to draw and a balance has to be struck.

2.6 Type P1 - Property

This level of coverage is often the only one that fire insurers and users will accept since all areas of the building are protected by automatic smoke and heat detectors, with the exception of:

- Water closets [12.1]
- Ceiling and floor voids less than 800mm in height [12.2.11].

Having, in consultation with interest parties, agreed the type of protection and coverage required for the building, the next step in the design process is to configure the zone arrangement within the premises, see section 3 (How to Configure Zones within Premises).

3. How to Configure Zones within Premises

3.1 The Meaning of a Fire Zone

The most positive and effective way of limiting fire spread within a building is to subdivide it into the smallest practicable compartments, such a compartment is known as a zone.

Subdividing the building into zones is achieved by means of fire resisting walls and floors. In this way the spread of fire from one part of a building to another can be impeded. Storage areas, chemical processes and plants should be compartmented in the same way.

In practice, however, walls and floors are perforated with openings such as doors, stair cases and service ducts, but as long as these openings are protected with a fire retarding media (for example, fire doors with at least 30 minutes resistance), the fire resistance of the compartment is preserved.

3.2 The Purpose of a Fire Zone

One major function of a fire control system unit is to indicate the location of a fire as precisely as possible. To this end, the detectors are grouped into fire zones.

For conventional systems, each zone is connected to the controller by a separate circuit. For addressable systems however, one circuit may connect up to 99 detectors and protect several zones. In either case each zone will have a separate number and visual indicator on the controller. In the event of a fire condition the visual indicator will illuminate thus directing the system operator to locate the origin of the fire by means of a zone chart.

Addressable systems are able to identify any detector or call point which is in the alarm condition, regardless of how many devices are connected to that circuit. Not withstanding this major benefit of being able to precisely locate the origin of the fire, the building shall be zoned in accordance with [Section 7] of the code [15.4.2]. In general, the code states that ‘the primary indication of the origin of the alarm should be an indication of the zone of origin’.

A display giving information only relating to the whereabouts of a particular detector alone in alarm, for example CIRCUIT 2 POINT 7 WORKS OFFICE is not forbidden but it may be useless to a person not familiar with the layout of the site. In fact, this could lead to difficulties in assessing the spread of the fire. The display of individual detectors in alarm should therefore be secondary to the zonal visual indication.

To meet this requirement, the control equipment used in the system should comply with BS 5839: Pt 4: 1988 [3.1.1 d] which states “for equipment capable of multi-zone operation, a separate and continuous visible indication for each zone in which a detector or call point has operated may be given on the control panel, or on a separate indicator panel connected to it”.

3.3 Zone Configuration Guidelines

There are several guidelines to the size and configuration of a zone that are common to both conventional and addressable fire systems:

1. The maximum floor area of a zone should not exceed 2000m².
2. The search distance, that is the distance that has to be travelled by a searcher within a fire zone in order to determine visually the position of the fire (not reach the fire), should not exceed 30m.
3. A single zone may extend to cover several fire compartments. An example of this is that small rooms may have adequate fire resistance to be considered as compartments but may be considered to be on the same zone as a larger adjacent compartment (See Figure 2). Zone boundaries, however, must lie along compartment boundaries (that is, walls and doors).
4. If the total floor area of a building is 300m² or less then the building need only be one zone, regardless of the number of floors [7.2].

5. If the total floor area of a building is greater than 300m², then each floor should be a separate zone (or set of zones, if the floor area is large enough). There are however two exceptions to this rule:

   a) If communication (via interconnecting doors) between two adjacent vertical compartments is at the lowest level, only then can each vertical compartment still be considered to be separate multi-storied zones. See Figure 3.

   b) Structures such as stairwells extending to more than one floor but remaining within the same vertical compartment can be considered as taken as multi-storey zones. See Figure 4.

   The justification of exception b) is in case of manual call points. People escaping via a staircase from a fire on the ninth floor for example, may not feel confident enough to stop and operate a break glass call point unit until they reach the fourth floor, the information on the fire system control panel would then be misleading if it indicated that the fire was on the fourth floor when it was actually on the ninth. If the call points are connected in a staircase zone, then misleading information becomes less likely.

3. For multi-occupancy buildings, zone boundaries should not cross occupancy boundaries, hence a zone should contain only one occupancy. This ruling may be relaxed for manual (Type M) systems.

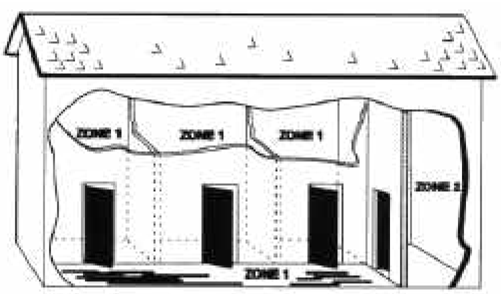


Fig. 2

Consider two adjacent areas with one of the offices containing three separately compartmented store rooms. The zoning may be as shown in this diagram (provided the maximum area and search distance limitations are not exceeded).

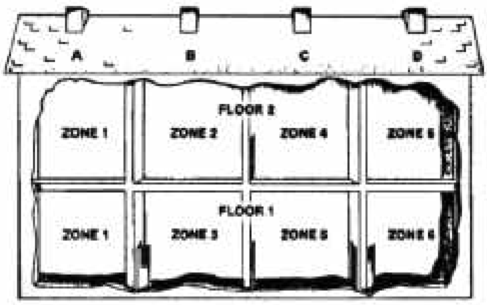


Fig. 3

Consider a row of four terraced houses (A, B, C and D) converted to a guest house with interconnecting doors as shown. The zones can be allocated as shown in this illustration.

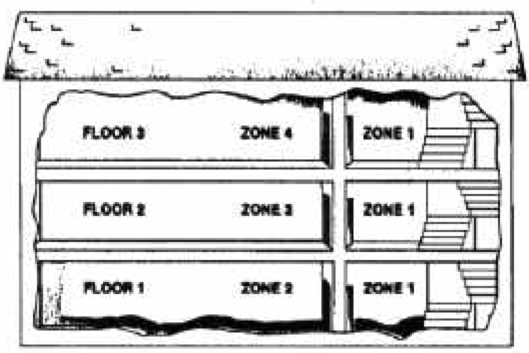


Fig. 4

Consider a three storey building with a stairwell as shown. Each floor shall be considered to be a zone but the stairwell can be a single vertical zone as shown left.

3.4 Zone Safeguards

It is possible for addressable detectors to share one circuit all round the building thereby having several zones serviced by the same two-wire circuit. For conventional detectors, each individual zone is serviced by its own dedicated two-wire circuit. There are advantages and disadvantages of having individual spurred wiring for each zone and having a complete loop (See Figures 5, 6 and 7).

One main problem concerning the choice of system which should be used in a building is that of fault monitoring. The code therefore makes a number of recommendations concerning how faults are monitored:

1. **A fault occurring on one zone should not affect the operation of other zones [6.6.2].**

   In conventional systems this will always be achieved since an open or short circuit condition will only affect the individual zone circuit concerned (See Figure 5).

   In addressable systems where a number of zones share the same ring circuit or loop (See Figure 6), an open circuit is not too much of a problem (just so long as the fault is reported) since the loop can be driven in both directions. The case of a short circuit however is far more serious since this condition could prejudice every device (up to 99) on the circuit. Short circuit protection is therefore required in all loop circuits. This is achieved by placing zone/line isolator devices in the loop circuit at zone boundaries.

   For example, with reference to the circuit shown in Figure 6, if a short circuit were to occur in zone 2, the two line isolators ‘X’ and ‘Y’ would operate and create two breaks in the circuit at points ‘X’ and ‘Y’. The loop would then drive in both directions, that is, zone 1 in one direction and zones 5, 4 and 3 in the other direction. The zone/line isolators would again automatically become passive after the short circuit has been repaired.

   In addressable systems where two or more zones can share the same circuit and the circuit is not connected in a loop (See Figure 7), to comply with the recommendation of the code then only one zone of detectors and call points may be connected to each addressable spur.

2. **A single fault should not remove protection from an area greater than that allowed for a single zone [6.6.2].**

   In conventional systems this will always be achieved (See Figure 5) and providing zone/line isolator modules are employed, as in the case of addressable loop systems, then this will also comply with the recommendation of the code.

3. **Two faults should not remove protection from an area greater than 10,000 square metres.**

   This recommendation imposes a maximum area of coverage for a single loop in an addressable loop system (See Figure 6). No loop in the system therefore should ever service a area of coverage greater than 10,000 square metres. If the area to be protected exceeds this maximum limit, then an additional loop(s) should be used.

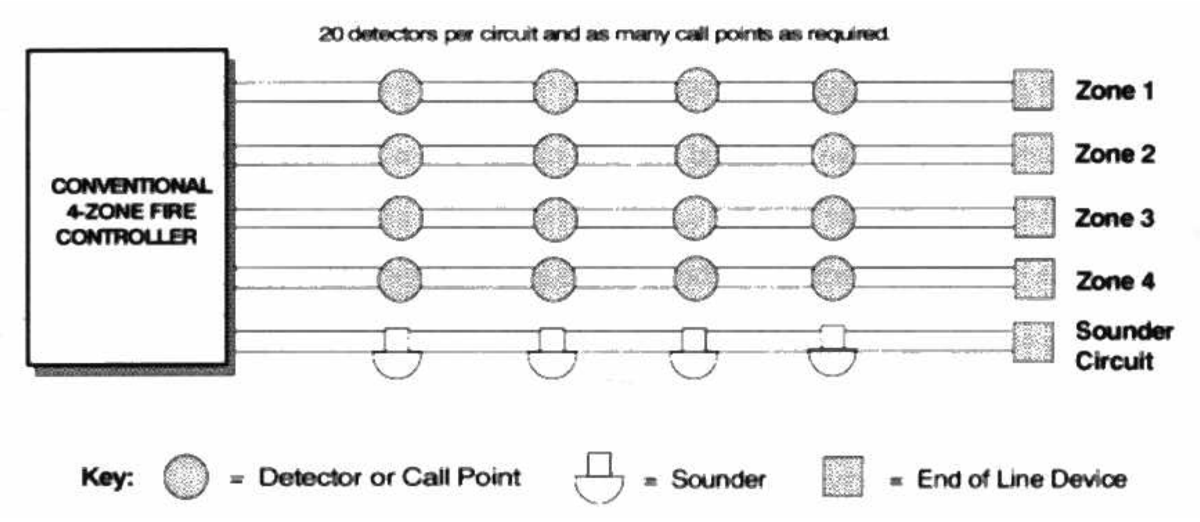
4. **Short circuit faults should be reported by the control panel within 100 seconds of occurrence and open circuit faults should be reported within 60 minutes of occurrence.**

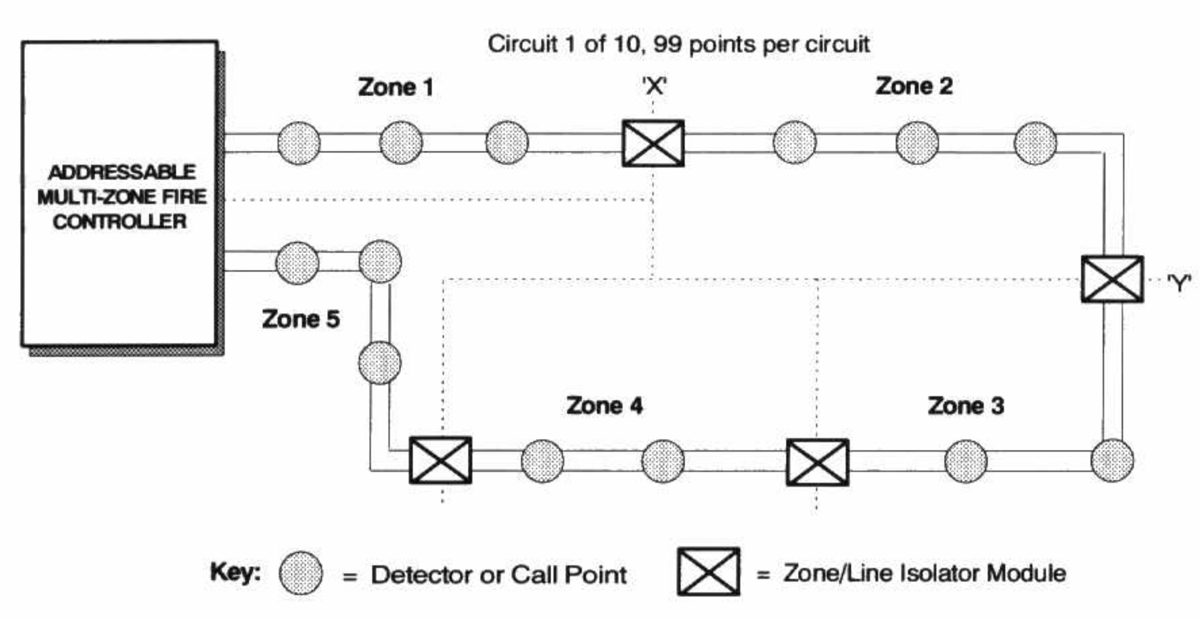
   These limitations should not be exceeded and in either case a false indication (due to the fault) should occur first.

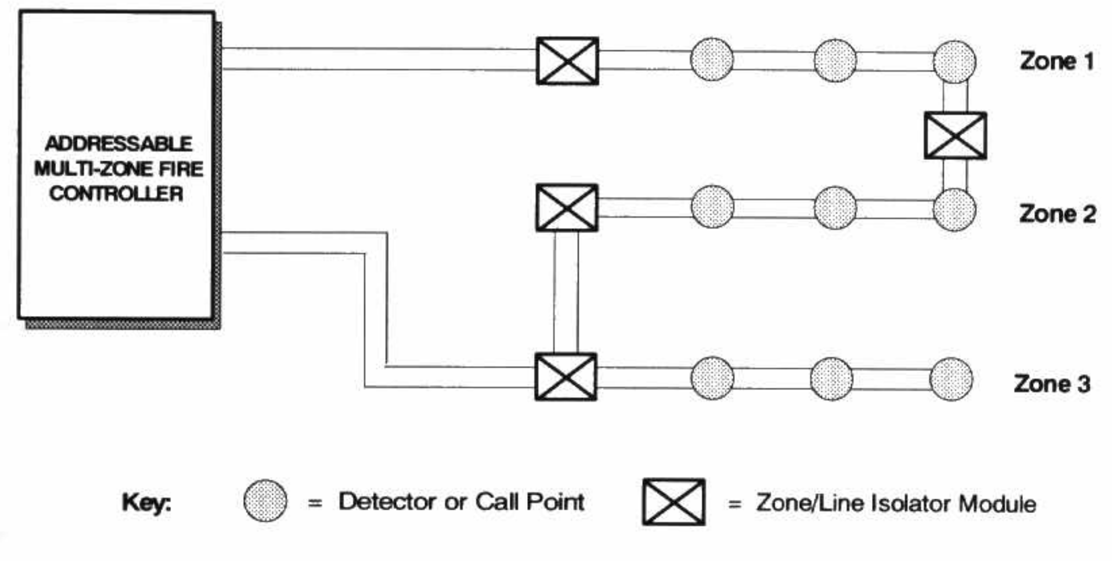
   The 60 minute limitation on open circuit faults is only applicable to loop configured systems which continue to operate under this condition.

   If the system is radially or spur wired, or for any other reason is not able to operate under an open circuit condition, then this fault should be indicated within 100 seconds.

When you have established the zone arrangement for the building, the next step in the design process is to decide which type of fire alarm system should be used, see section 4 (Which Type of Fire Alarm Detection System?).


20 detectors per circuit and as many call points as required
CONVENTIONAL 4-ZONE FIRE CONTROLLER
Zone 1
Zone 2
Zone 3
Zone 4
Sounder Circuit
Key:
= Detector or Call Point
= Sounder
= End of Line Device


Circuit 1 of 10, 99 points per circuit
ADDRESSABLE MULTI-ZONE FIRE CONTROLLER
Zone 1
'X'
Zone 2
'Y'
Zone 5
Zone 4
Zone 3
Key:
= Detector or Call Point
= Zone/Line Isolator Module


ADDRESSABLE MULTI-ZONE FIRE CONTROLLER
Zone 1
Zone 2
Zone 3
Key:
= Detector or Call Point
= Zone/Line Isolator Module

4. Which Type of Fire Alarm Detection System?

Three types of fire alarm detection systems are available and covered by the code. These types are broadly defined as:

- Conventional Systems
- Addressable Systems
- Analogue Addressable Systems

The code also recognises hybrid systems, that is, systems which comprise a combination of the features of these systems.

Irrespective of which type of system is selected, the guidelines set out in Sections 2 and 3 still apply.

In the following subsections, we compare and contrast the differences between the three types of systems.

4.1 Conventional Systems

As defined in the code, a conventional or two-state detector is a detector which gives one of two states relating to either ‘normal’ or ‘fire alarm’ conditions.

Conventional fire controllers provide a number of two wire circuits onto which conventional detectors and call points are connected. Similarly, separate two wire circuits are also provided for the purpose of connecting sounders (or alarm bells) to the system (see Figure 5 in Section 3).

The primary function of the fire controller unit is to indicate the location of a fire as precisely as possible. To achieve this objective, detectors are grouped into zones with each zone being connected to the fire controller by a separate circuit which also has a separate indicator on the control panel.

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

4.1.1 Zoning

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

In conventional systems all the detectors on a zone circuit continuously communicate with the control panel. When one detector goes into the ‘fire alarm’ state, the voltage on the circuit drops and all other detectors on that zone become disabled. During this period no further information about the zone can be obtained.

4.1.2 Detectors and Call Points

Smoke detectors used in conventional systems must comply with the requirements of BS 5445: Pt 7: 1984 (EN54: Pt 7: 1982) and respond to the relevant tests as prescribed in BS 5445: Pt 9: 1984 (EN54: Pt 9: 1982).

Similarly, heat detectors must comply with the requirements of BS 5445: PT 5: 1977 (EN54: Pt 5: 1976).

In addition, flame, heat and smoke detectors designed for use in hazardous areas must comply with the requirements of BS 5345 (EN50020) and be certified with suitable BASEEFA or equivalent approval.

Manual “Break Glass” call points which can share the same circuit as the detectors must comply with the requirements of BS 5839: Pt 2: 1988.

The code states that the removal of a detector on a circuit shall not prevent the operation of any “Break Glass” call point. This can be achieved by having an addressable system where call points are connected in a ring, or by installing all call points first on one spur and then connecting the detectors. It can also be achieved by using some newer conventional equipment which provides this facility automatically by use of special equipment.

4.2 Addressable Systems

An addressable system, as defined in the code, is one using addressable detectors and/or call points, signals from which are individually identified at the control panel.

In an addressable system, the fire controller can provide a number of two wire circuits onto which addressable detectors and call points may be connected. The two wire circuit should be connected to form a loop in order to provide circuit integrity. In addition to this, zone/line isolators should be used at zonal boundaries to ensure compliance with the code.

Essentially addressable detectors operate as conventional detectors as they only have two active states (‘normal’ and ‘fire alarm’) and the zoning requirements of the addressable system are the same as for a conventional system (see Figures 6 and 7 in Section 3).

The main departure from the conventional system is that the detector base is now addressable. As such, each base has several DIL switches which allow the unique address of the base to be set. It is quite common for addressable fire controllers to accommodate up to 1,000 detectors and call points on a number of detection loops.

An alternative method to setting base addresses by means of the DIL switches is a technique known as *Soft Addressing*.

Soft Addressing is carried out by the control panel automatically programming each device in the system with ascending address numbers. The problem within this type of addressing is that if an additional device is fitted, for example between devices 5 and 6, then the panel will automatically re-address the new device and give it the next number after 5 which is obviously 6. Consequently, all other devices downstream of the new device will have their address increased by 1. Because device addresses get changed in this way, zone charts and plans also require updating if a small site extension is required. Furthermore, all point and zone descriptions also need to be rewritten.

4.2.1 Operation of Addressable Systems

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

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

The control panel then sends out the next address, and so on until all devices have been addressed, and then it repeats the whole cycle again. Each device in the system should be interrogated at least 30 times a minute.

Clearly it is possible for many detectors on the same circuit to be in alarm at the same time and for the control panel to recognise this. This means that much more information about the spread of fire within a zone can be obtained. Because of the communication techniques involved, the detectors do not have to be arranged on the circuit in address order, hence circuit wiring can take the most economical route. This method obviates the necessity of accurate installation drawings.

4.2.2 Detectors and Call Points

Addressable smoke detectors used in the system must comply with the requirements of BS 5445: Pt 7: 1984 (EN54: Pt 7: 1982) and respond to the relevant test fires as prescribed in BS 5445: Pt 9: 1984 (EN54: Pt 9: 1982).

Similarly, addressable heat detectors must comply with the requirements of BS 5445: Pt 5: 1977 (EN54: Pt 5: 1976).

Addressable call points must comply with the requirements of BS 5839: Pt 2: 1988 and should raise a fire event and activate the sounders (or bells) within 3 seconds of operating.

The code states that the removal of a detector on a circuit shall not prevent the operation of any “Break Glass” call point. This can be achieved by having an addressable system where call points are connected in a ring, or by installing all call points first on one spur and then connecting the detectors. It can also be achieved by using some newer conventional equipment which provides this facility automatically by use of special equipment.

A contact monitor module is another device which can be used on a zone circuit. This device is used for monitoring very simple items that provide a closing or opening volt free contact, for example a sprinkler flow valve,

4.2.3 Output Devices

Besides handling input devices, that is, detectors and call points, addressable systems can also handle output devices on the zone circuits. This is possible because part of the address message from the control panel can be a command instruction to an output device, signalling it to turn its output ON or OFF. A typical application of this would be a sounder module used to drive a number of sounders (or bells), or a plant interface module used to shut down a piece of electrical plant. All command instructions sent to output devices are ignored by input devices on the circuit (see Figure 8 overleaf).

It is also acceptable to connect interface modules onto zone circuits for conventional detectors. These modules allow conventional detectors on spur detector circuits with to be connected to an addressable zone circuit and monitor the status of typically 20 conventional detectors. The conventional detectors on the spur communicate with the interface module and should any detector go into alarm, the interface module signals to the control panel that an alarm condition has occurred.

A conventional detector interface module is particularly useful for areas where fire coverage is a necessity, but where the use of addressable input devices would offer little or no advantage in terms of fire search, for example in an area such as an open plan warehouse. These modules are also often used to upgrade old conventional systems, by utilising the existing wiring. This is not recommended as new wiring should always used where possible.

In order to provide short circuit protection and comply with the requirements the code, where a detector wiring circuit crosses from one zone to another, zone isolator modules must be used in the circuit at all zone boundaries.

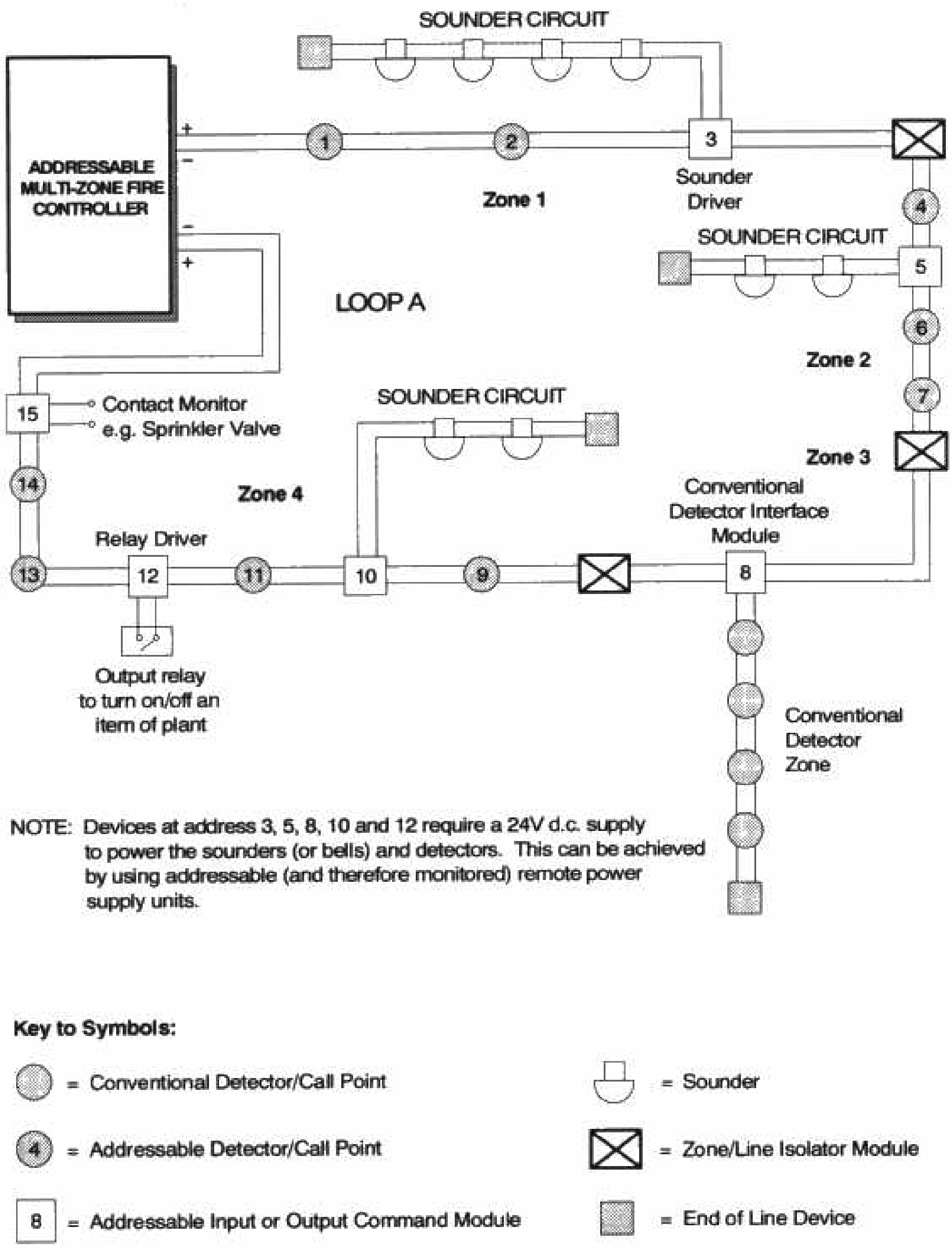


Fig. 8 Addressable Loop System Circuit with Conventional Spur and Addressable Output Modules

4.3 Analogue Addressable Systems

An analogue addressable system, as defined in the code, is one which uses analogue addressable detectors each of which give an output signal representing the value of the sensed phenomenon. The output signal may be a truly analogue signal or a digitally encoded equivalent of the sensed value.

Apart from the way in which analogue addressable detectors operate, and the fire controller communication principles employed, all system design elements of addressable systems (see Section 4.2) also apply to analogue addressable systems.

Conventional and two state addressable detectors can signal only two output states, that is ‘normal’ and ‘fire alarm’. Consequently, with these detectors it is impossible to ever establish how close the device is from an alarm condition, or whether the localised environmental conditions (which probably contains dust and dirt) are causing deteriorating changes in the detector’s sensitivity, thereby adversely affecting its performance. However, an analogue addressable system can offer a number of system performance improvements over both conventional and addressable type systems, details of which are highlighted in the following subsections.

4.3.1 Operation of Analogue Addressable Detectors

The output of an analogue addressable detector is variable and is a proportional representation of the sensed effect of fire, that is smoke, heat and flame (see Figure 9 below). Transmission of this output from the detector is usually in the form of an analogue current. When the addressable base of the detector is interrogated or addressed by the control panel, the analogue detector responds with an analogue current value rather than a status value as in the case of conventional detectors. In an analogue addressable system therefore, the analogue addressable detectors are simply acting as transducers which relay information (back to the control panel) concerning temperature, smoke density, etc. Microprocessor based circuitry in the control panel interprets the analogue value received and decides whether or not to indicate an alarm, pre-alarm, normal or fault condition.

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

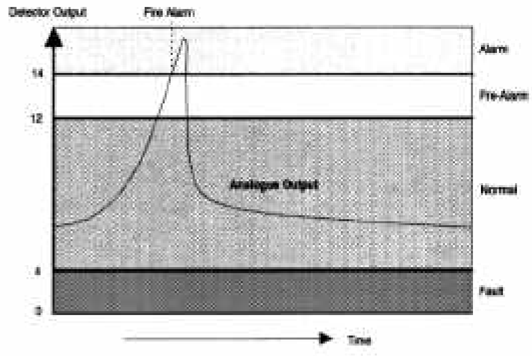


Fig. 9 Graph showing Analogue Current of an Analogue Addressable Detector Responding to a Fire

For the system to raise a pre-alarm in the event of a smouldering fire, the analogue value output by the detector must be in the pre-alarm condition (or band) for a period equal to the time taken to complete 10 successive address scans (or 20 seconds). The pre-alarm facility provides sufficient time to check the control panel for an indication of a smouldering fire. It does not provide sufficient time to visually check for the presence of a fire.

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

4.3.1.1 Detector Pre-Alarm Warning

Quite often in the early stages of a smouldering fire there is a slow build up of smoke before open burning takes place. With an analogue addressable smoke detector, the analogue value rises as the smoke builds up in the detector's sampling chamber. At a certain threshold level, that is the pre-alarm level (see Figure 10 below), the control panel can give a visual indication and audible warning of this pre-alarm condition before a full-scale evacuation of the building is required and before the fire brigade services are called. This situation allows the possible cause of the pre-alarm to be investigated prior to a full alarm condition. It also allows for primary fire fighting procedures (using portable extinguishers) to be put into effect.

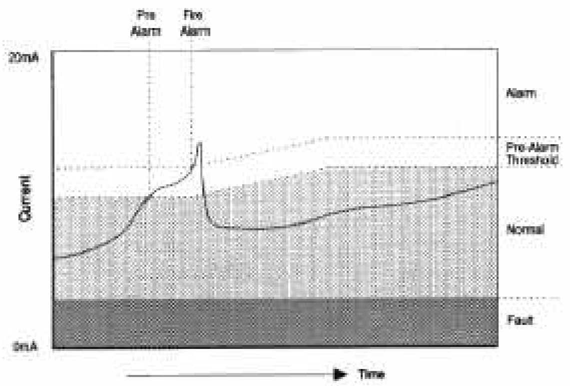


Fig. 10 Analogue Addressable Detector Typical Pre-Alarm Threshold Level

4.3.1.2 Detector Alarm Threshold Compensation

As detectors age and become contaminated with dust and dirt their performance begins to deteriorate such that their propensity to go into an alarm condition is that much higher, thus resulting in false alarms. The nuisance factor caused by false alarms is a serious problem for users and fire brigade services alike.

Since the output analogue value of each detector is checked by the control panel over 30 times a minute, the slow build up of contaminants in the detector is reflected by a slow increase in the analogue value. As this occurs, the control panel can alter the alarm (and pre-alarm) threshold in order to compensate for this phenomenon (see Figure 11 overleaf). This feature maintains the system at an optimum performance level and extends the life of each analogue addressable detector.

The threshold compensation is not adjusted every time there is a minor fluctuation in the detector's sampling chamber, however, the control panel does take an average of the analogue value over the preceding hour and alters the threshold level accordingly.

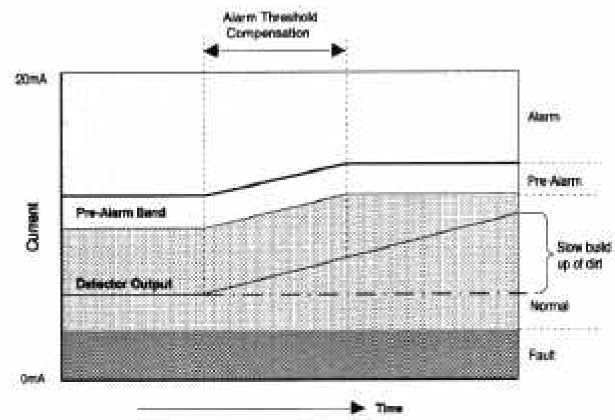


Fig. 11 Analogue Addressable Detector Alarm Threshold Compensation

4.3.1.3 Detector Condition Monitoring

In accordance with the threshold compensation (see subsection 4.3.1.2 above), there comes a time in the life of a detector when it would be unwise to raise the alarm threshold level any further (see Figure 12 below) as doing so would desensitise the detector too much and cause it to operate incorrectly. When this occurs, the control panel senses that the detector has reached the end of its operational life, and indicates a detector condition monitoring fault.

When a detector condition monitor fault is indicated, the detector must be replaced by a new one and the threshold compensation for the detector's address must also be reset. Typically this point will only be reached after several years of operation.

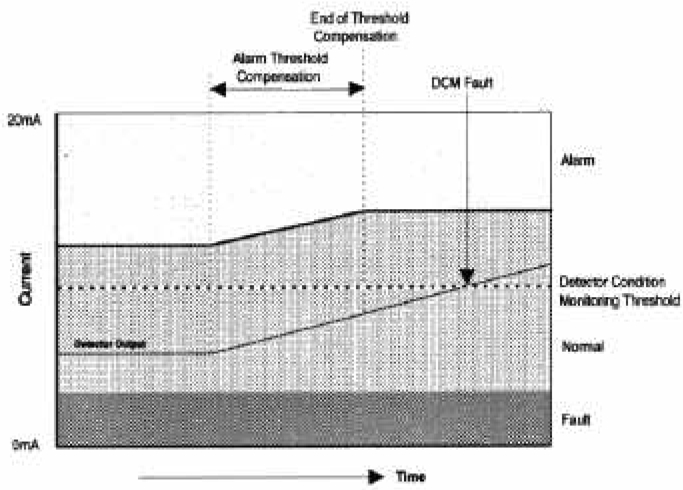


Fig. 12 Analogue Addressable Detector Condition Monitoring Threshold

4.3.1.4 Detector Sensitivity Setting

Unlike conventional or addressable fire detectors where the sensitivity is set, each analogue addressable detector can be made to emulate a normal, low or high sensitivity smoke detector by simply selecting the appropriate threshold settings for each address in the controller's software configuration. Likewise, heat detectors are selectable as Grade 1, 2, 3 or temperature range 2 response, again in the fire controller's software configuration.

The option of being able to change the sensitivity settings of detectors can be useful in many situations. For example, at certain times of the day when the building is occupied you might want to reduce the sensitivity level of detectors in selected zones, this feature allows the settings to be manually switched to low sensitivity for those zones and then switched back to normal sensitivity when the premises are again unoccupied (see Figure 13 below). There may be many reasons why you might want to do this, one being that you want to reduce the possibility of a false alarm occurring during the working day, but you want full protection at all other times.

The choice of alarm level sensitivities, plus any time delay which may be deliberately introduced, determine the overall system response to fire conditions. The alarm level and time delay can in theory be allocated any value, but in practice it is sufficient to select those levels which respond the same as conventional (two-state) detectors.

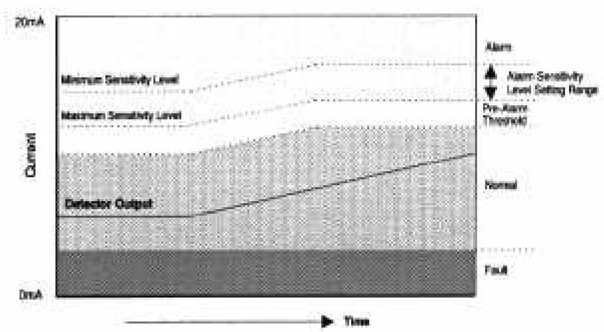


Fig. 13 Analogue Addressable Detector Alarm Sensitivity Level Setting Range

When you have determined the type of fire alarm detection system to use in the building, that is, conventional, addressable or analogue addressable, the next step in the design process is to decide which type of detectors should be used in the different areas (zones) to be protected, see section 5 (Detector Suitability).

5. Detector Suitability

Once you have decided upon the type of fire protection and alarm system to use in the building, that is conventional, addressable or analogue addressable, you now need to choose which type of detectors are to be used to protect the different areas (zones) within the premises.

There are several types of detector spread across the range, each of which responds to a different product of combustion (smoke, heat, etc.). Manual call points are used for the human initiation of the fire alarm.

The different detector types available are as follows:

- High Performance Optical Smoke Detector (point type)
- Ion Chamber Smoke Detector (point type)
- Photo-Optical Smoke Detector (point type)
- Heat Detector (point type)
- Infra-Red Flame Detector (point type)
- Split Optical Beam Detector (beam type)
- Aspirating Detector (specialised)
- Linear Heat Detector (line type)
- Duct Probe Unit (specialised)

5.1 General Fire System Engineering Principles

As each type of detector responds to a particular 'fire product', the relative speed of response of the detectors is therefore dependent upon the type of fire being detected. As smoke is normally present at an early stage in most fires, smoke type detectors (**Ion Chamber, Photo-Optical** or **High Performance Optical**) therefore are considered the most useful type available for giving early warning.

Most fires, in their later stages, emit detectable levels of heat, therefore in areas where rapid fire spread is unlikely and environmental conditions preclude the use of smoke detectors, heat type detectors (**Rate of Rise** or **Fixed Temperature**) are considered the most suitable alternative.

In situations where a burning liquid, for example alcohol, paint thinner etc. is likely to be the prime source of a fire, and flame is most likely to be the first indication a fire has started, then an **Infra-Red Flame** detector should be incorporated into the system.

Although both the heat and smoke type detectors are suitable for use inside most buildings, the flame type detectors may be used to supplement these where necessary. Flame detectors need an unobstructed line of sight, their greatest use being for such special applications as the supervision of an outdoor storage area or an area where petro-chemical processes are taking place, for example such as on offshore oil platforms.

Also available are specialised detectors which have been specifically designed for use in applications where point and line-type detectors cannot be used. Two types are available, namely **Aspirating** detector and **Duct Probe Unit**.

The **Aspirating** type detector is a compromise between the point and line-type smoke detector. It comprises a small pump which draws a sample of room air through a tube into a detector element. The detector element of the **Aspirating** detector is usually more sensitive than conventional point detectors to allow for the effects of dilution of smoke. This type of detector is normally used for protecting such areas as computer suites, clean rooms or the interior of historic buildings where point or line-type detectors would look out of place. For further information also see subsection 5.2.5.

The **Duct Probe Unit** has been designed for use in situations where the smoke, heat and flame type detectors cannot be used. It is primarily used for detecting the presence of smoke or combustion products in ventilation ducting systems. The detector operates much the same as the **Aspirating** detector in that it contains a small tube which draws air from the duct into a sampling chamber. For further information also see subsection 5.2.6.

5.2 Detector Selection for a Particular Area

The ability of any particular detector to respond to the various classes of fire within different types of environment depends upon two factors, namely the operating principle and the sensitivity chosen.

The decision as to whether the detector is conventional, addressable or analogue addressable is a separate issue because the principle of the detection method remains the same. The dirtier the environment is, however, the more preferable the analogue addressable variant becomes, and the more compartmentalised a building is, the more preferable addressable or analogue addressable becomes.

By making use of the detectable effects of the products of combustion, the protection of property against widespread fire damage can be achieved. Using the known environmental conditions, the height of the room or area under consideration, the expected fire type in the area and the known characteristics of the detectors, the correct choice of detector can be made.

In planning and designing the fire system, you may find the detector suitability selection chart shown in Table 1 below useful in determining the detector type(s) best suited for the specific environment into which the system is to be installed.

Table 1 Detector Suitability Selection Chart

	ENVIRONMENT TYPE					
FIRE TYPE	**VERY CLEAN** e.g. Computer Suite, Clean Room	**CLEAN** e.g. Office, Hotel, School	**MODERATELY CLEAN** e.g. Warehouse, Hospital	**MODERATELY DIRTY** e.g. Loading Area with Diesel Fork-Lifts	**DIRTY/SMOKY** e.g. Car Park, Machine Shop, Boiler Room	**VERY DIRTY/SMOKY** e.g. Hot Kitchen, Laundry
OVERHEATING e.g. Electrical equipment	HPO optical ion	HPO OPTICAL ion	HPO OPTICAL ion	HPO OPTICAL	optical	heat (R2)
SMOULDERING e.g. Wood, paper, fabric, plastic	HPO OPTICAL ion	HPO OPTICAL Iion	HPO OPTICAL ion)	HPO OPTICAL	optical	heat (R2)
FLAMING Early Stage e.g. Wood, paper, fabric, plastic	HPO ION optical	HPO ION optical	HPO ION optical	HPO ION flame	flame	flame
FLAMING High Heat Output e.g. Late stage flaming	HPO ION flame	HPO ION) heat (G1)	HPO ION heat (G1)	HPO ION HEAT (G1)	heat (G1) flame	heat (R2) flame
FLAMING Clean Burning e.g. Alcohol, petrol	FLAME	FLAME	FLAME	FLAME	FLAME	FLAME

Key to Preferred Detector Types:

The detector types shown in **UPPER CASE** are considered the most suitable types for use in the associated fire and environmental conditions. The detector types shown in **lower case** may be used as alternatives but they will not provide the same degree of protection.

Key to Recommended Sensitivity Settings: G1 = Grade 1 Response R2 = Temperature Range 2

The operation of each detector type is briefly described in the following subsections.

5.2.1 Smoke Detectors

To understand exactly how smoke detectors operate, you first need to know a little about the composition of smoke. Most fires produce smoke from their earliest stages, but the density and colour of the smoke depends very much upon the material that is burning and the conditions of burning.

The difference between various types of smoke are caused by the variation in the size of the particles that make up the smoke. As a general rule, the hotter the fire the greater the number of very small (invisible) smoke particles. Conversely, a fire with a low temperature decomposition produces proportionally more larger (visible) smoke particles.

Ion Chamber Smoke Detectors These detectors respond very quickly to smoke composed of very small particles (even those invisible to the naked eye), however, they respond appreciably slower to the dense smoke composed of large particles.

The detectors contain a small radioactive source which ionises the air within the sampling chamber. This causes a small current to be established which in turn sets up a potential difference between a collector electrode and the outer cover. When smoke/aerosols are introduced into the sampling chamber, the potential of the collector increases. The magnitude of this potential increase is used to indicate the smoke density. If the collector potential increase exceeds a preset level, the detector signals an alarm condition to the control equipment.

Photo Electric Scatter Smoke Detectors These detectors respond quickly to large smoke particles but they have a tendency to ignore small particle aerosols. They detect the visible particles produced in fires by using the light scattering properties of the particles.

The detectors comprise an optical system which consists of an emitter and a sensor, each of which have a lens in front, and are so arranged that their optical axes cross in the sampling chamber. The emitter produces a beam of light which is prevented from reaching the sensor by a baffle. However, when a certain type of smoke is present in the sampling chamber, a proportion of the light is scattered and some reaches the sensor. As the light which reaches the sensor is proportional to the smoke density, at a pre-determined threshold the output of the sensor signals an alarm condition to the control equipment.

High Performance Optical (HPO) Smoke Detectors The HPO detectors respond to smoke in the same way as the Photo Optical detectors, but when there is a rapid rate of rise in temperature, their sensitivity is increased so that they also respond to very small smoke particles, just like the Ion Chamber type detectors.

HPO detectors can be considered as universal detectors since they are capable of detecting all sizes of smoke particles (see Table 2 below).

Table 2 Test Fire Responses for Smoke Detectors

DESIGNATION	TYPE OF FIRE	HEAT DEVELOPED	SMOKE	AEROSOL	TEST RESPONSE		
					ION	OPTICAL	HPO
TF1	Open Cellulose	Strong	YES	Dark Invisible	A	N	C
TF2	Smouldering (Wood)	Nil	YES	Light Visible	C	A	B
TF3	Glowing Smouldering (Cotton)	Nil	YES	Light Visible	B	A	B
TF4	Open Plastics (Polyurethane Foam)	Strong	YES	Very Dark Visible	A	C	B
TF5	Liquid (N-heptones)	Strong	YES	Very Dark Visible	B	C	B
TF6	Liquid (Methylated Spirit)	Strong	NO	None	N	N	N

The sensitivity response classifications awarded to smoke detectors are A, B and C, *where* A is the highest sensitivity, B is the mid-range value and C is a pass. N means not classified.

It should be noted that test fire 6 (TF6) designated smoke detectors are not expected to pass this test since no smoke is developed and only a rate of rise in temperature can be detected.

In situations where there a mixed risk of fire, a class A response smoke detector should be regarded as too sensitive for practical purposes as it would be prone to give false alarms.

5.2.2 Heat Detectors

Heat detectors are normally used where both fire and material values are low, or where, for environmental or other such reasons, smoke detectors cannot be used in the system. In such circumstances, heat detectors can provide an acceptable, though less sensitive alternative. Three types are available which are the Rate of Rise detector, the Fixed Temperature detector and the LineType detector. Careful consideration should be given to the type of heat detectors that are to be used in certain areas. Rate of Rise type detectors for example, should not be used the in areas where large sudden changes in temperature are normal (such as in a kitchen), otherwise false alarms will occur.

The upper limit response times for the different types of heat detectors, as prescribed in BS 5445 (EN54): Pt 5, are shown in Table 3 overleaf.

Rate of Rise Heat Detectors Of the three heat detector types available, these are the preferred type. These detectors react to abnormally high rates of change of temperature and provide the fastest response over a wide range of ambient temperatures. A fixed temperature limit is also incorporated in these detectors. These detectors are ideally suitable for use in areas where any large change in ambient temperature will signal an alarm condition to the control equipment.

It is important to note that even with the rate of rise response of the detector, the air temperature at which an alarm is given is always higher for a Grade 2 response than a Grade 1 response. This means that environments that are subject to high temperatures, such as kitchens or boiler rooms, Grade 2 or 3 response detectors can safely be used without risk of false alarms. For even higher ambient temperatures, the Range 2 response should be chosen because this gives a static alarm at a temperature of between 90 °C and 100 °C.

Fixed Temperature (Static) Heat Detectors These detectors are similar to the Rate of Rise type detectors except that they react at a pre-determined temperature rather than a rate of rise temperature. These detectors are ideally suitable for use in areas where sudden large changes in temperatures are considered normal, for example in kitchens and boiler rooms.

Line-Type Heat Detectors These detectors are not commonly used, nevertheless they are another type that are available. Point-type detectors, such as the Rate of Rise and Fixed Temperature types are about the size of a teacup and are designed to sense the conditions near a fixed point. Line-Type detectors however, come in the form of a long wire or tube, and are designed to sense the conditions in the vicinity of the line. They are ideally suited for such applications as cable tunnels, cable trays and risers, high rack storage areas, transformer bays, thatched roofs, building services, subways and ducts, aircraft hangers, etc. Two versions are available, *non-integrating* and *integrating*.

The ***non-integrating*** Line-Type heat detector usually consists of a stretched wire, of fixed melting point, which is suspended over the area to be protected. If one small section of the wire is heated up (due to fire) and the temperature of the section is greater or equal to the melting point of the wire, the line will break and cause the system to go into alarm.

The ***integrating*** Line-Type heat detector is similar to the non-integrating version except here the average temperature is taken over the whole length of the wire rather than just sections of it. Consequently, a large amount of heat in a small area would need to be generated in order to create an alarm.

To allow for easy location of alarm or fault conditions, it is recommended that the maximum length of the sensing wire used with Line-Type detectors be limited to 200 metres — lengths of up to 500 metres are available for special requirements. High resistance sensor wire is also available for use in areas with high ambient temperatures, that is, temperatures greater than 50 °C.

Table 3 Upper Limit Response Times for Heat Detectors

Rate Of Rise	Grade 1	Grade 2	Grade 3	Temperature Range 2	Units
@ 30 ºC/min	1:34	2.08	2:42	1:56	minutes:seconds
@ 20 ºC/min	2:11	2:55	3:37	2:21	minutes:seconds
@ 10 ºC/min	4:02	5.10	6:18	4:00	minutes:seconds
@ 5 ºC/min	7:44	9.40	11:36	7:36	minutes:seconds
@ 3 ºC/min	12:40	15:40	18:40	11:40	minutes:seconds
@ 1 ºC/min	37:20	45:40	54:00	33:30	minutes:seconds
Static Response	58	66	74	98	degrees C
Max. Ambient Temp.	40	45	55	70	degrees C

5.2.3 Flame Detectors

Infra-Red flame detectors, unlike smoke and heat detectors, do not rely on convection current to transport the fire products to the detector, nor do they rely on a ceiling to trap the products. They detect electro-magnetic radiation which travels from a flame at the speed of light. They respond only to the short wavelengths of very high temperatures such as that present in flames. The radiation from flames is characterised by flickering in the range of 5 to 30 cycles per second.

To safeguard against false alarms, these detectors have inbuilt features which inhibit them from responding to phenomena such as the long wavelength radiation given off by hot or over-heated bodies, or the steady radiation given off from hot objects when there is no fire (even if the radiation is of the same wavelength as that of a flame). They also contain circuitry to prevent false alarms from momentary effects. The flickering shortwave infra-red radiation must be maintained for a period of time (depending on its magnitude) before an alarm is given.

These detectors can be used to protect large open areas without sacrificing speed of response to flaming fires. In order to ensure full coverage however, flame sensors do require direct line of sight to all parts of the area to be protected.

The detectors are designed to respond rapidly to fires that involve clean burning fuels such as alcohol or methane, that is fires that would not be detected by the use of smoke detectors (see BS 5445: Pt 9: Table 1).

For flaming fires, flame sensors are probably the most sensitive. The sensitivity of flame detectors can vary considerably, normally however they should be able to detect a 15cm high flame at a range of between five and ten metres. They will detect a 0.1m² petrol fire at 27m on the centre line, within approximately 10 seconds. A 0.4m² fire is detected at 47m. The flame height is roughly proportional to the range (see Figure 14 overleaf).

As infra-red flame detectors cannot respond until there is flame, it is considered practical to also use smoke detectors in conjunction with flame detectors in areas where the contents are likely to smoulder in the event of fire. In the case of smouldering fires, smoke is very often produced long before flaming occurs, consequently, the smoke detectors should cause the system to go into alarm before flaming can start. Conversely, if the contents are highly flammable then the flame detectors should cause the system to go into alarm long before the smoke detectors can detect the presence of smoke.

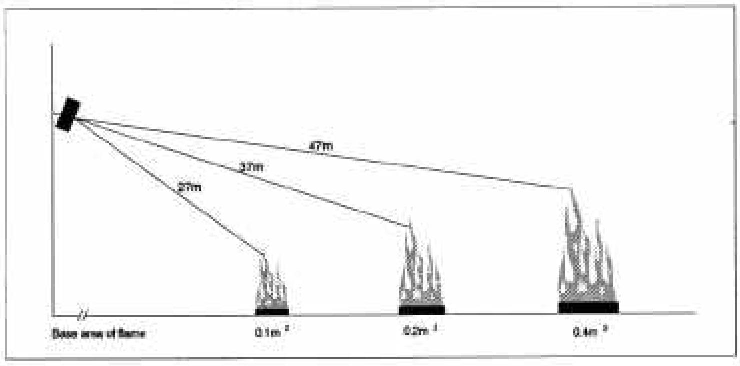


Fig. 14 Flame Detector Typical Response Characteristics (Centre line range against petrol flames)

5.2.4 Optical Beam Detectors

Optical beam detectors consist of two units, a Transmitter and a Receiver, which are displaced some distance apart (10 metres to 100 metres).

This type of detector is specifically designed for interior use in large open-type areas such as warehouses, manufacturing plants, aircraft hangers, workshops, etc. where the installation of point-type detectors would be difficult. They are also ideally suitable for installation in art galleries, cathedrals, etc. where, due to ornate and historic ceilings, point-type detectors and their associated wiring would be unsuitable.

During operation, the transmitter unit projects a modulated infra-red light beam directly at the receiver unit. The receiver unit converts the received light beam into a signal which is continuously monitored by the detector. If fire breaks out in an area protected by these detectors, smoke particles rising upward interrupt or partly deflect the light beam thus reducing the strength of beam received by the receiver unit (see Figures 15 below). If the signal in the receiver unit, which proportionally represents the strength of received light beam, is reduced by between 40 and 90 % for a period greater than five seconds (approximately), it causes the system to go into alarm.

For correct operation the transmitter and receiver units must be mounted in the roof space or just below the ceiling, whichever is applicable.

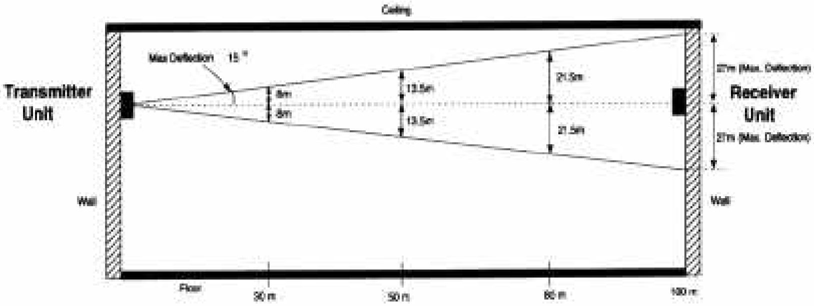


Fig. 15 Beam Detector Deflection Characteristics (Verticle Plane View)

Each detector is capable of protecting an area 7 metres each side of the beam centre line for a distance of up to 100 metres, thus providing a total coverage of up to 1400 square metres (see Figure 16 below).

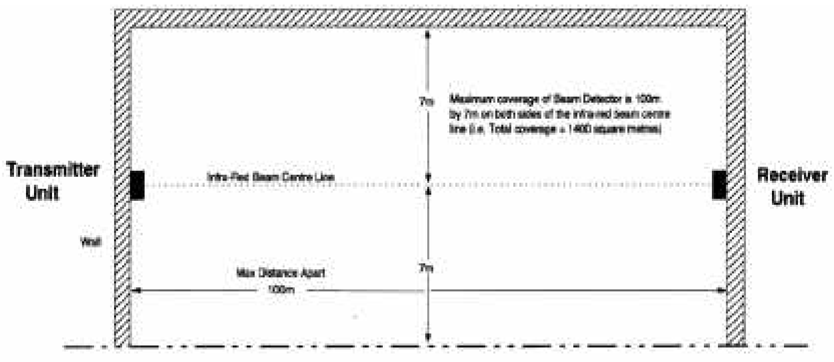


Fig. 16 Beam Detector Coverage Characteristics (Horizontal Plane View)

5.2.5 Aspirating Detectors

Aspirating detectors are a combination of the point and line-type smoke detectors. Each detector includes a small pump which draws samples of the room air through a tube into a detector element. The tube can be split into several smaller tubes (each drawing samples of air from different locations) or have several holes in it through which air samples can be drawn (see Figure 17 below).

To allow for the effects of dilution of smoke, the detector element of an aspirating detector is usually up to 100 times more sensitive than that of conventional point and line-type detectors. The air being sampled is often passed through a filter before being analysed for the presence of smoke.

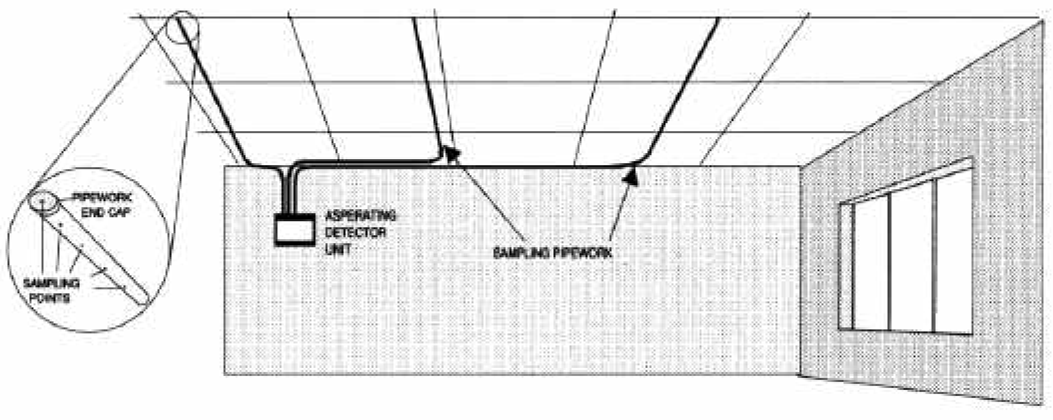


Fig. 17 Aspirating Detector Ceiling Mounted Pipework

The detector provides a number of outputs, each of which relate to a different density of smoke contained in the air being sampled. It is normal practice to monitor at least two outputs from each detector, one can indicate that smoke is present in the air (30% density), and the other that fire is present (60% density). These outputs can be reported on separate zones of a conventional fire system control panel but it is more appropriate for the outputs to be connected to two address points in an addressable fire system.

These detectors are particularly useful for protecting computer suites, clean rooms or historic buildings where point or line-type detectors would look out of place.

5.2.6 Duct Probe Unit

The duct probe unit is a detector which has been designed for use in situations where the standard smoke, heat and flame types cannot be used. Primarily it is used for detecting the presence of smoke or combustion products in extract ventilation ducting systems. The detector operates in much the same way as aspirating detectors except it does not contain a pump, but is designed to operate on the principle of differential air pressure (see Figure 18 below).

The detector, which includes two probes of different lengths, works on the differential air pressure created between the two probes which are inserted into the duct airflow. The longer probe contains a number of small holes along its length and usually extends the width of the ducting. The difference in air pressure between the two probes causes air to enter the inlet tube (i.e. the longer probe), pass through the detector sampling chamber and exhaust through the outlet tube (i.e. the short probe). The probe is flow direction sensitive and must be fitted accordingly. The air in the sampling chamber is analysed for the presence of smoke particles, and if found, the unit signals this condition to the control panel.

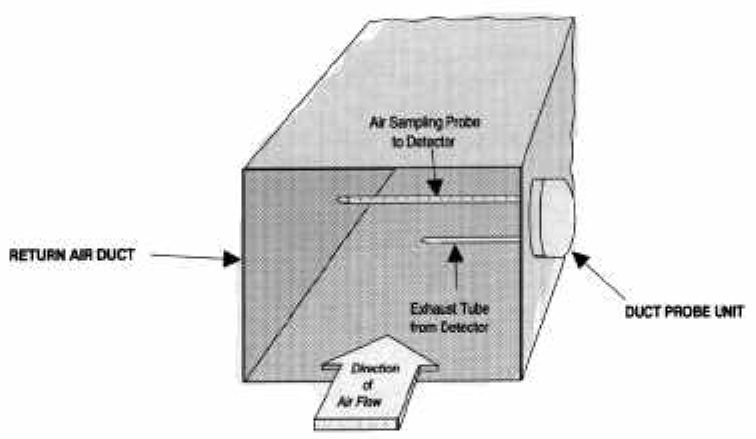


Fig. 18 Duct Probe Unit Installed in Return Air Duct

6. Detector Coverage

Clauses 12 and 13 of the code describe where detectors should be sited and what spacing should be used. Clause 12 deals with property protection and clause 13 with life protection, but in fact the two are very similar; clause 13 really deals with the small changes specific to life fire detection systems.

6.1 Spacing Under Flat Ceilings

In open spaces under flat horizontal ceilings, every point should lie within a horizontal distance of 7.5m to a smoke detector or 5.3m to a heat detector [12.2.2]. In simple terms, this means that each point within the protected area must be covered by at least one detector; the coverage of a detector is a circle centred on the detector and having a radius of 7.5m for smoke detectors and 5.3m for heat detectors. For beam detectors, the horizontal distance should be taken to the nearest point on the infra-red light beam, and the coverage should be taken as extending to that distance on both sides of the centre line of the beam (see Figure 19 below).

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

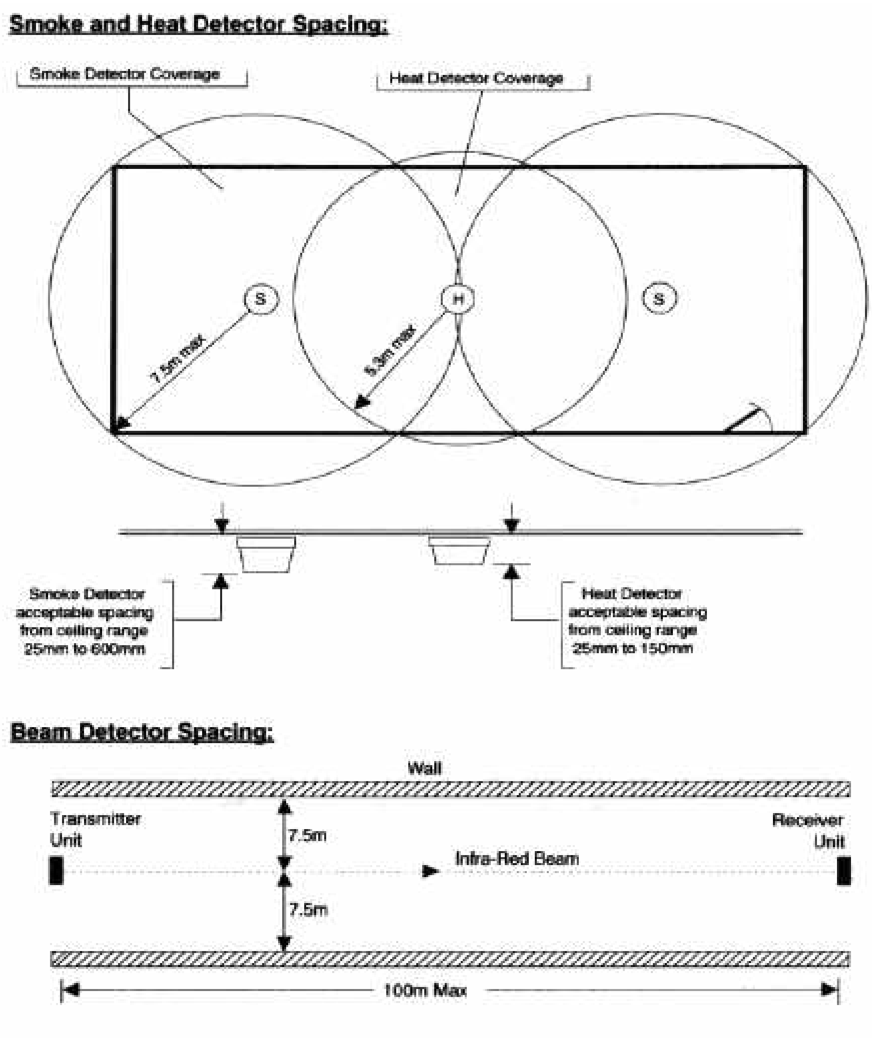


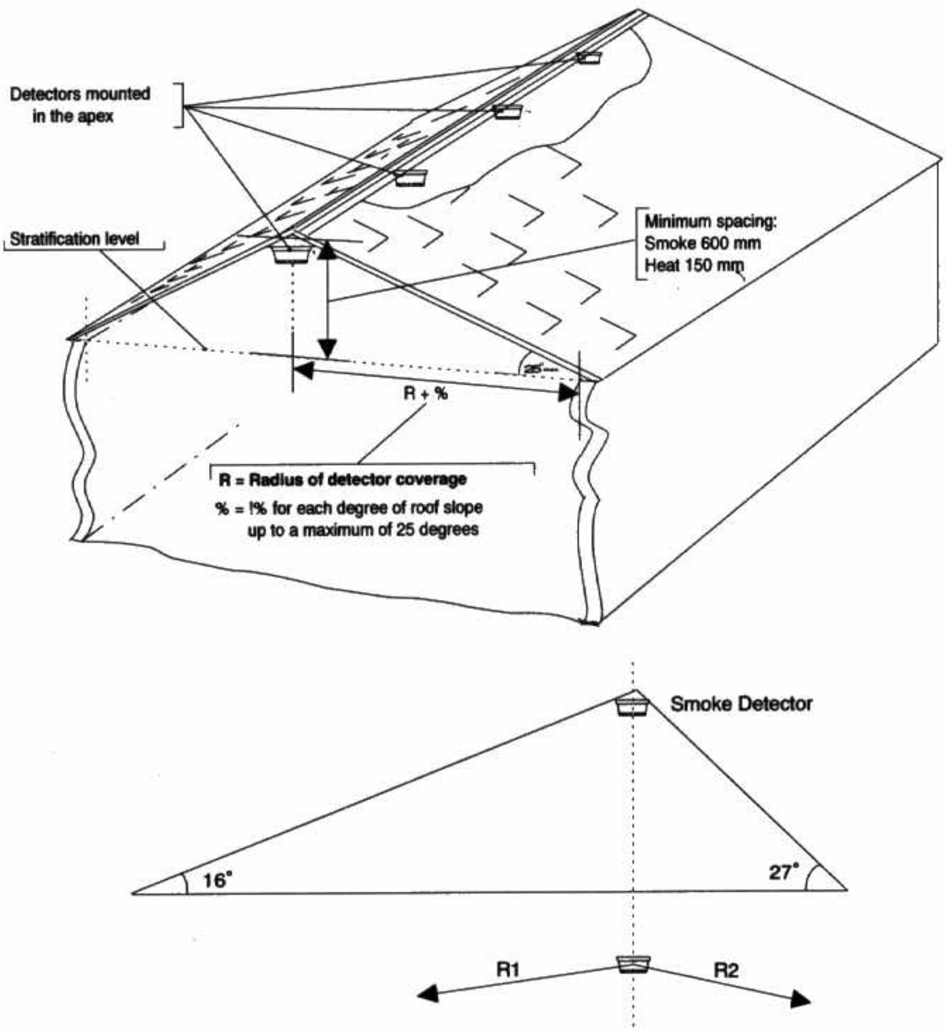
Fig. 19 Detector Coverage and Spacing Under Flat Ceilings

6.2 Spacing Under Pitched Ceilings

If the ceiling is pitched, sloping or north-light, and the difference in height between any apex and an adjacent 'valley' or low point of the ceiling exceeds 600mm for smoke detectors or 150mm for heat detectors, then detectors should be placed in the apex. If the differences are less than that quoted then the ceiling can be considered as flat. For detectors mounted in the apex, the radius of cover can be increased by 1% for each degree of slope up to a maximum of 25% [12.2.3] (see Figure 20 below).

For a semi cylindrical arch or a hemispherical dome, the radius of cover of a detector in the centre can be calculated as 8.93m for a smoke detector and 6.31m for a heat detector.

The code recommends that a row of detectors be mounted in the roof apex, and that the above increases in coverage (maximum 25%) only apply to this row.



Radii of coverage for Smoke Detectors is: R1 = 7.5m + 16% of 7.5m = 8.7m
R2 = 7.5m + 25% of 7.5m = 9.38m

Radii of coverage for Heat Detectors is: R1 = 5.3m + 16% of 5.3m = 6.15m
R2 = 5.3m + 25% of 5.3m = 6.63m

Fig. 20 Dector Coverage for Pitched Roofs

6.3 Spacing in Corridors

In corridors the constraints of the walls cause the hot gases given off by a fire to travel faster than they would otherwise move. Because of this phenomenon, an increased spacing is allowed provided the width of the corridor is less than 5m. The increase allowed in radius of cover is half the difference between 5m and the corridor width [12.2.8]. The maximum distance from a detector to an end wall (or door across the corridor) is half the maximum allowable spacing between detectors.

When calculating heat detector coverage for corridors, the information given in Table 4 below should be used. This table shows the allowable radius of detector coverage for several corridor widths and also provides details of the maximum spacing which may be used between the heat detectors.

Table 4 Heat Detector Coverage in Corridors

CORRIDOR WIDTH (m)	ALLOWABLE RADIUS OF DETECTOR COVERAGE(m)	MAXIMUM SPACING BETWEEN HEAT DETECTORS (m)
1.2	7.2	14.35
1.6	7.0	13.91
2.0	6.8	13.45
2.4	6.6	12.98
2.8	6.4	12.49
3.2	6.2	11.98
3.6	6.0	11.45
4.0	5.8	10.89
4.4	5.6	10.30
4.8	5.4	9.67
5.0 or more	5.3 or less	9.35

When calculating smoke detector coverage for corridors, the information given in Table 5 should be used. This table shows the allowable radius of detector coverage for several corridor widths and also provides details of the maximum spacing which may be used between the smoke detectors.

Table 5 Smoke Detector Coverage in Corridors

CORRIDOR WIDTH (m)	ALLOWABLE RADIUS OF DETECTOR COVERAGE (m)	MAXIMUM SPACING BETWEEN SMOKE DETECTORS (m)
1.2	9.4	18.76
1.6	9.2	18.33
2.0	9.0	17.89
2.4	8.8	17.44
2.8	8.6	16.97
3.2	8.4	16.49
3.6	8.2	16.00
4.0	8.0	15.49
4.4	7.8	14.97
4.8	7.6	14.42
5.0 or more	7.5 or less	14.14 or less

6.4 Obstructions

If the passage of smoke or hot gas from a fire to a detector is likely to be disturbed by a ceiling obstruction (such as a beam) which has a depth greater than 150mm but less than 10% of the height of the ceiling, then the normal coverage distance allowed for the detector (5.3m for a heat and 7.5m for a smoke) should be decreased by twice the depth of the obstruction [12.2.10]. Furthermore, detectors should not be mounted within 500mm of any such obstruction, wall or partition [12.2.9, 12.2.10].

Walls, partitions or dividers reaching within 300mm of the ceiling, or ceiling obstructions (such as beams) deeper than 10% of the ceiling height will obstruct the flow of fire gases to detectors, therefore the areas on either side of such walls, partitions, beams, etc. should be treated as separate rooms [12.2.9, 12.2.10].

6.5 Ceiling Heights

Detectors should not be mounted on ceilings higher than those listed under **General Limits** in Table 6 below [12.2.5]. Under certain conditions however, mounting detectors at heights greater than these limits is permitted. The conditions are as follows:

1. If in the event of a fire, an alarm is automatically sent to the fire brigade service and their usual attendance time is 5 minutes or less, then the ceiling heights listed under **Rapid Attendance Limits** in Table 6 can be used [12.2.6].
2. If there are small sections of the ceiling which do not exceed 10% of the total ceiling area, then the ceiling heights listed under **Rapid Attendance Limits** in Table 6 can also be used.

   If the sections are to be protected by point-type heat detectors, their heights must not exceed 10.5m if the **General Limits** are applicable, or 15m if the **Rapid Attendance Limits** apply.

   If the sections are to be protected by point-type smoke detectors, their heights must not exceed 12.5m for the **General Limits** or 18m for **Rapid Attendance Limits** [12.2.5, 12.2.6].

Table 6 Ceiling Height Limits

DETECTOR TYPE	CEILING HEIGHT LIMITS (metres)	
	General Limits	Rapid Attendance Limits
Heat Detectors (BS 5445: Part 5) Grade 1 Grade 2 Grade 3	 9.0 7.5 6.0	 13.5 12.0 10.5
Point-Type Smoke Detectors [11.3]	10.5	15.0
High Temperature Heat Detectors (BS 5445: Pt 8)	6.0	10.5
Optical Beam Smoke Detectors (BS 5839: Pt 5)	25.0	40.0

6.6 Walls and Partitions

A wall has two effects on the movement of smoke under a ceiling:

1. It slows down its movement towards the wall.
2. It deflects it in a direction parallel to the wall.

Because of the slowing down effect, there tends to be dead spots near the wall. The code therefore states that detectors should not be mounted within 500mm of any wall [12.2].

The deflecting effect though, causes the smoke to move along the wall faster than might be expected. The effect becomes even more noticeable in a corridor, where both walls act together by constraining movement of the smoke along the corridor (see subsection 6.3, Tables 4 and 5).

As in the case of walls, partitions also have an effect on the movement of smoke, and they do not even have to reach right up to the ceiling for the effect to occur. If just a small gap is left between the partition and the ceiling, movement of the smoke again becomes constrained and flows parallel to the partition. In the case of partitions, the code states that if the partition (or similar construction, for example a storage rack) reaches within 300mm of the ceiling, then it should be treated as if it reached the ceiling, and the sections of the protected space each side of the partition should be treated as separated rooms [12.2.9].

6.7 Voids

Ceiling and under-floor voids 800mm or more in height should also be zoned and protected by detectors. Any void less than 800mm in height need not be protected unless extensive spread of fire or its products, particularly between rooms or compartments, can take place within it before detection [12.2.11].

Where it is considered necessary to install detectors in shallow voids having poor ventilation, for example under-floor service voids, special care should be taken with the positioning of the detectors. As the initial smoke layer in a fire usually takes up the top 10% of the void height, in shallow voids this may be small compared with the dimensions of the detector. Care should therefore be taken to ensure that the sensing element of the detector lies within the top 10% of the void's height.

6.8 Ventilation

Ventilation systems in buildings should also be taken into account when designing fire systems because air movements in a space protected by heat or smoke detectors can have a number of effects on the operation of the devices.

Extraction systems can draw the fire products away from normally sited detectors, and fresh air inlets can keep clean air passing over detectors even when the room air is smoky. Increased air turbulence can give increased dilution of the smoke, and in some detectors clean air can cause a false alarm if it moving fast enough.

All heat and smoke detectors depend on the movement of fire products from the fire to the detector. Movement of air in the building may be due to many causes, all of which can have an effect on the movement of the fire gases. As the fire gets bigger its convective effects gradually overpower all other causes of air movement. This, however, is not of much use to us as we need to detect fires when they are small.

Computer Suites A case of special importance lies in the protection of computer suites. These usually combine a high financial value with high ventilation rates; just when we need to detect fires particularly quickly, the ventilation makes things especially difficult! The code recommends that BS 6266 (*Code of practice for fire protection of electronic data processing installations*) should be consulted here.

Ventilated Rooms The code does provide useful advice on installation of detectors in ventilated rooms [12.2.16]. Detectors should not be mounted directly in the fresh air input from air conditioning systems. In general, a spacing of not less than 1m between the detector and the air inlet should be maintained. Where the air inlet is through a perforated ceiling, the ceiling should imperforate for a radius of at least 600mm round each detector.

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

If the smoke is going to be drawn out of the room by the ventilation system, then duct probe units (detectors) should also be installed in the ventilation system extract duct(s).

7. Manual Break Glass Call Points

7.1 General Information

Every fire detection system must include call points, so that in the event of a fire, help can be called immediately. They should be placed in identical positions on the various floors in buildings if possible. Call points are also to be placed on all exits in the buildings and no person should have to travel more than 30 metres to reach a call point. This distance may be less if the occupants are slow moving and if movement through multiple offices is required to in order to reach a call point. . They must also be mounted at a hight of 1.4m from the floor.

Manual call points should comply with British Standard BS 5839: Pt 2: 1988. All call points in the installation must have the same method of operation. A system in which some call points require impact by a hammer and others which just require thumb pressure is not acceptable [10.1].

The delay between operation of a call point and the sounding of the alarm should not exceed 3 seconds and ideally should not be above 1 second.

Call points should only be resettable by means of replacing the glass/perspex, or by the use of a special tool not normally carried by the general public.

All call points should be clearly identifiable and should not require instructions as to their mode of actuation.

Break glass/impact type call points must not be installed in food preparation areas or areas where flammable/explosive atmospheres are likely to be present. If installed in food preparation areas, breaking the frangible element may result in glass fragments getting into food.

7.2 Operation of Addressable Call Points

Addressable call points do not have a delay sequence like analogue addressable detectors, however they must operate and give audible warnings within three seconds of being operated. Addressable call points should comply with the requirements of BS 5839: Pt 2: 1988.

Operation of the call points is by way of a switch contact that is operated by the breaking of the frangible glass element. When the call point is addressed by the fire controller, it signals the condition of the switch contact to the controller. Each addressable call point also contains a LED indicator which illuminates every time the controller addresses the device in the ALARM condition.

Testing of addressable call points for correct operation is a simple and easy procedure that can be carried out at any time with the aid of a special tool provided. When this tool is inserted into the side of the call point housing, it moves the glass element down and operates the switch contact.

7.2.1 Alarm Signal Setting

Addressable call points can be set to signal one of two alarms (EVACUATE or ALERT) to the controller. The alarm signalled by the call point is set by selecting the appropriate value of a resistor (R) within the call point.

7.3 Siting of Manual Call Points

Manual call points should be located on exit routes and in particular on the floor landings or stairways, and at exits to the open air. Special consideration needs to be given for staged alarm systems because the design has to ensure that any call points in the circuit remain operational in the event of a fault occurring; ring and loop circuits are normally used to facilitate this requirement [7.3 and 9.9].

The call points should be so located, that to give the alarm, no person in the premises need travel more than 30m [10.2]. It may be necessary to have travel distances to a call point much less than 30m where the expected occupants of the building are likely to be slow in movement, or where potentially hazardous conditions exist, for example in close proximity to cellulose spray booths. The action to be taken in the event of fire may make the provision of additional manual call points necessary.

The siting of call points should generally follow these guidelines:

1. Comply with the 30m distance rule.
2. Use the same method of operation throughout the building.
3. The time between operation and the sounding of the alarm should ideally be less than 1 second.
4. Be mounted at a height of 1.4m from the floor.
5. Be mounted free of any obstructions.
6. Be mounted against a contrasting background.
7. Present a side profile area of not less than $750mm^2$.

7.4 Manual Call Points in Automatic Systems

If manual call points and automatic devices such a detectors are to be installed in the same building for the purpose of providing a general alarm in the event of fire, then they may be incorporated into a single system.

Manual call points included within a zone may be wired to the detector circuit for that fire zone as long as the recommendations of the code are followed [6.6]. 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 are sited , for example, on staircase landings in a multi-zone building, their indication of the position of the fire may be misleading; its preferable for each to be arranged in a separate zone [7.3].

Where manual call points are to be incorporated into an automatic system, the delay between the operation of the call point and the indications of the alarm should not exceed three seconds [10.1].

8. Audibility Requirements of Alarm Sounders

Where a fire system is installed for the protection of the property only, the alarm sounders need only be sufficient to summon the local fire-fighters or the fire service. In most premises however, there is also a risk to life because there are occasions when someone will be in the building, therefore property only protection is unacceptable. In fact, the requirement for property only fire protection systems is quite small, whereas the need for life protection systems is now the normal requirement.

When designing fire systems, careful consideration must also be given to the positioning of sounders. The audibility levels of sounders can differ quite significantly depending upon where they are located. You should ensure that sounders are not located in positions where, because of closed doors or other obstructions, the audible level of the devices are not diminished.

8.1 Level of Sound

For general use, the code recommends that the minimum sound level produced by the sounders in all parts of the building should be either 65 dB (A), or 5 dB (A) above any other noise likely to persist for longer tham 30 seconds, whichever is the greater [9.4]. There is one exception to this however, and that is, if communication with the fire brigade service is by means of telephone, care should be taken to ensure that the operation of the fire alarm (and fault warning) sounders do not interfere with telephone speech and thus result in a confused message being relayed. Furthermore, certain sounder frequencies can sometimes confuse tone-selective dialling systems and lead to failure of the emergency call [8.3].

If the fire routine for the premises requires the alarm to arouse sleeping persons then the minimum sound level should be 75 dB (A) at the bedhead with all doors closed. This will not guarantee that every person will be awakened but it can be reasonably be expected to wake a sleeping person in most circumstances.

Table 17 below shows typical output dB fall-off figures (in open space) for different types of bells and sounders fitted in various locations.

Table 17 Sounder Audibility Design (dB fall-off) Levels

SOUNDER TYPE	SOUNDER OUTPUT dB (A)				
	@ 1 Metre	@ 2 Metres	@ 4 Metres	@ 8 Metres	@ 16 Metres
6” Bell	91	85	79	73	67
8” Bell	95	89	83	77	71
Banshee Sounder	103	97	91	85	79
Bedlam Sounder	113	107	101	95	89
Bedhead Sounder	96	90	84	78	72
Squashni Sounder	85	79	73	67	-

8.2 Discrimination and Frequency

Two important factors relating to any sounders used in fire alarm systems are Discrimination and Frequency.

Discrimination The type, number and location of fire alarm sounders should be such that the alarm sound is distinct from all the background noise. The note of the fire alarm sounders should also be distinct from any other that are likely to be heard, and in particular it should be distinct from the audible fault warning signal given by the control equipment.

All fire alarm sounders within the 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 used, for example flashing coloured beacons [9.4.2].

Frequency Young persons are 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 attenuate sound; in general, the higher the frequency of the sound, the greater the attenuation. Because of this, fire alarm sounders should therefore ideally lie in the range 500 Hz to 1000 Hz [9.4.3].

If a two-tone alarm is used, at least one of the major frequencies should lie within the 500 Hz to 1000 Hz range. Where the frequency range of background noise is such that it masks the range, then the use of frequencies outside this range may be acceptable

8.3 Sound Continuity

The code states that the sound of the fire alarm should be continuous although the frequency and amplitude may vary (for example, as in a warbling note) provided the distinction from the ‘alert’ signal is clear [9.4].

8.4 Audible Alarms in Noisy Areas

In areas of a building where there are noisy machines, the power requirements of high powered sounders needed to comply with the recommendations of the code (see 8.1 above) may place excessively high demands on the power capacity of the fire alarm system. In such cases, the primary sounders may be reinforced by secondary sounders operated directly from the mains supply and without standby supplies, provided the following conditions apply [9.4.5]:

1. When the machine noise ceases and the secondary sounders are out of service, the primary sounders meet the sound levels recommended in the code (see 8.1 above).
2. The primary sounders in all other areas of the building are distinctly audible at all times when operated.
3. Failure of the supply to the secondary sounders either result in the silencing of the noisy machines or an audible and visible fault warning is given at the control panel.

8.5 Grouping of Fire Alarm Sounders

In small buildings the sounding of alarms can usually be so arranged that any alarm operates the sounders throughout the whole of the building.

If the fire alarm system extends to several buildings, or to other areas of the building which is 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 adjoining areas, or in that zone and in other areas where fire might be particularly dangerous, for example because of flammable contents, etc.

It is essential that the grouping of fire alarm sounders is based on consideration of the fire routine of the building or individual areas, and on the action required of the occupants in the event of fire. The sounders should be so grouped that, wherever the origin of the fire, any person needing immediate warning (whether for evacuation or other reason) receives that warning automatically and without manual intervention. The grouping should be reflected in the fire instructions issued for the use of occupants [9.5].

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 a failure in any other group.

8.6 Guidelines for Alerting Occupants

Where premises are occupied, the guidelines for alerting the occupants of the building, in the event of fire, are as follows:

- A sounder should be located near the control panel.
- In normal surroundings, the sound level should be at least 65dB(A) or 5dB above ambient.
- If sleeping persons are to be woken up, the sound level should be at least 75dB(A), measured at the bedhead.
- The alarm sound should be the same for all parts of the building.
- The frequency of the sounders should be between 500Hz and 1000Hz.
- Visual alarm signals, such as flashing beacons, etc. should be provided in areas of high background noise or where some occupants may have impaired hearing.
- Voice evacuation as an alternative to alarm sounders or bells is permitted, for example by use of a Voice Module.

9. Controller Equipment

The control equipment used in all fire systems should comply with BS 5839: Pt 4: 1988 and be approved by the Loss Prevention Certification Board. The complete range of fire control equipment, detectors, sounders, call points and ancillary modules available from Thorn all comply with these requirements.

Although we described the features and operation of the different types of fire detection systems in section 4, there are also other factors which should also be considered when designing a system, namely Siting of Control Equipment, Location of Origin of the Alarm and Security of Control Equipment. Each of these topics are described below.

9.1 Siting of Control Equipment

The siting of the control equipment should satisfy a number of recommendations:

1. Since the control equipment is at the heart of the system, it should always be placed in an area of low fire risk [15.3.5]. If a suitable site cannot be found for the control equipment then it may be necessary to provide a duplicate indicator control panel at the building entry point to be used by the fire brigade.
2. Its indications should be quickly available, both to staff, who might have to carry out actions in the event of fire [15.3.1], and to the attending fire brigade [15.3.2].
3. Indicators should be easily visible both in darkness and in sunlight.
4. If some ambient lighting is required, it should be provided either by the building's emergency lighting supply or by a special luminaire fed from the fire alarm system supply. If the fire alarm supply is used, the lamp circuitry should be designed such that the lamp is illuminated only when the system is in the alarm state; this requirement is necessary in order that the power of the standby supply is preserved [15.3.3].
5. Noise or other sound levels in the vicinity of the control equipment should not mask out the audible alarm of sounders located near the control equipment [15.3.4].
6. In multi-occupancy buildings, siting should be agreed with the other occupants.

9.2 Location of Origin of the Fire

Although addressable systems can precisely locate the position of the fire, one requirement for all fire systems is for a Display Layout of the building. The Display Layout (also commonly referred to as a Mimic Diagram) should be situated alongside the control panel.

The Display Layout may be in the form of a chart or geographic plan of the premises which details the entrances, circulation routes, escape routes and the zones. An example of a Display Layout is shown in Figure 21 overleaf.

In the case of addressable systems which can provide alarm related messages via an LCD display, the code states that point information regarding exact location should still be subsidiary to zonal lamp indication. After all, how would a fireman who enters the premises with an axe at 3.00am in the morning know where the "marketing department" is located!

The Display Layout provides the quickest and most accurate method by which the location of the fire can be displayed. It enables both the zone and the room or detector of origin to be displayed, and its indications can be more rapidly appreciated than by other methods.

9.3 Security of Control Equipment

The code recommends that the operation of the fire detection and alarm system control equipment be limited to authorised personnel only. Where the restriction is not provided on the control equipment, for example by means of a key switch, the code allows for security of the equipment to be provided by restricting access it.

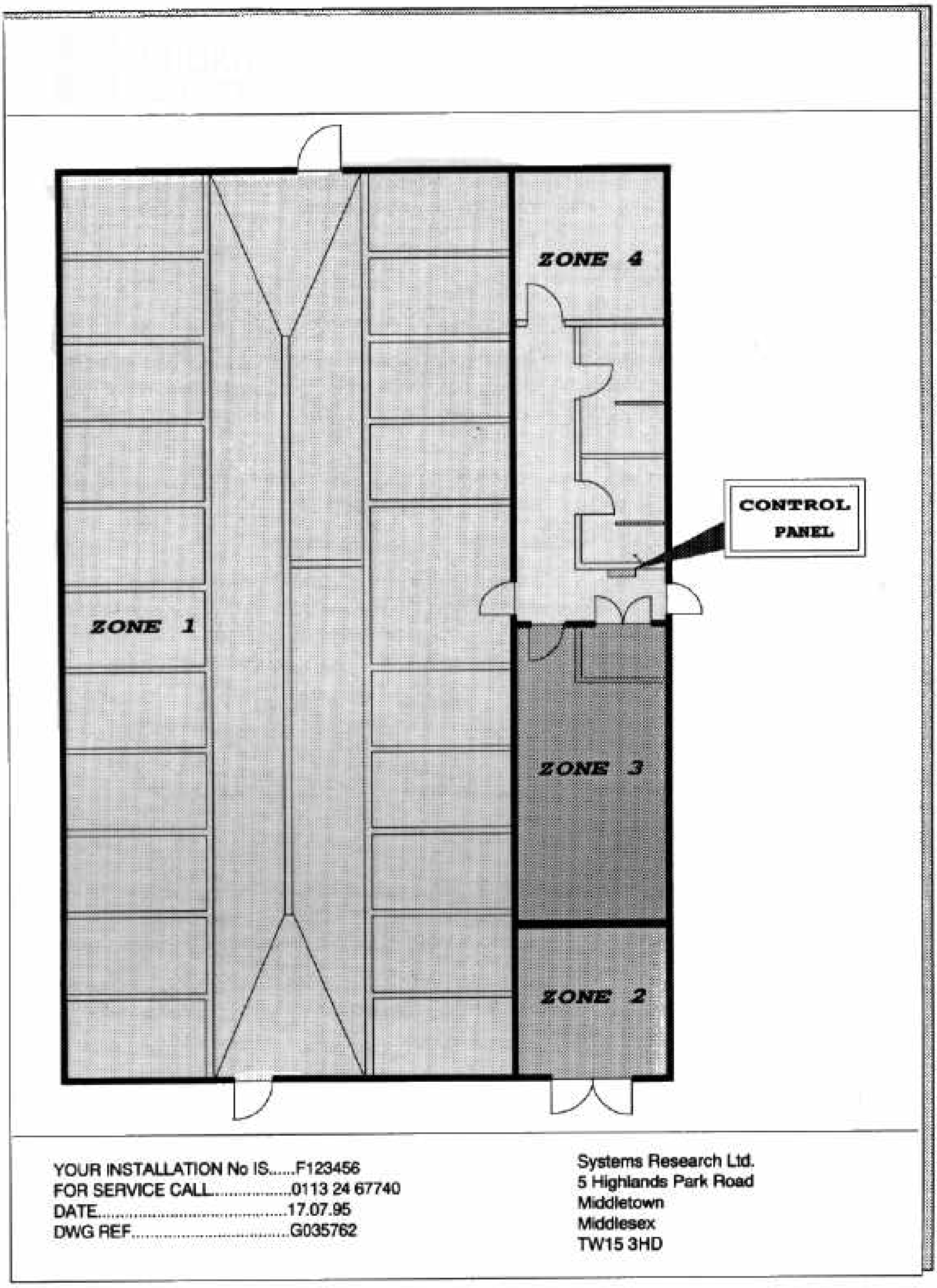


Fig. 21 Example of a Display Layout

10. Power Supplies

Small manual systems designed for single zone coverage can use simplified power supplies which comply with [Appendix G] of the code, however, the public mains supply should be used where available. All other systems should comply fully with the recommendations outlined in [clause 16] of the code.

In the case of most designs, the system will be powered from the public mains supply, with a secondary standby supply being provided by rechargeable batteries or a generator. If the standby supply is being provided by a generator then it may be permissible to reduce the standby capacity, as outlined in the code [16.3.2.2, 16.5.1.5].

Both the primary mains supply and the secondary standby supply shall be able to provide the maximum load independently of each other. The alarm load of the fire system is the maximum load which the power supply must provide under fire conditions. This includes power to operate the fire controller, all sounders, all detectors, fault devices and transmission of signals to a remote central station.

10.1 Mains Supply

Connection of all systems to the public mains supply should be in accordance with the recommendations outlined in BS 7671 (*Requirements for Electrical Installations - IEE Wiring Regulations, Sixteenth Edition*). The mains supply for the system should be connected via an isolating switch-fuse or circuit breaker used solely for the purpose of the fire detection and alarm equipment. The switch used for disconnecting the mains supply to the fire alarm system should be coloured red and clearly labelled ‘FIRE ALARM: DO NOT SWITCH OFF’.

Because this switch is independent of the other building mains supply, there is a danger that people may not realise that switching off the main switch for building supply will not totally disconnect the mains wiring in the building. For this reason, labels warning of this danger should be placed on both the mains isolator switch for the building and the switch for the fire alarm system.

Residual current devices protecting the building’s mains supply should not isolate the supply for the fire alarm system.

The condition of the mains supply for the system shall be indicated by a green power ‘on lamp’ on the fire controller.

10.2 Standby Supply

The standby supply will usually be provided by secondary batteries with an automatic charger. The batteries should have an expected life of at least four years; the code specifically disallows the use of car-starting type batteries. In order that the full life of the batteries is achieved it is important to ensure that the characteristics of the charger match those of the batteries being used [16.3.2.1].

The standby supply batteries and charger shall fulfil the following requirements:

1. Have a life expectancy of not less than four years.
2. The charging rate (from discharged state to fully charged) shall not exceed 24 hours.

In the event of a mains supply failure, the capacity of the standby supply must be sufficient to provide protection until the normal mains supply has been restored. The code is not explicit about minimum standby supply duration requirements, however, it does provide details on how these can be determined. In each case though, the code does state that at the end of the standby period there must be sufficient capacity remaining to either signal an evacuation in all zones or operate all sounders for 30 minutes.

The minimum requirements for the different system types and conditions are described in the following subsections.

10.2.1 Life Protection (L and M Type Systems)

Where the premises are either supervised or have a remote link to a central station, the capacity of the standby supply shall be capable of providing for 24 hours normal operation, and also have sufficient capacity remaining to provide an evacuation alarm for 30 minutes thereafter.

Where the premises are unsupervised and do not have a remote link to a central station, the capacity of the standby supply shall be sufficient to maintain the system for the unsupervised period plus 24 hours, and also have sufficient capacity remaining to provide an evacuation alarm or to operate the alarm sounders for 30 minutes thereafter.

For example, if the premises are unoccupied from 6.00pm (closing time) Friday until 8.00am (opening time) Monday and the normal operating current of the system is 350mA, and the alarm current is 2.0A, the capacity of the standby batteries required for normal operation of the system can be calculated using the following formula:

((Maximum Unsupervised Time + 24 Hours) x Operating Current) + (Alarm Current x Alarm Duration)

i.e. (86 x 0.35) + (2.0 x 0.5)

= 31.1 Ah capacity batteries (minimum)

In order that some spare capacity is provided, 36 Ah batteries should be used for the standby supply in this case.

To cater for longer unsupervised periods, such as extended holiday weekends, etc., the code allows for batteries to be manually connected if required. For example, a set of fully charged batteries could be manually switched in mid-point during the unsupervised period so as to provide sufficient power for the system to continue normal operation throughout the whole period [16.5.1.3]

10.2.2 Property Protection (P Type Systems)

The capacity of the standby supply required for property protection type systems of is dependent on whether or not a mains supply failure will be immediately recognised within the building or via a remote link to a central station.

If the premises are occupied or if a remote link is available, the capacity of the standby supply shall be capable of providing sufficient power for normal operation of the system for 24 hours, and also have sufficient capacity remaining to provide an evacuation alarm or to operate the alarm sounders for 30 minutes thereafter [16.5.2.2].

If the premises are unoccupied and a remote link is not available, the capacity of the standby supply shall be capable of providing power for normal operation of the system for the whole of the unoccupied period plus 24 hours, and also have sufficient capacity remaining to operate the alarm sounders for 30 minutes thereafter [16.5.2.3].

11. Cabling Considerations

Correct operation of a fire alarm system depends very much on the interconnections between the control equipment, detectors, call points and sounders. Unless these interconnections operate correctly when required the system will not fulfil its intended functions [17].

The components of most fire detection and alarm systems are connected by cables and wiring. For specialised applications where cabling cannot be used, fiber optics and/or radio links are used [18].

When selecting cables for a fire alarm system due consideration should be given to the following:

1. Resistance to fire
2. Current carrying ability.
3. Voltage drop under maximum current conditions.
4. Insulation characteristics.
5. Mechanical robustness, resistance to corrosion and rodent attack, etc.
6. Screening (where applicable).

Although a wide variety of different cables could be used in various parts of a fire alarm system, many may be restricted in their suitability because of their varying abilities to resist both fire and electrical or mechanical damage. For this reason cables which are considered suitable for use in fire detection and alarm systems are classified according to their need for fire protection. The recommended cable types are described in the following subsection.

11.1 Recommended Cable Types

The types of cable, its routing and its physical and electrical protection characteristics should be specified for each particular installation. Wiring, in general, must comply with the latest issue of BS 7671 *Requirements for Electrical Installations - IEE Wiring Regulations* (currently *Sixteenth Edition*). Wiring for specific systems may also be required to conform to BS 5839: Pt 1: 1988 *Fire Detection and Alarm Systems in Buildings Code of Practice for System Design Installation and Servicing*.

For fire detection and alarm system applications, cables are divided into two main types [17.2]:

- Type 1 (Prolonged operation during a fire required)
- Type 2 (Prolonged operation during a fire not required)

Type 1 cables are those which must continue to function in a fire for at least 30 minutes. Two cable types that satisfy these requirements without further protection [17.4.2] are as follows:

1. Mineral-insulated copper-sheathed cables (MICC) complying with BS 6207, with or without an overall PVC sheath.
2. Cables complying with BS 6387 and meeting at least the requirements for categorisation as AWX or SWX.

Cables other than these two types may be used where prolonged operation during a fire is required provided they are protected against exposure to the fire by either:

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

b) Separation from any significant fire risk by a wall, partition or floor having at least 30 minutes resistance to fire in accordance with the appropriate British Standards and Building Legislation [17.4.2].

Type 2 cables are those which having served their purpose in a fire can then fail. The cable types that satisfy these requirements are as follows:

a) Mineral-insulated copper-sheathed cables (MICC) complying with BS 6207, with or without an overall PVC sheath (see Note 1).

b) Cables complying with BS 6387 and meeting at least the requirements for categorisation as AWX or SWX (see Note 1).

c) Cables complying with BS 6387 and meeting at least the requirements for categorisation as A or S.

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

e) PVC-insulated and non-sheathed cables complying with BS 6004.

f) General purpose elastomer-insulated textile-braided and compounded cables complying with BS 6007.

g) PVC-insulated cables of types BK, BR and BU complying with BS 6346.

h) Sheathed steel-wire-armoured cables with cross-linked polyethylene or hard ethylene propylene rubber insulation complying with BS 5467.

i) Polyethylene-insulated PVC-sheathed coaxial cable with a central conductor of not less than 16 strands/0.2 mm in diameter, but otherwise complying with the dimensional requirements BS 2316: Part 3 for Uniradio Sheet M210 (see Note 2).

j) Cables designed for the detection of heat (see Note 2).

Notes:

1. Cables used in applications requiring prolonged operation during exposure to fire should be either as described in a) or b) above [17.4.2].
2. The code states that coaxial cable or cables designed for the detection of heat (see I) and j) above) may be used for the inter-connection of detectors within a zone, provided that the system is such as to give a fire alarm in response to the occurrence of fire at such a cable [17.4.1].
3. Cables other than those listed in a), h) and I) above are not sufficiently robust to withstand the mechanical hazards which they may experience in practice, such as impact, abrasion or attack by rodents. PVC-insulated non-sheathed cable, as described in e) should always have mechanical protection. Cables other than those described in a), e), h) and I) should be given mechanical protection if they are not monitored or they are less than 2.25 m above the floor, or if physical damage or rodent attack is likely. Mechanical protection can be provided by installing the cables in conduit, ducting or trunking, or by laying them in a channel [17.5.2].

11.2 Cable Suitability

For Power Type 1 cables should be used for the purpose of connecting power to the control equipment, the sounder circuits, and if applicable the alarm circuits used for transmitting an alarm signal to a central station or the fire brigade.

For Signals Type 2 cables should be used for purpose of carrying fire alarm signals generated by detectors, sensors, call points and ancillary devices such as door retention units, etc.

11.3 Conductor Sizes

When selecting conductor sizes, regard should be paid to physical strength and the limitations imposed by voltage drop. Voltage drop down a cable should not be such as to prevent devices from operating within their specification limits, even under minimum supply and maximum load conditions. Special consideration should also be given to any possible extensions which might need to be incorporated into the system sometime in the future.

Unless otherwise recommended, cable conductors should be of copper and have a cross-sectional area of not less than $1mm^2$ [17.7].

11.4 Segregation

The code states that 'conductors carrying fire alarm power or signals should be separated from conductors used for other systems' in the building [17.10]. The reason for this requirement is twofold. First, the possibility that other conductors nearby might produce interference on the fire alarm system, and second, that electric cabling is a known cause of fires.

The methods used to separate fire alarm system cables from other cables in the building may be any one of the following:

1. Installation in conduit, ducting, trunking or a channel reserved for fire alarm conductors.
2. Installation in multi-compartment trunking consisting of a mechanically strong, rigid and continuous partition manufactured in a non-combustible material.
3. Mounting the cables at a distance of at least 300mm from conductors of other systems.
4. Wiring with cables having BASEC certificates of compliance with BS 6387 and assessed under any scheme (such as the BASEC scheme) as suitable for use without segregation.
5. Wiring with mineral-insulated copper-sheathed cable with an insulating sheath or barrier. The exposed-to-touch rating defined in BS 7671 (*Requirements for Electrical Installations - IEE Wiring Regulations, Sixteenth Edition*) should not be exceeded

The mains supply cables on the supply side of the fire alarm system isolating switch-fuse device need not be segregated. Cables carrying power in excess of extra-low voltage should always be kept separated from other fire alarm system cables. In particular, the mains supply cable should NOT be brought through the same cable entry as cables carrying extra-low voltage power or signals.

11.5 Cable Failure

The concept of 'circuits protected against cable failure' has already been discussed in subsection 3.4 (Zone Safeguards). It is again used in setting the requirements for cable protection.

Any of the cables described earlier in subsection 11.1 may be used in the fire alarm system if the design is such that a single fault on the cabling connections between devices satisfies the following:

1. A single fault must not affect more than the components immediately adjacent to it.
2. A single fault must not affect the correct working of the remainder of the system beyond the immediately adjacent components.
3. A cabling fault must result in a fault warning at the control equipment.
4. An indication must be given of the section of cabling affected by the fault.

11.6 Cable Runs

Cables may be run between all units, detector bases, call points and sounders as specified on the Installation Diagram and in accordance with the following conditions:

1. Fire alarm system cables run in troughs must be kept physically separated from other cables in order to avoid induced currents which can cause a fire detection system to malfunction.
2. Wherever specified, compliance with special earthing requirements must be adhered to in order to avoid earth loops.
3. Detector circuit wiring must be physically separate from all other circuits. The wiring of an Intrinsically Safe (I.S.) circuit and that of any non-I.S. circuit must be at least 50 mm apart in order to avoid arcing or invasion of the I.S. circuit due to contact or induction.
4. A.c. and d.c. power supply cables must be physically separate so as to avoid induced a.c. in the d.c. cables.
5. Electrical equipment installed in hazardous areas must comply with BS 5345 Part 4 and with any special certification requirements, such as for example, capacitance, inductance and inductance/resistance effects, etc.

11.7 Cable Fixings

Consideration should be given to the type of fixings used to support and/or secure fire detection and alarm system cabling and wiring. Primarily, it is the material in which the fixings are manufactured, i.e. plastic or metal, that is of importance. There would be little point in securing alarm system cables to a wall or the underside of a tray with plastic fixings if in the event of a fire these were to melt or burn and allow the cables to fall and become damaged in some way and prevent the alarm condition being given.

In general, plastic cable fixings should only ever be used for fixing cables run in or on top of horizontal trays. Metal type cable fixings should be used in all other situations. The type of fixings recommended for use in various situations are as follows:

Cables in/on Horizontal Trays

Where cables run in (or on top of) horizontal trays they should be neatly and securely fixed at suitable intervals with either plastic or metal cable ties.

Cables under Horizontal Trays

Where cables are run along the underside of horizontal trays, metal cable ties or metal ‘P’ clips should be used to neatly and securely fix the cables at suitable intervals (plastic fixings must not be used).

Cables in Vertical Ducts or Shafts

Cables run in vertical ducts or shafts should be neatly and securely fixed at suitable intervals with metal cable ties or metal ‘P’ clips. For long ducts and shafts, cables should be secured to staggered fixing pins so as to prevent them from stretching under their own weight.

Cables on Walls

Cables run along walls should be neatly and securely fixed at suitable intervals to metal wall brackets with metal ‘P’ clips.

In all other respects, the installation of cabling and wiring should be undertaken generally in accordance with BS 7671 (*Requirements for Electrical Installations - IEE Wiring Regulations, Sixteenth Edition*) [24].

12. System Installation

The requirements for installing fire detection and alarm systems is covered in [clauses 23, 24 and 25] of the code. Most of these are simply the normal requirements of any electrical installation.

12.1 Siting and Accommodation

Siting and accommodation of the control equipment should comply with the requirements outlined in the code that are as follows:

1. Care should be taken in planning the accommodation for the equipment to ensure that the structure can accept the necessary loading, and that heavy or bulky equipment can be readily transported to or from its installed position [23.1].

2. Easy access to the equipment should be provided to allow for cleaning and maintenance [23.1].
3. Provision should be made at the control equipment for the following:

   a) The diagrammatic representation [15.4.3] (see section 9, Figure 18).
   b) Operating instructions for the correct action to be taken in the event of a fire or fault indication.
   c) The log book [28.2.2].

4. All metallic parts of the system, including conduit, trunking, ducting, cabling and enclosures, should be well separated from any metalwork forming part of any lightning protective system [23.2].

5. Siting of the control equipment and the routing of cables should take account of any hazards that might exist in the area when the building is occupied.

6. In locations having a potentially explosive atmosphere the recommendations of [clause 6.5] should be followed.

12.2 Installation of Cables and Wiring

Cables Ducts, Conduit or Trunking If cables are to be installed in ducts, conduit or trunking, plenty of room should be provided to ease the job of drawing in cables. Suitable access for drawing the cables should also be given. If there is a possibility that the system may require extending in the future then additional space should be provided to accommodate any future cabling requirements [24.1]

Cable Holes Where cables pass through an external wall a smooth-bore sleeve should be sealed into the wall and should slope downwards towards the outside. It should also be plugged with a suitable non-hardening waterproof compound to prevent the entry of rain, dust or vermin. The sleeve should be free from sharp edges to guard against damage to the cables during installation [24.2.1]

Where cables pass through an internal wall a smooth clearance hole should be provided. If additional protection is required then a smooth-bore sleeve should be sealed into the wall as in the case of an external wall, but without the need for waterproofing [24.2.2].

Where cables pass through a floor a smooth-bore sleeve should be sealed into the floor and extend as far above floor level as is required to protect the cables it is to carry, and in any case not less than 300 mm. Where cables pass through a horizontal structural element external to the building, then as in the case of an external wall, the sleeve should be also plugged with a non-hardening waterproof compound [24.2.3].

Precautions against Fire Spread In order to keep fire spread to a minimum, ensure that the fire alarm system does not breach the fire separation between compartments. To achieve this use suitable fire stopping materials to fill holes or gaps round the cables or the cable conduit. Fire stopping should also be used inside ducts or trunking wherever they pass through compartment walls or floors unless the duct or trunking has at least the same resistance to fire as the wall or floor through which it is passing [24.3].

Cabling and Wiring The installation of cabling and wiring should be undertaken generally in accordance with the requirements of BS 7671 (*Requirements for Electrical Installations - IEE Wiring Regulations, Sixteenth Edition*) [24.4].

For further details of the different cable types, etc. which should be used in fire system installations (see Section 11, Cabling Considerations).

12.3 Inspection, Testing and Commissioning

When installation of the fire system has been completed, it should be inspected to ensure that the workmanship is satisfactory, and that the system complies with the requirements of the code [26.2].

Before certification and handover, the system should be tested. At least the following tests should be carried out:

1. Cables and wiring should be insulation tested at 500V after they are installed. The insulation resistance to earth and between conductors should comply with the requirements of BS 7671 (i.e. the IEE Wiring Regulations). Because 500V can damage electrical equipment, it is better if this test is carried out before the cables are connected to the equipment. The completed installation should be tested at a low, non-damaging voltage, as recommended by the manufacturer [26.3].
2. Earth continuity should be tested in accordance with BS 7671 [26.4]
3. Each detector and manual call point should be dynamically tested to ensure that they work satisfactorily, and that the correct indications and other responses are given by the control equipment.
4. The alarm sounders should be tested to ensure that the correct sound levels are achieved in the building.
5. System which give signals to ancillary equipment (i.e. door retention units, fire extinguishing equipment, etc.) should be checked to ensure that the correct signals are given following operation of each detector.
6. Where possible, any link to the fire brigade or remote monitoring centre should be checked.

12.4 Certification

Upon successful completion of all inspections, testing and commissioning, the installer should certify that the installation complies with the recommendations outlined in Part 1 of the code, or if deviations have been agreed [4.3] then a statement of these deviations should be given by the installer [Appendix B].

12.5 Records, Drawings and Operating Instructions

On completion of system installation and testing, the paperwork to be handed over to the person responsible for use and care of the system should include the following [26.1]:

1. Full operating instructions.
2. Instructions for routine maintenance by the user.
3. Instructions of any necessary test procedures to be carried out by the user.

4. Record drawings showing the positions of the system's components and wiring, particularly where routine maintenance requires access to components.
5. The system log book [28.2.2 and Appendix D].
6. Certificates of installation and commissioning [26.6 and Appendix B].

12.6 System Handover

Formal handover of the system should be agreed between the installer and the purchaser. Where possible the person responsible for use and care of the system should also be involved in the handover so that he/she can be assured that the system is fully functional [26.7].

Once the system has been handed over, whether or not it goes into immediate service, the planned programme of routine servicing should be started.

12.7 Extensions and Alterations to Existing Systems

Where the work consists of an extension or alteration to an existing installation, the existing equipment should be thoroughly tested to ensure that it will function satisfactorily in conjunction with the new equipment [27]. The power supply should also be checked to ensure that it has adequate capacity to supply the existing system plus the additional load.

Before undertaking any changes or extensions, consideration should also be given to their effect on the performance of the existing system. Agreement should be obtained from all interested parties (for example, the local fire authority, the fire insurers, the Health and Safety Executive, etc.) before commencing any work..

After completion of the alterations, inspection, testing, commissioning and certification (see above) should be carried out in accordance with the recommendations in [clause 26] of the code.

A summary checklist of the requirements relating to work involving extensions and alterations follows:

1. The addition should be compatible with the existing system.
2. The capacity of the power supply should should still meet the recommendations of the code.
3. The paperwork (i.e. Records, Drawings and Operating Instructions) should be corrected, updated or replaced so that it provides a complete and up-to-date record of the system.

13. Responsibilities of User

The owner or other person having control of the premises should appoint a responsible person to supervise the fire detection and alarm system. This person, herein after called the system supervisor, should be given sufficient authority to ensure that all procedures required to maintain the system in correct working order are carried out. These procedures should include maintaining drawings, updating operating instructions, recording details of system events, faults, etc. in the log book, and ensuring that the recommended servicing requirements are followed [28].

The functions of the system supervisor can be summarised as follows:

1. In conjunction with the appropriate fire authority (usually the local fire brigade), lay down procedures for dealing with the various alarms, warnings or other events which can originate from the system [28.1.2].
2. Ensure that all persons who may use the system are instructed in its proper use and that all occupants of the building are instructed and practised in the appropriate actions to be taken in the event of fire [28.1.3].
3. Liaise with the building services personnel to ensure that any work on the building (such as decoration or cleaning) does not adversely affect the operation of the system [28.1.4].
4. Ensure that the efficiency of the system is not reduced by obstructions preventing the movement of fire products to the detectors, or obscuring or blocking access to manual call points [28.1.5].
5. Ensure that the system drawings and operating instructions are kept up to date and available for convenient reference [28.2.1].
6. Keep a log book. This should include brief details of every significant event affecting or resulting from the system. The log book should be available for inspection by any authorised person [28.2.2].
7. Prevent (or reduce) false alarms caused by operations in the vicinity of detectors, carried out either negligently or in ignorance. Where temporary work is likely to generate dust or smoke, precautions (such as removal or covering of detectors) should be taken to prevent false alarms or damage to the detectors by contamination [28.4].
8. Ensure that the system is properly reinstated (i.e. detectors refitted or uncovered) upon completion of any temporary work [28.4.5].
9. Ensure that the system is given correct routine attention at the proper intervals [29.2].
10. Ensure that the system is correctly serviced following any alarm or warning, and that it is correctly repaired and tested if damage has occurred [29.3].

13.1 Routine Attention

To ensure continued trouble-free operation of the system under normal circumstances, routine attention is essential [29.2]. The system supervisor should therefore ensure that the following Daily, Weekly, Monthly, Quarterly, Annual and Five Yearly checks are carried out on the system:

Daily Attention [29.2.3]

1. Check the control panel for normal operation. If a fault is indicated take appropriate action to rectify the fault. In either case, record details of the condition in the log book.
2. Check any fault from the previous day to ensure that it has received attention.

Weekly Attention [29.2.4]

1. Operate at least one detector or one call point to check correct operation of the fire controller, alarm sounders and the indicating equipment. The test procedure should be such that the interval between each zone being tested is not greater than 13 weeks. Thus for a system that has 16 zones, for four weeks in every quarter at least two zones must be tested in order to ensure that the whole system is tested. Details of the device, zone and test results should be recorded in the log book.
2. Check the connections to the standby supply batteries.
3. If applicable, check the standby generator.
4. If applicable, check printer for paper and ink or ribbon — there should be sufficient amount for at least two weeks usage.

Monthly Attention [29.2.5]

If applicable, check the standby generator by simulating a failure of the normal mains supply and allow it to energise the fire alarm system standby supply for one hour.

Quarterly Inspection and Test [29.2.6]

(These checks and tests are to be carried out by the installer or the maintenance company.)

1. Check the entries and actions taken and recorded in the log book.
2. Check the standby supply batteries for correct operation and connections (see Note below).
3. If applicable, check the condition of secondary batteries (see Note below).
4. Check the battery voltages on a high rate of discharge (see Note below).
5. Check the control panel for correct operation of detector or call point as in weekly attention test. If applicable, also test the monitoring link to the remote central station by simulating a fault condition. Inspect the control panel for damage and moisture ingress or other such conditions.
6. Check the premises for any structural or occupancy changes which may affect the operation of a detector. (Detectors should be at least 1m from any partition and have a vertical clearance of at least 750mm.)
7. If applicable, carry out any additional checks or tests specified by the installer of the original system.

Note: Checks 2, 3 and 4 need not be carried out if the fire controller monitors the batteries.

Any defect found should be recorded in the log book and reported to the system supervisor. The system supervisor should take appropriate action to correct the fault. Upon completion of all work, a 'certificate of testing' should be prepared and given to the system supervisor.

Annual Inspection and Test [29.2.7]

(These checks and tests are to be carried out by the installer or the maintenance company.)

1. Perform the Quarterly Inspection and Test as described above.
2. Check each detector in the system for correct operation.
3. Visually check all cable fittings and equipment to ensure that they are secure and undamaged.

Any defect found should be recorded in the log book and reported to the system supervisor. The system supervisor should take appropriate action to correct the fault. Upon completion of all work, a 'certificate of testing' should be prepared and given to the system supervisor.

Five Yearly Check [29.2.8]

(These checks and tests are to be carried out by the installer or the maintenance company.)

The system wiring should be tested in accordance with testing and inspection requirements of BS 7671 (the IEE Wiring Regulations). If the building's electrical system is tested at shorter intervals, then the fire alarm system wiring can be tested more frequently.

Any defect found should be recorded in the log book and reported to the system supervisor. The system supervisor should take appropriate action to correct the fault. Upon completion of all work, a 'certificate of testing' should be prepared and given to the system supervisor.

13.2 Special Attention

The routine attention described in subsection 13.1 is intended to maintain the system in operation under normal circumstances. There may, however, be special circumstances in which the system requires other attention [29.3.1]. This section describes the actions which the system supervisor should take in such situations:

Action by User After a Fire [29.3.2]

Irrespective of whether the fire was detected automatically or not, the system supervisor should ensure that the following work is carried out as soon as possible after the fire, and that normal use of the area is not resumed until the work is completed:

1. Check all detectors utilising ionising radioactive isotopes for contamination and take appropriate action to deal with any leakage.
2. Check and test any detector or call point which may have been adversely affected by the fire, for correct operation.
3. Check and test each alarm sounder for correct operation.
4. Visually check all parts of the system which lie within the fire area or which might have been damaged by the fire.
5. Any defect found should be recorded in the log book and immediate action taken to correct the fault.
6. Inform the maintenance company and check that repairs to defects are carried out.
7. If the fire was not detected or was detected at a late stage then the reasons for this should be investigated and the system modified if required in order to prevent any repetition.

Upon completion of all work, and if applicable, investigations, obtain a 'certificate of testing' from the maintenance company engineer and update the records with details of any changes carried out.

Action by User After a False Alarm [29.3.3]

A false alarm can be a serious condition for any fire system since all confidence in the system can be lost. Each alarm, however, must be treated as a real alarm until proven otherwise. If an alarm is found to be false, the system supervisor should ensure that the following actions are carried out:

1. Identify the offending detector or call point (if possible).
2. Establish the cause of the false alarm (if possible). This may require an evaluation of all events which occurred prior to the alarm condition.
3. Record details of the false alarm in the log book and instruct the maintenance company to thoroughly investigate the cause.

If one detector or a group of detectors is responsible for more than one false alarm every two years, or the system produces more than one false alarm per year for each ten detectors then a special investigation should be undertaken by the maintenance company to resolve the cause.

Action by User Following a Fault [29.3.4]

Whenever a fault is detected or indicated, the system supervisor should ensure that the following actions are taken:

1. Determine the area affected and decide whether special action (such as fire patrols) is required in that area.
2. Determine the reason for the fault (if possible) or establish the events which occurred immediately prior to the fault in the area affected.
3. Record details of the fault in the log book and arrange with the maintenance company to have it repaired.

Action by User Following a Pre-Alarm Warning [29.3.5]

Only analogue addressable fire systems comprising analogue addressable detectors are capable of giving a pre-alarm warning. If a pre-alarm warning is indicated at the control panel, it indicates that either one of the following conditions exists:

- A slowly growing fire has been detected and a full alarm condition has not yet been reached.
- A detector has become contaminated and requires cleaning or changing.

The system supervisor should ensure that the following actions are taken:

1. Determine the detector and area which caused the pre-alarm warning.
2. Thoroughly inspect the area protected by the detector for fire and if one is found, carry out the pre-planned fire routine.
3. If no fire is found, record details of the incident in the log book and arrange with the maintenance company to have the detector serviced or replaced.

13.3 Non-Routine Attention

In addition to the routine and special attention needed to keep the system fully operational (see subsections 13.1 and 13.2), there are other occasions that attention may be required. As the following can affect the effectiveness of the fire alarm system, the system supervisor should be prepared to carry out the necessary modifications to cater for the following [29.3.7]:

1. Extensions or alterations to the premises [27].
2. Changes in occupancy or activities in the area covered by the system.
3. Changes in the ambient noise level or sound attenuation such as to change the sounder requirements.
4. Damage to the installation, even though no fault may be immediately apparent.
5. Changes in ancillary equipment.

14. Communication to the Fire Brigade

For a fire detection and alarm system to give maximum benefit, its alarm should be transmitted to the fire brigade with the smallest possible time delay. Occasionally it may be permissable for the alarm to be passed on by telephone, however the only reliable method is over an automatic link [8.1].

Where the building is divided into separate occupancies, the 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 as to who is responsible for calling the fire brigade can lead to either a number of calls being made almost simultaneously, or more seriously, no call being made at all.

Consultation with the fire authority is advisable for systems serving buildings in multiple occupation.

14.1 Automatic Transmission of the Alarm

There are several methods available for automatically transmitting the alarm status of the fire controller equipment to the fire brigade. Although a number of different methods are available, in practice the method used often depends on the arrangements made by the fire authority for connection to the fire brigade control. The requirements of each method may be different in each case, however, the available systems include the following [8.2 and Appendix A]:

1. Direct connection to the fire brigade control. This method depends on the mobilization policy of the brigade concerned.
2. Communication with the fire brigade via a telecommunications operator line with transmit and receive signals.
3. Connection to a remote manned centre (i.e. commercially owned central fire alarm station). The user is charged for the private BT line and central station operator charges. The central station has a dedicated direct line to the fire brigade.
4. Provision of local ‘collectors’ where a number of premises can be connected to the same ‘collector’ and from there the signals are transmitted together (i.e. multiplexed) over a common line to the central station. In this type of system the cost of the line is shared between the all users.
5. Commercial system that ‘dials’ the central station using the public switched telephone network (PSTN). In this type of system, once the connection is made a coded message detailing the type of alarm and the address of the premises is relayed to the operator on a screen. This type of system, known as a ‘digidialler’, dials one number up to eight times or two numbers up to four times each and then stops. The system does not monitor the BT line for faults (or sabotage) and is therefore less secure than its monitored counterparts.

14.1.1 Alarm Transmission Delays

It is permissible to delay the transmission of an alarm to the fire brigade only if a high level of false alarms are expected from the fire detection and alarm system. Furthermore, alarm transmisson delays are acceptable only whilst the premises are occupied, and should be configured as follows:

1. Manually activated alarms should be transmitted immediately.
2. Automatically activated alarms from detectors, etc. may be delayed by two minutes whilst the cause is investigated.
3. An extra delay of five minutes can be activated by a manual operation at the control panel.

14.2 Non-Automatic Transmission of the Alarm

If communication with the fire brigade is by means of the telephone, care should be taken to ensure that the operation of the fire alarm and fault warning sounders does not interfere with telephone speech. Furthermore, if the mouthpiece picks up the sound of the alarm sounders, the resultant signal can confuse the tone-selective dialling system and lead to failure of the emergency call [8.3].

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

Appendix 1 Fire Systems Glossary

This Glossary provides definitions of various terms and phrases used in this guide and in relation to Fire Systems in general.

Addressable system	A system in which signals from each detector and/ or call point are individually identified at the control panel.
Analogue system	A fire alarm system in which the detectors and sensors give output signals that represent the value of the sensed phenomena. The detectors and sensors themselves do not determine if there is a fire, this is decided by the control equipment. This type of system uses both radial and loop circuits, and in the event of a fire, the actual location of the fire within a zone can determined and indicated by the control equipment.
Aspirating detector	A detector system in which a sample of the atmosphere in the protected space is drawn by a fan or pump into a detector which may be remote from the protected space.
Automatic system	A system in which the fire alarm can be initiated automatically.
Call point	A device for manually operating a fire alarm system.
Central station	A permanently manned centre, usually provided by a commercial organisation, the staff of which, upon receiving a fire alarm signal from a premises notify the fire service.
Control and indicating equipment	Equipment, which on receipt of a fire signal, controls the initiation of a fire alarm by activating one or more sounders, alarm indicating equipment, or transmitting a signal to other fire alarm control equipment such as a fire alarm transmission link.
Conventional system	A fire alarm system in which all detectors give the same output signal that represents an alarm of fire. This type of system uses radial circuits in which each spur monitors just one zone. An alarm of 'fire' is given by the control equipment whenever it receives a signal from any detector. In this type of system, only the zone in which a fire occurs can be indicated by the control equipment; the actual location of the fire within the zone cannot be determined.
EOL	End of line device used for open and short circuit monitoring of detector and sounder circuits.
Final voltage of a battery	The voltage at which the cell manufacturer considers the cells to be fully discharged at the specified current.
Fire alarm transmission link	An electrical circuit for transmitting fire alarm signals and fault warnings to a central station or control room.
Fire alarm warning	A warning of outbreak of fire in an area of the premises originated either by a person or an automatic device such as a fire alarm system.

Heat Detector	A monitoring device designed to automatically initiate alarm at a fixed temperature, or at a specified rate of rise of temperature, or a combination of both.
HPO	High Performance Optical smoke detector.
Lantern-light	A construction standing above the surface of a roof and intended to admit light to the space below.
Manual system	A system containing no automatic detectors and in which an alarm indication may only be initiated manually.
Mimic diagram	Plan of a protected premises showing the layout of the fire alarm system in relation to the compartments or subdivisions of the building.
Monitored wiring	Failure of wiring, whether to open circuit or to short circuit, will result in a fault warning and not an alarm indication.
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.
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. A phased evacuation will normally require at least a two-stage alarm system.
Protection	The definition of this term is dependent on the context in which it is used. Four definitions are applicable: 1. The presence of one or more detector(s) able to initiate actions needed for 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.
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.
Sector	A subdivision of a protected premises normally containing several zones. A sector may cover more than one building.
Sensor	A device capable of being operated automatically to initiate a fire alarm, for example a detector.
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 invisible smoke (less than 200 nm) to visible smoke (1 µm and bigger).

Smoke detector

A monitoring device designed to automatically initiate an alarm when smoke is detect in the air. Three types are available, namely Ionisation Smoke Detector, Photo Optical Smoke Detector and High Performance Optical (HPO) Detector.

The Ionisation type detector contains a small radioactive element which measures the electrical conductivity of the air. The electrical conductivity of air changes if smoke is present.

The Photo Optical type detector measures the smoke content in the air by transmission or reflectance of light.

The HPO type detector responds to smoke in the same way as the Photo Optical detector, but when there is a rapid rate of rise in temperature, its sensitivity is increased so that it also responds to very small smoke particles just like the Ionisation type detector.

Sounder

A device used in fire alarm systems to give an audible fire alarm warning in the event of a fire.

Standby supply

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

Staged alarm system

An alarm system in which two or more stages of alarm can be given within a given area.

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. The normal condition under which no alarm is given, is not counted as an alarm stage.

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.

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. A zone usually consists 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.

Appendix 2 Features and Benefits of Analogue Addressable Fire Controller Systems

Features	Benefits
• Analogue Addressable System	⇨ Reduced wiring costs ⇨ Extensive fire and fault monitoring ⇨ Rapid response to any condition ⇨ Long term detector drift analysis
• Connection to existing fire alarm systems	⇨ Allows updating of old systems
• User definable zone and point description	⇨ Simple English text message ⇨ Allows easy fire location
• Detector condition monitoring option	⇨ Reduced maintenance costs
• Optional pre-alarm function	⇨ Allows early warning of a possible fire condition
• Threshold compensation option	⇨ Keeps system working at optimum performance
• Designed to meet the requirements of BS 5839: Pt 4: 1988	⇨ Allows system to be installed to BS 5839: Pt 1: 1988
• Simple prompt driven menu display	⇨ User friendly and interactive
• Can be used with conventional and analogue addressable fire detectors	⇨ Allows system design flexibility
• Designed and manufactured to ISO 9001	⇨ Quality assurance standard
• Rapid call point scan	⇨ Allows call point response in less than one second
• Walk test facility	⇨ Allows single man testing of system
• Configuration and re-configuration on site	⇨ Cost effective re-programming
• Software defined zoning	⇨ No need to separately wire zones

Features	Benefits
• 80 character LCD displays	➩ Indicates number, type of event, zone, absolute point number scroll/toggle command plus user definable messages
• 8, 16 or 80 individual zone identification LED indicators	➩ Easy fire location for brigade
• Internal battery and charger options	➩ Eliminates need for extra housing ➩ Compact design
• Flush mounted option	➩ Aesthetically pleasing and unobtrusive
• Output to printer	➩ Hard copy of historical data
• Optional output to VDU	➩ No need for printer paper
• Optional output to radio pager	➩ System flexibility
• Weekly system test reminder	➩ Helps user to maintain system integrity and to meet user requirements defined in BS 5839: Pt 1: 1988
• Programmable output relays on address loop	➩ Provides system flexibility for plant control
• Programmable sounder modules on address loop and software controlled bell mapping	➩ Provides for ease of sectored sounder operations and enables flexible evacuation options
• Remote addressable switch mode power supply module	➩ Saves the need for cabling power around large site
• Multi-tasking high speed software	➩ Continuous monitoring ➩ Displays, prints and controls simultaneously
• Multi-isolation facility	➩ By circuit, zone, point, device or function
• Detector sensitivity set by software	➩ Pre-alarm and time of day response
• Expandable from 1 to 10 loops in 2 loop module increments	➩ Ease of operation and easy system extension
• Two common monitored sounder outputs	➩ Conforms to requirements of BS 5839

Features	Benefits
• Programmable user access codes	⇨ To meet customers operational needs
• Fault monitoring	⇨ Open and short circuit ⇨ Signalling ⇨ Software ⇨ Mains supply ⇨ Battery condition ⇨ Sounder outputs ⇨ Alarm and fault relays
• Remote communications bus	⇨ Output to drive repeaters, mimics, remote printers, etc.
• Built in Network capacity	⇨ Up to 60 Minerva fire controllers can be seamlessly networked together
• Graphics link	⇨ May be linked to the ThornGraph graphical user interface
• Remote communications network	⇨ Either direct line or PSTN signalling to central station monitoring system
• Sophisticated event action	⇨ Allows software programming of inputs to outputs thus allowing for co-incidence operation and bell delay sequences
• 500 event log with printer option	⇨ Provides historical data file
• Time of day response	⇨ Enables sensitivity adjustment, i.e. normal sensitivity during the day and high sensitivity at night

PART 2

Specification for an Analogue Addressable Fire System

Specification for an Analogue Addressable Fire System

CONTENTS

1 GENERAL REQUIREMENTS

1.1 The Fire Alarm contractor shall be responsible for the design, supply, installation, commissioning and servicing of an analogue addressable fire detection and alarm system.

1.2 The Fire Alarm contractor shall be capable of providing a remote alarm monitoring service with a direct communications link to the Fire Brigade Service.

1.3 The Fire Alarm contractor shall have an adequate number of staff trained and experienced in the design, installation, commissioning and servicing of analogue addressable fire detection and alarm systems.

1.4 The Fire Alarm contractor shall have a minimum of 10 years experience in designing, installing, commissioning and servicing fire detection and alarm systems, at least 5 years of which must be with analogue addressable systems.

1.5 The Fire Alarm contractor must be LPS 1014 Registered.

1.6 All equipment central to the operation of the analogue addressable fire alarm system shall be designed and manufactured by the company installing and commissioning the system. As a minimum requirement, this clause covers the following:

- control and indicating equipment
- repeater equipment
- addressable ancillary equipment
- power supplies and automatic point detection equipment.

1.7 The supplier shall be approved to ISO 9002 Quality system standard for the design and manufacture of the equipment referred to in clause 1.6.

1.8 The main equipment proposed for use in the in the analogue addressable fire detection and alarm system shall be approved by at least one of the following UK or international organisations:

- Loss Prevention Council (LPC)
- British Standards Institution (BSI)
- Underwriters Laboratories (UL)

1.9 The Fire Alarm contractor shall have available a complete set of technical manuals for all equipment installed. This must cover technical specification, system design recommendations and guidelines for installation, commissioning, operating and servicing the proposed equipment.

1.10 The Fire Alarm contractor, given reasonable notice, shall permit the buyer, or its nominated agent, to conduct a quality audit at the premises where the proposed equipment is manufactured.

1.11 All deviations from this specification that the contractor proposes to make shall be clearly indicated in writing, making reference to the relevant paragraph(s) of this specification.

2 STANDARDS AND SPECIFICATIONS

2.1 Where applicable, the fire detection and alarm system, and installation, shall comply fully with the following British Standards and/or other nominated rules and regulations:

2.2 BS5839 Fire detection and alarm systems for buildings:

2.2.1 BS5839: Pt.1: 1988 Code of practice for system design, installation and servicing.

2.2.2 BS5839: Pt.2: 1983 Specification for manual call points.

2.2.3 BS5839: Pt.3: 1988 Specification for automatic release mechanisms for certain fire protection equipment.

2.2.4 BS5839: Pt.4: 1988 Specification for control and indicating equipment.

2.2.5 BS5839: Pt.5: 1988 Specification for optical beam smoke detectors.

2.3 BS4678: Pt.4: 1988 Specification for cable trunking made of insulating material.

2.4 BS5345 Code of practice for selection, installation and maintenance of electrical apparatus for use in potentially explosive atmospheres (other than mining applications or explosives processing and manufacture).

2.4.1 BS5345: Pt.1: 1989 General recommendations.

2.4.2 BS5345: Pt.2: 1990 Classification of hazardous areas.

2.4.3 BS5345: Pt.3: 1990 Installation and maintenance requirements for electrical apparatus with type of protection 'd'. Flameproof enclosure.

2.4.4 BS5345: Pt.4: 1977 Installation and maintenance requirements for electrical apparatus with type of protection 'i'. Intrinsically safe electrical apparatus and systems.

2.4.5 BS5345: Pt.6: 1990 Recommendations for type of protection 'e'. Increased safety.

2.4.6 BS5345: Pt.7: 1990 Installation and maintenance requirements for electrical apparatus with type of protection N.

2.5 BS5445 Components of automatic fire detection systems:

2.5.1 BS5445: Pt.1: 1977 (EN 54: Pt.1: 1976) Introduction.

2.5.2 BS5445: Pt.5: 1977 (EN 54: Pt.5: 1976) Heat sensitive detectors - point detectors containing a static element.

2.5.3 BS5445: Pt.7: 1984 (EN 54: Pt.7: 1982) Specification for point-type smoke detectors using scattered light, transmitted light or ionization.

2.5.4 BS5445: Pt.8: 1984 (EN 54: Pt.8: 1982) Specification for high temperature heat detectors.

2.6 BS5446: Pt.1: 1990 Specification for self-contained smoke alarms and point-type smoke detectors.

2.7 BS5501 Electrical apparatus for potentially explosive atmospheres:

2.7.1 BS5501: Pt.1: 1977 (EN 50014: 1977) General requirements.

2.7.2 BS5501: Pt.5: 1977 (EN 50018: 1977) Flameproof enclosure 'd'.

2.7.3 BS5501: Pt.6: 1977 (EN 50019: 1977) Increased safety 'e'.

2.7.4 BS5501: Pt.7: 1977 (EN 50020: 1977) Intrinsic safety 'i'.

2.7.5 BS5501: Pt.9: 1982 (EN 50039: 1980) Specification for intrinsically safe electrical systems 'i'.

2.8 BS6207: 1991 Specification for mineral-insulated copper sheathed cables with copper conductors.

2.9 BS6266: 1992 Code of practice for fire protection for electronic data processing installations.

2.10 BS6387: 1994 Specification for performance requirements for cables required to maintain circuit integrity under fire conditions.

2.11 BS6724: 1990 Specification for armoured cables for electricity supply having thermosetting insulation with low emission of smoke and corrosive gases when affected by fire.

2.12 BS7273: Pt.1: 1990 Code of practice for the operation of fire protection measures. Electrical actuation of gaseous total flooding extinguishing systems.

2.13 BS7671: 1992 Requirements for electrical installations. IEE Wiring regulations. Sixteenth Edition.

2.14 HTM82 Fire safety in health care premises. Fire alarm and detection systems.

2.15 BFPSA Code of practice of category 1: aspirating detection systems.

2.16 Draft British Standard code of practice for the design, installation and servicing of voice systems associated with fire detection systems (BS5839: Pt.8).

3 CONTROL AND INDICATING EQUIPMENT

3.1 General

3.1.1 The control and indicating equipment shall form the central processing unit of the system, receiving and analysing signals from fire sensors, providing audible and visual information to the user, initiating automatic alarm response sequences and providing the means by which the user interacts with the system.

3.1.2 The control and indicating equipment shall be modular in construction to allow for future extension of the system.

3.1.3 The control and indicating equipment shall be easily configurable so as to meet the exact detection zone and output mapping requirements of the building.

3.1.4 The control and indicating equipment shall be microprocessor based and operate under a multitasking software program. Operating programs and configuration data must be contained in easily up-datable non-volatile memory (EEPROM).

3.1.5 The control and indicating equipment shall incorporate a real-time clock to enable events to be referenced against time and date. This clock shall be accurate to within 1 minute per year under normal operating conditions.

3.1.6 It shall be possible for an engineer to perform configuration updates on site by plugging a portable personal computer into the control and indicating equipment. Configuration data shall be retained on a micro-floppy disk.

3.1.7 The company responsible for the installation shall operate an approved document control system for the retention of configuration data.

3.1.8 The control and indicating equipment shall meet the requirements of BS5839 Part 4 and shall be approved, together with associated ancillary equipment, by the Loss Prevention Council Board (LPCB).

3.1.9 The control and indicating equipment shall comprise separate processors, cross-monitoring each others correct operation, for the major functions of the systems. In particular, different processors must be used for the main control function, the detection input and alarm output functions, and the display and control function.

3.1.10 No more than 200 addressable input or output points shall be controlled by a single processor.

3.1.11 To ensure continuous stability of the system, the setting of the address code in each addressable device shall be by either a DIL switch in the detector base or smart card technology.

3.1.12 In the case of plug-in analogue addressable detectors, the address code shall be set in the base to prevent unauthorised and potentially dangerous reconfiguration of the system.

3.1.13 The control and indicating equipment shall incorporate a keyswitch with three positions “Normal”, “Trapped Normal” and “Enable” to prevent unauthorised use of the manual controls.

3.2 System Configuration

3.2.1. The control and indicating equipment shall be capable of operating with any of the following types of automatic detection equipment:

- conventional detectors
- addressable two-state detectors
- analogue addressable detectors

3.2.2. The control and indicating equipment shall be capable of operating with intrinsically safe conventional detectors and analogue addressable detectors suitable for installation in hazardous areas.

3.2.3. Addressable input and output devices shall be connected to addressable loops capable of accepting up to 99 devices.

3.2.4. The control and indicating equipment shall have a minimum capacity for operating 1 fully loaded addressable loop. This shall be extendible up to a maximum capacity of 10 addressable loops.

3.2.5. Provision shall be made for each addressable loop to be sub-divided into a maximum of 8 geographical zones. The section of wiring corresponding to each zone circuit shall be protected from faults in other sections by line isolator modules.

3.2.6. It shall be possible to allocate all 99 addressable devices on the loop to a single zone.

3.2.7. In order to facilitate re-configuration and system extension, the allocation of addresses to devices shall be independent of their physical arrangement on the loops.

3.2.8. The control and indicating equipment shall have provision to drive and monitor up to 20 repeater panels providing a repeat of the indications on the control and indicating equipment display and up to a further 3 repeater panels also incorporating the full set of system manual user controls.

3.2.9. The control and indicating equipment shall have provision to house the AC Main power supply and batteries required to power systems of up to 16 zones.

3.2.10. The control and indicating equipment shall have provision for the connection of external power supplies, either local to the control and indicating equipment or distributed throughout the system, to supply power in excess of that stated in clause 3.2.9.

3.2.11. The control and indicating equipment shall have provision for the connection of an 80 character line printer, either locally via a parallel port or remotely via a serial port.

3.2.12. The control and indicating equipment shall be capable of interfacing directly to an electronic radio paging system.

3.2.13. The control and indicating equipment shall be capable of being interfaced with other similar control and indicating equipment without locking up or being affected by feedback signals.

3.2.14. It shall be possible to connect a VDU monitor to the control and indicating equipment to display the information that would otherwise appear on the printer referred to in clause 3.2.11.

3.2.15 The control and indicating equipment shall have the facility to enable an on board communications module to be added to allow local area networking to other controllers.

3.3 Mechanical Design

3.3.1 The housing(s) containing the control and indicating equipment shall be of metal construction and no greater in size than 500 mm (wide) x 350 mm (high) x 140 mm (deep).

3.3.2 The housings shall be capable of being surface or semi-recessed mounted and shall come complete with cable entries, fixings, knock-outs and covers.

3.3.3 The display component of the control and indicating equipment shall be mounted on an hinged front cover that must not open at an angle greater than 90 degrees to prevent cover damage.

3.3.4 The housings shall afford a minimum ingress protection to IP43.

3.3.5 It shall not be possible to open the control and indicating equipment without the use of a special tool.

3.3.6 The control and indicating equipment shall be of a neutral light grey colour.

3.4 Basic System Functions

3.4.1 The control and indicating equipment shall monitor the status of all devices on the addressable loops for fire, short-circuit fault, open-circuit fault, incorrect addressing, unauthorised device removal or exchange, pre-alarm condition and contaminated detector condition.

3.4.2 The control and indicating equipment shall monitor the status of all internal connection and interfaces, including charger, battery and remote signalling functions.

3.4.3 The control and indicating equipment shall provide the following discrete visual indications:

POWER ON	green LED indicator
FIRE ALARM	dual red LED indicator
FAULT	yellow LED indicator
DISABLED/ISOLATED	yellow LED indicator
FIRE ZONES	red LED indicator per zone.

3.4.4 In addition to the indications provided in clause 3.4.3, the control and indicating equipment shall also have an integral 80 character LCD alphanumeric display. In order that an easy identification of different information is provided, the LCD display shall be arranged as follows:

Row 1:	Event type
Row 2:	Zone message
Row 3:	Addressable point message
Row 4:	Circuit identifier/Point number/Zone number and Number of events in the system.

3.4.5 The control and indicating equipment shall provide a set of push button controls to enable an authorised operator to perform the following:

EVACUATE	(actuates ALL alarm sounders in the system)
SILENCE	(stops all currently actuated alarm sounders)
RESET	(returns the control and indicating equipment to quiescent condition)

3.4.6 The control and indicating equipment shall provide a facility to manually check all the discrete LED indicators. This shall be clearly marked LAMP TEST and be accessible at all time.

3.4.7 The control and indicating equipment shall provide a simple to operate keypad to enable a user to access the various built-in functions, and interact with the information displayed on the LCD. For security reasons, the control and indicating equipment shall provide a customer configurable password code facility for the following levels of access:

- User Operator
- User Manager
- User Engineer
- Specialist Engineer
- Specialist Engineer Supervisor
- Alarm Company Engineer

3.4.8 The control and indicating equipment shall provide facilities to drive visual indication LED mimic displays for each of the following zonal status:

Alarm
Fault
Isolated

3.4.9 The control and indicating equipment shall provide facilities for signalling the following system conditions to a remote (Central Station) and/or an on-site monitoring centre:

Alarm
Pre-alarm
Fault
Zone Isolated

3.4.10 The control and indicating equipment shall be capable of monitoring and controlling remote site devices, such as door release units and relays for the control of plants and dampers, directly from the addressable loops.

3.4.11 The control and indicating equipment shall be capable of monitoring fire doors such that, in the event of a fire alarm condition, an event is generated to warn of the failure of a fire door to close.

3.4.12 The control and indicating equipment shall provide programmable outputs to activate emergency lighting in the event of a mains supply failure.

3.5 Alarm Monitoring Functions

3.5.1 The control and indicating equipment shall interrogate each addressable device at least once every 2 seconds.

3.5.2 The control and indicating equipment shall incorporate fire decision algorithms specifically adapted to the response characteristics of the analogue addressable detectors employed.

3.5.3 The algorithms mentioned in clause 3.5.2 shall perform a trend analysis of the signal received from the analogue addressable detectors in order that non-fire events may be differentiated.

3.5.4 The control and indicating equipment shall be designed so that, for each type of analogue addressable detector, the overall response time, including that for the sensor, the signal transmission system and the fire decision algorithm, meets the requirement of the relevant part of BS5445 (EN54).

3.5.5 The response time of the control and indicating equipment to two-state addressable detectors and conventional detectors shall not exceed 10 seconds.

3.5.6 The control and indicating equipment shall have a special scanning sequence so that designated manual call points provide alarm indication and warning within 1 second of operation.

3.5.7 The control and indicating equipment shall have a facility to automatically adjust the sensitivity of analogue detectors to a higher level for periods of time when the building is unoccupied.

3.5.8 The control and indicating equipment shall have, as an optional software enhancement, the ability to annunciate a pre-alarm condition designed to give the earliest possible warning of a potential fire condition without raising the full alarm condition.

3.5.9 The control and indicating equipment shall have, as an optional software enhancement, the ability to automatically adjust the alarm and pre-alarm threshold levels to compensate for changes in detector sensitivity due to contamination over a period of time.

3.5.10 The control and indicating equipment shall have, as an optional software enhancement, the ability to provide automatic warning that a detector has reached a level of contamination which requires that it be replaced or serviced.

3.6 Alarm Output Functions

3.6.1 The control and indicating equipment shall provide the necessary outputs to separately operate two monitored circuits of common system sounders. Each output shall be capable of driving a sounder load of up to 1Amp.

3.6.2 The control and indicating equipment shall be able to monitor and control the integrity of zonal sounder circuits, via a suitable addressable module.

3.6.3 The control and indicating equipment shall be capable of providing a two-stage alarm sounder facility that can be programmed, either on a zonal basis or common system basis, to meet the requirements of the fire authority. Three possible sound output signals shall be available as follows:

Alert pulsed tone (1 second ON, 1 second OFF)
Evacuate continuous tone
User definable tone for specialised events, for example bomb alert.

3.6.4 The control and indicating equipment shall have the facility to change, on a per sounder zone basis, the sound output dependent upon whether the source of alarm is:

An automatic detector, for example smoke or heat
A manual call point,
An EVACUATE command, or
A non-fire event, for example plant alarm etc.

3.6.5 The control and indicating equipment shall be capable of generating customer definable time delay sequences to upgrade alarm sounder responses, without the need for external timers, as follows:

Silent to Alert
Alert to Evacuate
Silent to user defined tone.

3.6.6 The control and indicating equipment shall be capable of operating addressable voice alarm units and monitoring the integrity of the wiring connection to individual loudspeakers.

3.6.7 The control and indicating equipment shall provide an interface to drive a public address system as described in section 9.2 of BS5839: Pt.1: 1988. The system shall be arranged such that, in the event of a failure of the public address system, back-up sounders are available to alert or evacuate the relevant areas of the protected premises.

3.6.8 The control and indicating equipment shall have the ability to delay the transmission to the Fire Brigade of fire alarm signals from automatic detectors in pre-determined detection zones. The time delay shall be configurable up to a maximum time of 2 minutes.

3.6.9 The control and indicating equipment shall provide the facility to automatically inhibit the delay function described in clause 3.6.8 when the building is unoccupied.

3.6.10 The facility described in clause 3.6.8 shall not apply to alarms generated by manual call points which shall always be transmitted immediately.

3.7 Supervision and Fault Reporting

3.7.1 The control and indicating equipment shall monitor all critical system components and interconnections (internal and external). In the event of a failure occurring which prevents correct operation of the alarm functions, a FAULT indicator will light and a message shall be given on the alphanumeric display within 100 seconds of occurrence.

3.7.2 The following faults shall be reported in the manner described in clause 3.7.1:

- Loop Short Circuit
- Loop Open Circuit
- Unconfigured Device
- Addressable Device Failure
- Device Not Responding
- Incorrectly Configured Device
- Detector Condition Monitoring Warning
- Conventional Call Point Wiring Open Circuit
- Conventional Call Point Wiring Short Circuit
- Conventional Detector Circuit Wiring Fault
- Repeater/Repeater LCD, Remote Printer Failure
- PSU Fault
- Charger Fault
- Battery Fault
- Battery Critical
- Mains Failure
- Auxiliary PSU Failure
- Relay Output Stuck
- Signalling Fault
- Sounder Wiring Open Circuit
- Sounder Wiring Short Circuit

3.7.3 To help rapid fault finding and repair, the control and indicating equipment shall provide text messages to indicate the precise location of where a fault has occurred in the system.

3.7.4 The control and indicating equipment shall be capable of monitoring and indicating the status of auxiliary units, such as a remote signalling transmitter. This shall be achieved using a suitable addressable contact monitor module.

3.7.5 With respect to clause 3.7.4, the control and indicating equipment shall have the facility to delay the generation of an event to confirm operation of the monitored device. This shall be either 6 seconds for normal de-bounced contacts, or 40 seconds for fluctuating contacts, e.g. sprinkler flow valve switches.

3.8 System Management Facilities

3.8.1 The control and indicating equipment shall incorporate the following system management facilities:

- Isolate/re-connect a particular addressable point
- Isolate/reconnect a particular detector zone
- Isolate/re-connect a particular sounder zone
- Walk-test of a selected zone to verify detectors and sounders
- View the number of alarms since power up
- View the number of software initialisations since power up
- View common alarm status
- View common fault status
- View common disabled status
- View zonal alarm status
- View zonal fault status
- View zonal isolated status
- View point address status
- Print event log
- Print points isolated
- Print points in detector Condition Monitoring fault
- Print point statuses.

3.8.2 Access to the facilities described in clause 3.8.1 shall be restricted to User Engineer level or above.

3.8.3 The control and indicating equipment shall have an event log capable of storing up to the last 500 events that have occurred. It shall be possible to view the content of the log via the alphanumeric display. Events shall be displayed in chronological order in any of the following three options:

- Newest event first
- Oldest event first
- Highest priority event first.

3.8.4 The control and indicating equipment shall be capable of providing audible and visual warning when a weekly system test, as defined in BS5839: Pt.1: 1988, is required.

3.8.5 The control and indicating equipment shall be capable, via a suitable timer unit, of isolating a group of selected detectors in areas of the building where maintenance work is carried out. The detectors shall be automatically re-instated after a pre-determined time.

3.8.6 The control and indicating equipment shall have a facility to enable the user to easily change the time and date settings of the system real-time clock.

3.9 Technical Specification

3.9.1 The boxes used to house the control and indicating equipment, standard system power supply and standard repeater panel shall not exceed the following overall dimensions:

Height :	320 mm
Width :	440 mm
Depth :	140 mm

3.9.2 The overall weight of the control and indicating equipment, standard power supply unit and standard repeater unit shall not exceed 7 Kg (weight of batteries excluded).

3.9.3 The control and indicating equipment shall operate on a mains power supply of:

240 V a.c. +10% -6% @ 50 Hz +- 2 Hz

or

115 V a.c. +15% -10% @ 50/60 Hz

3.9.4 The control and indicating equipment, standard power supply unit and standard repeater unit shall comply with the following environmental conditions:

Operating temperature range:	-10 C to +55 C
Storage temperature:	-20 C to +65 C
Relative humidity:	up to 95% RH (non-condensing)
IEC protection category:	IP43 minimum

3.9.5 The control and indicating equipment, standard power supply unit and standard repeater unit shall comply with, at least, the EMC test requirements described in BS5839: Pt.4: 1988 and the EEC requirements for the EMC Directive 89/336/EU and subsequent amendments 92/31/EU.

4 AUTOMATIC FIRE DETECTORS

4.1 General Requirements

4.1.1 The Fire Alarm contractor shall have available the following types of automatic detectors, manual call points and line modules for direct connection to the system addressable loops:

- Ionisation smoke detectors
- Optical smoke detectors
- High Performance Optical smoke detectors
- Infra-red flame detectors
- Heat detectors
- Manual call points for indoor use
- Manual call points for outdoor use
- Ionisation smoke detectors for hazardous areas
- Optical smoke detector for hazardous areas
- Infra-red flame detectors for hazardous areas
- Heat detectors for hazardous areas
- Conventional detector interface module
- Addressable relay interface module
- Addressable contact monitoring module
- Addressable sounder driver module
- Addressable voice alarm module
- Addressable power supply module
- Line isolator module
- Special detector interface module

4.1.2 The Fire Alarm contractor shall be capable of offering both an analogue addressable and a two-state addressable version of the following type of automatic fire detectors:

- Ionisation smoke detector
- Optical smoke detector
- High Performance Optical smoke detector
- Heat detector

4.1.3 The Fire Alarm contractor shall have available the following types of conventional automatic detectors, manual call points and ancillary units for connection to the system via suitable interfaces:

- Ionisation smoke detectors
- Optical smoke detectors
- High Performance Optical smoke detectors
- Infra-red flame detectors
- Heat detectors
- Optical beam smoke detectors
- Aspirating smoke detectors
- Manual call points for indoor use
- Manual call point for outdoor use
- Sounder booster module
- Remote indicator module

4.1.4 The automatic fire detectors shall be fixed to the installation by mean of plug-in detector bases. Both an addressable detector base and a conventional detector base shall be available.

4.1.5 The two types of bases specified in clause 4.1.4 shall incorporate the optional feature of being able to lock the detectors in place once plugged in.

4.1.6 The addressable base must incorporate all the circuitry required for communicating detector status to the control and indicating equipment, including the address setting switch.

4.1.7 Addressable detectors and modules must be able to transmit to the control and indicating equipment a pre-set and unique identifier to detect unauthorised changes in the system configuration.

4.1.8 The Fire Alarm contractor shall produce standard accessories for installing smoke detectors in air ducts. This equipment shall be designed to accommodate the manufacturer's standard smoke detectors and bases, both conventional and addressable.

4.1.9 It must be possible to connect and mix automatic detectors, manual call points and addressable modules within the same zone sub-division of an addressable loop.

4.1.10 The Fire Alarm contractor shall have available suitable equipment to test and exchange all four main types of automatic detectors.

4.1.11 The Fire Alarm contractor shall have available intrinsically safe versions of all four types of automatic detectors, the plug-in bases and the line isolator.

4.1.12 The Fire Alarm contractor shall also have available an intrinsically safe version of the addressable contact monitoring module for connection of 'simple apparatus' such as conventional manual call points.

4.1.13 The intrinsically safe devices specified in clauses 4.1.10 and 4.1.11 shall be designed to comply with BS5501: Pt.7 and be certified by BASEEFA to EEx ia IIC T5.

4.1.14 It shall be possible to connect several circuits of intrinsically safe addressable devices to a standard addressable loop via standard BASEEFA approved safety barriers from the loop as spurs.

4.1.15 All equipment connected to the system addressable loops, either directly or via interfaces, shall be proofed against electrical noise, high frequency pulses and electromagnetic influences from other equipment.

4.1.16 Both the conventional and addressable detector base shall be capable of driving a separate alarm LED indicator module.

4.2 Ionisation Smoke Detectors

4.2.1 The ionisation smoke detectors shall be capable of detecting visible and invisible combustion gases emanating from fires.

4.2.2 The ionisation smoke detectors shall meet the requirements of BS5445: Pt.7: 1984 (EN54: Pt.7).

4.2.3 The ionisation smoke detectors shall have a sensitivity sufficient to be classified as 'B' or better in BS5445: Pt.9: 1984 (EN54: Pt.9) test fires TF1, TF3 and TF4 and TF5.

4.2.4 The ionisation smoke detectors shall be approved and listed by the Loss Prevention Council Board (LPCB).

4.2.5 The ionisation smoke detectors shall use a dual ionisation chamber in which the air is ionised by a single radioactive source.

4.2.6 The radioactive source employed shall have an emission rating of less than 38 Kbq.

4.2.7 The ionisation smoke detectors shall be designed to have high resistance to contamination and corrosion.

4.2.8 The ionisation detectors shall include RFI screening and feed-through connecting components to minimise the effect of radiated and conducted electrical interferences.

4.2.9 The ionisation smoke detectors shall be suitable for operation in wind speeds of up to 5 m/s.

4.2.10 The ionisation smoke detectors shall incorporate screens to minimise the effect of small insects.

4.2.11 The Fire Alarm contractor shall have available the following versions of the ionisation smoke detector to meet different applications:

- Analogue addressable
- Analogue addressable - intrinsically safe
- Two-state addressable - normal sensitivity
- Conventional - high sensitivity
- Conventional - high sensitivity - delayed response
- Conventional - normal sensitivity
- Conventional - normal sensitivity - delayed response
- Conventional - low sensitivity
- Conventional - normal sensitivity - intrinsically safe

4.2.12 The ionisation smoke detector shall incorporate an LED, clearly visible from the outside, to provide indication of alarm actuation.

4.3 Optical Smoke Detectors

4.3.1 The optical smoke detectors shall be capable of detecting visible combustion gases emanating from fires.

4.3.2 The optical smoke detectors shall meet the requirements of BS5445: Pt.7: 1984 (EN54: Pt.7).

4.3.3 The optical smoke detectors shall have a sensitivity sufficient to be classified as 'A' in BS5445: Pt.9: 1984 (EN54: Pt.9) test fires TF2 and TF3.

4.3.4 The optical smoke detectors shall be approved and listed by the Loss Prevention Council Board (LPCB).

4.3.5 The optical smoke detectors shall employ the forward light-scatter principle, using optical components operating at a wavelength of 4.35 nm.

4.3.6 The design of the optical smoke detector sensing chamber shall be optimised to minimise the effect of dust deposits over a period of time.

4.3.7 The optical smoke detectors shall incorporate screens designed to prevent all but the smaller insects from entering the sensing chamber.

4.3.8 The optical smoke detectors shall incorporate a fin structure designed to totally eliminate the effect of very small insects such as thunder flies.

4.3.9 The optical smoke detectors shall be designed to have high resistance to contamination and corrosion.

4.3.10 The optical smoke detectors shall include RFI screening and feed-through connecting components to minimise the effect of radiated and conducted electrical interferences.

4.3.12 The Fire Alarm contractor shall have available the following versions of the optical smoke detector to meet different applications:

- Analogue addressable
- Analogue addressable - intrinsically safe
- Two-state addressable - normal sensitivity
- Conventional - high sensitivity
- Conventional - normal sensitivity
- Conventional - normal sensitivity - delayed response
- Conventional - low sensitivity
- Conventional - normal sensitivity - intrinsically safe

4.3.13 The optical smoke detector shall incorporate an LED, clearly visible from the outside, to provide indication of alarm actuation.

4.4 High Performance Optical Smoke Detectors

4.4.1 The high performance optical smoke detectors shall be capable of detecting visible combustion gases emanating from fires.

4.4.2 The high performance optical smoke detectors shall be design in accordance with the functional requirements of BS5445: Pt.7: 1984 (EN54: Pt.7).

4.4.3 The high performance optical smoke detectors shall have a sensitivity sufficient to be classified as 'B' or better in BS5445: Pt.9: 1984 (EN54: Pt.9) test fires TF2 to TF5 inclusive and as 'C' in test fire TF1.

4.4.4 The high performance optical smoke detectors shall be approved and listed by the Loss Prevention Council Board (LPCB).

4.4.5 The high performance optical smoke detectors shall employ the forward light-scatter principle, using optical components operating at a wavelength of 4.35 nm.

4.4.6 The high performance optical detectors shall monitor and use rapid changes in temperature to increase the normal sensitivity of the light-scatter optical sensor to obtain an improved response to fast burning fires.

4.4.7 The high performance optical detectors shall not generate an alarm condition from a rate of rise of temperature or absolute temperature alone.

4.4.8 The design of the high performance optical smoke detector sensing chamber shall be optimised to minimise the effect of dust deposits over a period of time.

4.4.9 The high performance optical smoke detectors shall incorporate screens designed to prevent all but the very small insects from entering the sensing chamber.

4.4.10 The high performance optical smoke detectors shall incorporate a fin structure designed to eliminate the effect of very small insects such as thunder flies.

4.4.11 The high performance optical smoke detectors shall be designed to have high resistance to contamination and corrosion.

4.4.12 The high performance optical smoke detectors shall include RFI screening and feed-through connecting components to minimise the effect of radiated and conducted electrical interferences.

4.4.13 The Fire Alarm contractor shall have available the following versions of the high performance optical smoke detector to meet different applications:

- Two-state addressable - normal sensitivity
- Conventional - normal sensitivity
- Conventional - normal sensitivity - delayed response
- Conventional - normal sensitivity - intrinsically safe

4.4.14 The high performance optical smoke detector shall incorporate an LED, clearly visible from the outside, to provide indication of alarm actuation.

4.5 Infra-Red Flame Detectors

4.5.1 The infra-red flame detectors shall be capable of detecting infra-red radiation produced by flaming fires involving carbonaceous materials.

4.5.2 The infra-red flame detectors shall be approved and listed by the Loss Prevention Council Board (LPCB).

4.5.3 The infra-red flame shall be able to detect a fuel fire of 0.1 square meter area from a distance of 30 meters for the following fuels:

Petrol (gasoline)
N-heptane
Kerosene
Diesel oil
Alcohol (I.M.S)
Ethylene glycol

4.5.4 The infra-red flame detectors shall employ narrow band optical filters that block unwanted radiation such as that emanating from the sun or tungsten filament lamps.

4.5.5 The infra-red flame detectors shall be designed to be sensitive to modulation of the received radiation in a small range of frequencies corresponding to the flicker of flames.

4.5.6 The infra-red flame detectors shall be designed to have high resistance to contamination and corrosion.

4.5.7 The electronic assembly of the infra-red flame detectors shall be encapsulated in high resistivity epoxy resin.

4.5.8 The infra-red flame smoke detectors shall include RFI screening and feed-through connecting components to minimise the effect of radiated and conducted electrical interferences.

4.5.9 The Fire Alarm contractor shall have available the following versions of infra-red flame detectors to meet different applications:

- Analogue addressable - intrinsically safe
- Conventional - intrinsically safe

4.5.10 The intrinsically safe versions of the infra-red flame detectors shall be suitable for use with safe area circuits.

4.5.11 The infra-red flame detector shall incorporate an LED, clearly visible from the outside, to provide indication of alarm actuation.

4.6 Heat Detectors

4.6.1 The heat detectors shall be capable of detecting rapid rise in temperature and fixed absolute temperatures.

4.6.2 The heat detectors shall meet the requirements of either BS5445: Pt.5 (EN54: Pt.5) for detectors suitable for normal environment or BS5445: Pt.8 (EN54: Pt.8) for detectors designed for high ambient temperatures.

4.6.3 The heat detectors shall be approved and listed by the Loss Prevention Council Board (LPCB).

4.6.4 The heat detectors shall employ two heat sensing elements with different thermal characteristics to provide a rate of rise dependent response.

4.6.5 The temperature sensing elements and circuitry of the heat detectors shall be coated with epoxy resin to provide environmental protection.

4.6.6 The heat detectors shall include RFI screening and feed-through connecting components to minimise the effect of radiated and conducted electrical interferences.

4.6.7 The Fire Alarm contractor shall have available the following versions of the heat detectors to meet different applications:

- Analogue addressable
- Analogue addressable - intrinsically safe
- Two-state addressable - grade 1
- Conventional - grade 1
- Conventional - grade 1 - intrinsically safe
- Conventional - grade 3
- Conventional - grade 3 - intrinsically safe
- Conventional - range 2 (98 C)
- Conventional - range 2 - intrinsically safe
- Conventional - static 60 C (grade 2)
- Conventional - static 90 C

4.6.8 The heat detectors shall incorporate an LED, clearly visible from the outside, to provide indication of alarm actuation.

4.7 Linear Heat Detectors

4.7.1 The linear heat detectors shall be capable of detecting fire (or overheat) conditions in confined or polluted areas.

4.7.2 The sensor cable of the linear heat detectors shall be unaffected by dust, moisture or vibration and require little maintenance.

4.7.3 The detectors shall have a calibration switch mounted internally to set the alarm sensitivity threshold.

4.7.4 The detectors shall generate an alarm condition if the pre-determined alarm threshold is exceeded.

4.7.5 The detectors shall generate a fault condition if the sensor cable has an open or short circuit condition present.

4.7.6 The detectors, upon detecting a cable open or short circuit or fault, shall be capable of signalling the condition to the main fire controller.

4.7.7 The linear heat detectors shall meet the requirements of either BS5445: Pt.5 (EN54: Pt.5) for detectors suitable for normal environment or BS5445: Pt.8 (EN54: Pt.8) for detectors designed for high ambient temperatures.

4.7.8 The linear heat detectors shall be approved and listed by the Loss Prevention Council Board (LPCB).

4.7.9 The detectors shall be suitable for use in hazardous areas and have mechanical protection for cables in areas where damage may occur.

4.7.10 The detectors shall incorporate red Fire and yellow Fault LEDs, clearly visible from the outside, to provide indication of alarm condition.

4.8 Beam Smoke Detectors

4.8.1 The beam smoke detectors shall be capable of detecting the presence of smoke in large open-type interiors.

4.8.2 The beam smoke detectors shall project a modulated infra-red light beam from a transmitter unit to a receiver unit. The received signal shall be analysed and, in the event of smoke being present for a pre-determined period, an alarm condition is activated.

4.8.3 The detectors shall be capable of providing cover in open areas up to 100m in length and up to 14m wide, giving an effective protection area of up to 1400sq m.

4.8.4 The fire alarm output of the detectors shall be activated in the event of smoke reducing the signal strength between 40% and 90% for a period of approximately 5 seconds.

4.8.5 In the event of a power failure at the transmitter unit or if the transmitted signal is reduced by more than 90% for a period in excess of 1 second, then a fault alarm condition shall be indicated. This condition shall inhibit the fire alarm until the signal is restored.

4.8.6 The receiver unit of the detectors shall be capable of performing an automatic reset, approximately 5 seconds after a fault is indicated, if the fault is no longer present.

4.8.7 The detectors shall include Automatic Gain Control (AGC) circuitry capable of providing compensation for long-term degradation of signal strength caused by component ageing or build-up of dirt on the optical surfaces of the transmitter and receiver unit lenses.

4.8.8 The beam smoke detectors shall meet the requirements of either BS5445: Pt.5 (EN54: Pt.5) for detectors suitable for normal environment or BS5445: Pt.8 (EN54: Pt.8) for detectors designed for high ambient temperatures.

4.8.9 The beam smoke detectors shall be approved and listed by the Loss Prevention Council Board (LPCB).

4.8.10 The receiver unit of the detectors shall incorporate an alignment/fault lamp, clearly visible from the outside, to provide indication of both alignment and fault conditions.

4.9 Aspirating Smoke Detectors

4.9.1 The aspirating smoke detectors shall be capable of detecting the presence of smoke particles in air samples drawn from many different locations.

4.9.2 The aspirating smoke detectors shall provide a continuous analogue profile of ambient air conditions.

4.9.3 The detectors shall be capable of responding to a developing fire situation with multiple staged alarms.

4.9.4 The fire alarm output of the detectors shall be programmable to allow sufficient time for action to be taken; from a detailed investigation of the cause of the alarm to a full-scale evacuation.

4.9.5 The design of the detectors shall be such that they can be integrated with a fire alarm system and guard against specific pieces of equipment, such as computers, equipment racks, power boards and telecommunications switching racks, as well as entire rooms or floors.

4.9.6 The detectors shall include a facility to allow sensitivity threshold adjustments to suit the needs of particular environments.

4.9.7 Each detector shall be capable of monitoring an area up to 2000 sq m using easy to install PVC conduit. (Depending on the level of risk or hazard involved, it may be appropriate to use a greater number of detectors.)

4.9.8 The aspirating smoke detectors shall meet the requirements of either BS5445: Pt.5 (EN54: Pt.5) for detectors suitable for normal environment or BS5445: Pt.8 (EN54: Pt.8) for detectors designed for high ambient temperatures.

4.9.9 The aspirating smoke detectors shall be approved and listed by the Loss Prevention Council Board (LPCB).

4.9.10 The detectors shall incorporate a LED indicator, clearly visible from the outside, to provide indication of alarm or fault condition.

4.10 Remote Indicator Module

4.10.1 The remote indicator module shall provide a remote indication for any conventional or analogue addressable detector that may be located in an enclosed or locked compartment.

4.10.2 The remote indicator module shall be driven directly from its associated local detector.

4.10.3 The connection to the remote indicator module shall be monitored for open and short-circuits.

5 ASSOCIATED ANCILLARY EQUIPMENT

5.1 Addressable Manual Call Points

5.1.1 The addressable manual call points shall monitor and signal to the control and indicating equipment the status of a switch operated by a 'break glass' assembly.

5.1.2 The addressable manual call point shall meet the requirements of BS5839: Pt.2.

5.1.3 The addressable call points shall be capable of operating by means of thumb pressure and not require a hammer.

5.1.4 The addressable call points shall be capable of being mounted in weather-proof affording protection to IP65.

5.1.5 The addressable call points shall incorporate a mechanism to interrupt the normal addressable loop scan to provide an alarm response within less than 1 second.

5.1.6 The addressable call points shall be field programmable to trigger either an alert or an evacuate response from the control and indicating equipment

5.1.7 The addressable call points shall be capable of being tested using a special 'key' without the need for shattering the glass.

5.1.8 The addressable call points shall provide an integral red LED to indicate activation.

5.2 Conventional Detector Interface Module

5.2.1 The conventional detector interface module shall monitor and signal to the control and indicating equipment the status of up to 20 conventional detectors and manual call points.

5.2.2 The conventional detector interface module shall be able to signal alarm, open-circuit fault, short-circuit fault and power supply fault status.

5.2.3 The conventional detector interface module shall be capable of monitoring automatic detectors and manual call points from existing conventional systems.

5.2.4 The conventional detector interface module shall provide integral red LED indication when in the alarm state.

5.2.5 The conventional detector interface module shall operate from a monitored 24 V d.c. power supply.

5.3 Addressable Relay Output Module

5.3.1 The addressable relay output module shall provide a volt free changeover relay contact operated by command from the control and indicating equipment

5.3.2 The contacts of the addressable relay output module shall be rated at a minimum of 1Amp at 24 V d.c.

5.3.3 The addressable relay output module shall monitor the relay coil for open-circuit and transmit the fault signal to the control and indicating equipment

5.3.4 The addressable relay output module shall be capable of deriving its operating power from the addressable loop.

5.3.5 The addressable relay output module shall provide a red LED indication that the relay has operated.

5.4 Addressable Contact Monitoring Module

5.4.1 The addressable contact monitoring module shall provide monitoring of the status of switched input signals from either normally open or normally closed contacts.

5.4.2 The addressable contact monitoring module shall provide a red LED indication when the contact has operated.

5.4.3 The addressable contact monitor module shall be capable of deriving its power directly from the addressable loop.

5.5 Addressable Sounder Driver Module

5.5.1 The addressable sounder driver module shall be capable of monitoring and driving a circuit of alarm sounders.

5.5.2 The output of the addressable sounder driver module shall be rated at 500mA.

5.5.3 The addressable sounder driver module shall be capable of operating the sounders in a pulsing or continuous mode as determined by the control and indicating equipment

5.5.4 The addressable sounder driver module shall provide the facility to monitor the wiring to the sounders for open or short-circuit and transmit the necessary fault signal to the control and indicating equipment

5.5.5 The addressable sounder driver module shall provide the facility to monitor for failure of the power supply for the sounders and transmit the necessary fault signal to the control and indicating equipment

5.5.6 The addressable sounder driver module shall provide a red LED indication that the sounder circuit has been actuated.

5.6 Sounder Booster Module

5.6.1 The sounder booster module shall be capable of monitoring and a driving a heavy duty circuit of sounders up to 15 Amps.

5.6.2 The sounder booster module shall be capable of interfacing either to the common sounder outputs of the control and indicating equipment or to the output of the addressable sounder driver module.

5.6.3 The sounder booster module shall be designed to maintain the monitoring of the sounder circuit and transmit a fault signal either via the addressable sounder driver module or directly to the control and indicating equipment

5.7 Addressable Power Supply Module

5.7.1 The addressable power supply module shall be capable of supplying up to 24 V d.c., 3 Amps of power to local sounder circuits and ancillary equipment.

5.7.2 The addressable power supply module shall derive its power from the 115/240 V a.c. mains supply.

5.7.3 The addressable power supply module shall be able to contain and maintain in a charged state a 24 V battery set of up to 15 A/h capacity.

5.7.4 The addressable module shall monitor the mains power supply and the battery and transmit a fault signal as appropriate to the control and indicating equipment

5.8 Line Isolator Module

5.8.1 The line isolator module shall provide protection on the addressable loop by automatically disconnecting the section of wiring between two zones where a short-circuit has occurred.

5.8.2 The line isolator module shall derive power directly from the addressable loop.

5.8.3 The line isolator module shall provide an LED indication that the module has tripped.

5.9 Smoke Damper Module

5.9.1 The smoke damper module shall provide the inputs and outputs required to monitor and control a smoke damper.

5.9.2 The smoke damper module shall be fully addressable and provide one volt-free changeover relay contact rated 240 V a.c. @ 5 Amps.

5.9.3 An external 24 V d.c. supply shall be provided to operate the changeover relay.

5.9.4 The changeover relay contact of the smoke damper module shall be monitored and controlled by commands signalled from the fire alarm system control panel via the addressable loop.

5.9.5 The smoke damper module shall be capable of monitoring up to two external relay contacts.

5.9.6 The module shall derive its power directly from the addressable loop.

5.9.7 The outputs of the smoke damper module shall be capable of being controlled using a keypad via the addressable loop.

5.9.8 The keypad shall be capable of forcing the relay outputs LOW, HIGH or AUTO. It shall also be capable of reading the status of the relay outputs.

5.9.8 The smoke damper module shall have a red LED, clearly visible on the fascia panel of the unit, to provide an indication of relay operation.

5.10 Shop Unit Module

5.10.1 The shop unit module shall provide all inputs and outputs typically required to interface individual shop units with a landlords site-wide monitoring system.

5.10.2 The shop unit module shall be fully addressable and provide multiple volt-free changeover relay contacts rated 24 V d.c. @ 1 Amp.

5.10.3 An external 24 V d.c. supply shall be provided to operate the changeover relays.

5.10.4 The changeover relay contacts of the shop unit module shall be monitored and controlled by commands signalled from the monitoring system control panel via the addressable loop

5.10.5 The shop unit module shall be capable of monitoring multiple external relay contacts.

5.10.6 The module shall derive its power directly from the addressable loop.

5.10.7 The shop unit module shall be capable of being link configured to provide 2 inputs/2 outputs, 4 inputs/4 outputs or 6 inputs/6 outputs as required.

5.10.8 The shop unit module shall have six consecutive addresses provided for configuration.

5.11 Plant Interface Module

5.11.1 The plant interface module shall provide inputs and outputs required to monitor and control plant and machinery.

5.11.2 The plant interface module shall be fully addressable and provide multiple volt-free DPDT changeover relay contacts rated 240 V a.c. @ 5 Amps.

5.11.3 An external 24 V d.c. supply shall be provided to operate the changeover relays.

5.11.4 The changeover relay contacts of the plant interface module shall be monitored and controlled by commands signalled from the fire alarm system control panel via the addressable loop.

5.11.5 The module shall be capable of monitoring multiple external relay contacts.

5.11.6 The plant interface module shall derive its power directly from the addressable loop.

5.11.7 The plant interface module shall be capable of being link configured to provide 2 inputs/2 outputs, 4 inputs/4 outputs or 6 inputs/6 outputs as required.

5.11.8 The plant interface module shall have six consecutive addresses provided for configuration.

6 DOCUMENTATION

6.1 Tender Documentation

6.1.1 At the time of tendering, the Fire Alarm contractor shall fully and accurately describe the proposed fire detection and alarm system and its design concepts.

6.1.2 The Fire Alarm contractor shall provide a complete set of layout drawings and specifications describing all aspects of the system, including:

1. Detailed component and equipment list with model and manufacturers part numbers.
2. Product sheets for each item of equipment.
3. Theory of Operations with description of system functions.
4. Written confirmation that a manufacturer trained representative will provide:
   a) on-site supervision during system installation
   b) perform all final testing and commissioning of the installed system
   c) instruct operating personnel on all system operations.

6.1.3 The Fire Alarm contractor shall provide a schedule showing the times required to design, build, install, test and commission the system. The schedule shall also include any special requirements, such as additional training for operating personnel, etc.

6.2 Contract Documentation

6.2.1 The Fire Alarm contractor shall provide a complete set of documents describing the system and its design concepts, installation, final testing, commissioning, and required operating and maintenance procedures.

6.2.2 As a minimum, the following documentation shall be provided for the system:

1. System description.
2. Checklist of equipment and components.
3. Installation instructions.
4. Equipment connection diagrams showing wiring detail of Addressable Device positions with addresses.
5. Standby battery calculations showing system power requirements and formulas used to calculate specified power.
6 Final testing instructions.
7. Commissioning instructions.
8. Certification documents.
9. Log book.
10. System operating instructions.
11. Routine maintenance instructions and schedules.
12. Remote monitoring link description and operating instructions (if this option is being provided).

6.2.3 As a minimum, the following drawings shall be provided for the system:

1. System schematic diagram.
2. Cabling and wiring diagram.
3. Detailed equipment connection diagrams.
4. Building plan showing zoning and location of fire controller, detectors, call points, sounders and ancillary devices.

6.2.4 The Fire Alarm contractor shall provide a complete set of system operating and service manuals for the following:

1. Fire controller
2. Detectors
3. Call points
4. Sounders
5. Ancillary devices
6. Remote monitoring link (if this option is being provided).

6.2.5 The date for submission of all documentation shall be in accordance with the schedule provided by the Fire Alarm contractor and as agreed with the customer.

7 INSTALLATION

7.1 General

7.1.1 Correct installation, combined with the use of high quality equipment, components and cabling, ensures that the fire detection and alarm system shall operate as designed and provide many years of trouble-free service.

7.1.2 The Fire Alarm contractor shall install the alarm system in accordance with the documented installation instructions.

7.1.3 The Fire Alarm contractor shall provide all relevant installation documentation required for each component of the system.

7.1.4 Installation of the system shall be in accordance with the recommendations set out in BS 5839: Pt 1: 1988 (*Fire detection and alarm systems for buildings - Code of practice for system design, installation and servicing*) and BS 7671 (*Requirements for Electrical Installations - IEE Wiring Regulations, Sixteenth Edition*).

7.1.5 The Fire Alarm contractor shall be responsible for the correct siting of all equipment and components of the system in accordance with previously agreed plans and drawings.

7.1.6 All cabling and wiring shall be tested **before** they are connected to the fire controller and its associated devices.

WARNING If the tests are carried out after the cables and wires have been connected to the controller and its devices, components within the controller and the devices will be damaged by high voltages used during testing.

7.2 Materials

7.2.1 All cabling and wiring to be used in the system shall be fire resistant and approved to BSI and LPCB specifications for use in fire detection and alarm systems.

7.2.2 Wiring used for driving devices requiring high currents (e.g. bells, etc.) shall limit the voltage drop to less than 10% of the nominal operating voltage.

7.2.3 Cables used for the transmission of system data and alarm signals shall be in accordance with the types recommended by the manufacturer of the fire alarm system.

7.2.4 The ends of all cables shall be sealed by means of proprietary seals and associated glands. No heat shall be applied to any seal or termination. Cable tails shall be insulated by means of blank PVC sleeving anchored and sealed into the seal.

7.2.5 Where protection of the cable glands is required or terminations are on display, the glands shall be enclosed in red coloured shrouds of the appropriate British Standard colour.

7.2.6 All cables to brick/concrete shall be securly fixed by means of copper saddles sheathed with red PVC. These saddles shall be provided near bends and on straight runs at intervals no greater than recommended in the British Standards or by the manufacturer.

7.2.7 Where multiple cables are to be attached to a wall or soffit, copper saddles shall enclose all cables and shall be secured by means of suitable masonry plugs and two round head plated woodscrews

7.2.8 Where multiple cables are to be attached to the top of horizontal trays they shall be neatly run and securely fixed at suitable intervals. Copper or plastic cable fixings shall be used.

7.2.9 At detector and sounder locations, cables shall be terminated in approved black enamelled/galvanised BESA or MI Clamp type junction boxes. All other devices forming part of the system shall utilise dedicated /custom back boxes.

7.3 Installation of Detectors

7.3.1 All detectors (and bases) shall be installed in accordance with guidelines set out in BS 5839: Pt 1: 1988, BS 7671 and the installation instructions provided by the manufacturer.

7.3.2 All detectors shall be installed in the exact locations specified in the design drawings; thus providing the best possible protection.

7.3.3 The type of detector installed in each particular location shall be the type specified in the design drawings.

7.3.4 All detector bases shall be securely fixed to BESA boxes and allow for easy fitting and removal of detectors.

7.3.5 Cable and wire entries to detector bases shall be fitted with grommets to prevent possible damage to the insulation.

7.3.6 Cable and wire strain relief clamps shall be provided at all entries to detector bases.

7.3.7 Cable entries of detector bases used in environments with abnormal atmospheric or operating conditions shall be appropriately sealed to prevent ingress of dust, water, moisture or other such contaminants.

7.4 Installation of Control Devices

7.4.1 All control devices (e.g. call points, sounders, interface modules, etc.) shall be installed in accordance with the guidelines set out in BS 5839: Pt 1: 1988, BS 7671 and the installation instructions provided by the manufacturer.

7.4.2 All control devices and associated modules shall be installed in the exact locations specified in the design drawings.

7.4.3 The type of control device installed in each particular location shall be the type specified in the design drawings.

7.4.4 All control devices and associated modules shall be securely fixed, and if required, marked with appropriate notices, warnings, signs as applicable.

7.4.5 Cable and wire enteries to all control devices and associated modules shall be fitted with grommets or glands so as to prevent possible damage to the insulation.

7.4.6 Cable and wire strain relief clamps shall be provided at entries to control devices and associated modules as required.

7.4.7 Cable entries of control devices and associated modules used in environments with abnormal atmospheric or operating conditions shall be appropriately sealed to prevent ingress of dust, water, moisture or other such contaminants.

7.5 Installation of Fire Controller Equipment

7.5.1 The fire controller equipment shall be installed in accordance with the guidelines set out in BS 5839: Pt 1: 1988, BS 7671 and the installation instructions provided by the manufacturer.

7.5.2 The fire controller and its associated component parts shall be installed in the location specified in the design drawings.

7.5.3 The type of fire controller and its associated component parts installed shall be the type specified in the design drawings.

7.5.4 The fire controller equipment shall be securely fixed, and if required, marked with appropriate notices, warnings, signs as applicable.

7.5.5 Cable and wire entries to the fire controller and associated devices shall be fitted with grommets or glands to prevent possible damage to the insulation.

7.5.6 Cable and wire strain relief clamps shall be provided at entries to fire controller and associated devices as required.

7.5.7 The fire alarm system mains power connections to the fire controller equipment shall be accordance with the guidelines set out in the relevant British Standards and the installation instructions provided by the manufacturer.

7.5.8 The fire alarm system mains power isolating switch shall be coloured red and clearly labelled 'FIRE ALARM: DO NOT SWITCH OFF'.

7.5.9 Each circuit of the system shall be connected to the fire controller via associated fuse or circuit breaker devices located within the fire controller unit.

7.5.10 All cables from the fire controller equipment to the detection and alarm devices shall be clearly labelled as part of the fire detection and alarm system.

8 COMMISSIONING

8.1 General

8.1.1 Both the installation (see Section 7) and the commissioning activities shall be undertaken as a single continuous operation.

8.1.2 Upon completion of the installation activity, the Fire Alarm contractor shall Test, Start-up, Commission and Handover the system to the customer.

8.1.3 The Fire Alarm contractor shall make use of the following documents to record test results and details of commissioning tests:

- Cable Test Sheets
- Installation Check Report
- System Layout Drawing(s)
- System Schematic Diagram(s)

8.1.4 In addition, Point Description Sheets which are used to configure the text descriptions displayed at the controller must be returned to the Fire Alarm contractor 21 days prior to the date agreed for commencement of commissioning. Copies of Point Description Sheets are provided to the customer upon receipt of the order for the fire system.

8.2 Testing and Start-up

8.2.1 The Fire Alarm contractor shall be responsible for inspecting and testing the complete system, including:

1. Detectors
2. Call Points
3. Sounders
4. Ancillary Devices
5. Fire Controller Equipment and Associated Devices
6. Auxiliary Equipment (e.g. Plant Interface Module, etc.)
7. Operating and Control Software.

8.2.2 The fire controller and associated devices and modules shall be tested in accordance with the guidelines set out in BS 5839: Pt 1: 1988 and the testing instructions provider by the manufacturer.

8.2.3 The Fire Alarm contractor shall start up and operate the system for a trial period to ensure that it operates correctly.

8.2.4 The Fire Alarm contractor shall test all functions of the system, including the software, to ensure that it operates in accordance with the requirements of the design specification and relevant standards.

8.2.5 The Fire Alarm contractor shall undertake audibility tests during which the sounders may be operated continuously over a period of two hours. (Should the customer require these tests to be carried out at a separate visit, or out of normal working hours, this can be arranged at additional cost.)

8.3 Commissioning

8.3.1 Commissioning of the system shall constitute practical completion

8.3.2 Following the satisfactory completion of installation, testing and start up, the Fire Alarm contractor shall demonstrate to the customer that the system successfully performs all of the functions set out in the design specification.

8.3.3 The Fire Alarm contractor shall provide the customer with an agreed quantity of spare parts testing equipment and consumerables which are to be used during routine maintenance and testing of the system.

8.3.4 The Fire Alarm contractor shall provide a customer appointed fire system supervisor with on-site training in the use, operation and maintenance of the system and explain the procedures to be followed in the event of fire and false alarms. The system supervisor shall also be shown how to carry out routine maintenance and testing procedures, and how to keep the Log Book. (also see Section 9).

8.3.5 The Fire Alarm contractor shall prepare a report detailing all tests performed during installation and commissioning of the system. The report shall include the results of the tests and details of any specific settings or adjustments made. Any outstanding tasks or activities which are to be completed at another time shall also be included in the report.

8.3.6 The Fire Alarm contractor shall present an Acceptance Certificate for signature by the customer.

8.4 Handover

8.4.1 The Fire Alarm contractor, upon completion of the commissioning activity, shall hand over the system to the customer.

8.4.2 At the time of hand over, the Fire Alarm contractor shall provide the customer with the following documentation:

1. Copy of detailed report (see clause 8.3.5 above)
2. Component and equipment list
3. Product description sheets
4. System design specification
5. System design drawing(s)
6. System schematic diagram(s)
7. System operating and service manuals
8. Certificate of certification
9. Fire system users handbook, containing log book, routine maintenance instructions and schedules
10. Remote monitoring link description and operating instructions (if this option was provided).

9 TRAINING

9.1 General

9.1.1 The Fire Alarm contractor shall provide the customer with details of the training required by personnel to operate and maintain the fire detection and alarm system.

9.1.2 The Fire Alarm contractor shall provide two levels of training:

- System Supervisor Training
- Other Staff Training

9.1.3 The Fire Alarm contractor and the customer shall jointly agree the number of staff to attend the training courses.

9.2 System Supervisor Training

9.2.1 System supervisor training shall include technical training sessions provided at the Fire Alarm contractor's premises and on-site training given during installation and commissioning of the system.

9.2.2 System supervisor training shall be given by an experienced and competent engineer familiar with the fire system being installed.

9.2.2 The scope of training provided shall depend on the type, size and complexity of the system.

9.2.3 The Fire Alarm contractor shall initially provide technical training in all aspects of the system. The trainee shall then be given full instructions in the use, operation and maintenance of the system. This shall include instruction in the procedures to be followed in the event of fire and false alarms, routine maintenance and testing procedures, and how to keep the Log Book.

9.3 Other Staff Training

9.3.1 Other staff training shall include training sessions provided on-site after hand over of the system.

9.3.2 The training sessions shall be given by an experienced and competent engineer familiar with the fire system installed.

9.3.3 The scope of training provided shall include full operating instructions in the use of the fire system. This shall include instruction in the procedures to be followed in the event of fire and false alarms.

10 MAINTENANCE

10.1 General

10.1.1 According to the recommendations in BS 5839: Pt 1: 1988 (clause 29), fire systems should be regularly maintained under a maintenance agreement.

10.1.2 Fire and planning authorities, and in certain cases insurers, have powers to check that fire systems are maintained. Failure to maintain the fire detection and alarm system could contribute to death or injury in the event of fire.

10.1.3 The customer shall be responsible for ensuring that daily, weekly and monthly routine maintenance is carried out in accordance with the recommendations set out in BS 5839: Pt 1: 1988 and the service and maintenance instructions provided by the Fire Alarm contractor or manufacturer.

10.1.4 The Fire Alarm contractor shall provide detailed information about the maintenance services which can be provided after hand over of the system.

10.1.5 If requested, the Fire Alarm contractor shall prepare and submit a draft maintenance contract for consideration by the customer.

10.1.6 The draft contract shall include complete details of all materials and labour required to maintain the system in correct working order. It shall also include details of the testing procedures which will be carried out and specify the proposed number of visits per year.

10.2 System Spares

10.2.1 The Fire Alarm contractor shall provide a detailed list of the system spares which should be kept on-site for maintenance of the system.

10.2.2 Although the quantity of each item required is dependent upon the type and size of installation, the system spares which should be considered for inclusion in the list are as follows:

- Heat Detectors
- Smoke Detectors
- Flame Detectors
- Call Points
- Sounders
- Beacons
- Door Retention Units
- Fuses
- Circuit Breakers

10.2.3 The draft maintenance contract shall also include details of the system spares which are be kept on-site for maintenance of the system.

10.2.4 The Fire Alarm contractor shall guarantee the availability of all system spares for a period of not less than ten years.

10.3 System Test Equipment

10.3.1 The Fire Alarm contractor shall provide a detailed list of the system test equipment and consumerables required on-site to maintain the system in perfect working order.

10.3.2 As the quantity of each item required is dependent upon the type and size of installation, the system test equipment and consumables which should be considered for inclusion in the list are as follows:

- Detector Head Removal Tool
- Detector Base Skirt Removal Tool
- Call Point Testing Tool
- Detector Test Smoke Canister
- Detector Test Adaptor
- Aerosol Dispensing Tube
- Extension Tubes
- Spare Log Book

10.3.3 The draft maintenance contract shall also include details of the system test equipment and consumerables which are be kept on-site for routine maintenance and testing of the system.

10.3.4 The Fire Alarm contractor shall guarantee the availability of all system test equipment and consumables for a period of not less than ten years.