

Application of fire safety engineering principles to the design of buildings —

Part 4: Detection of fire and activation of fire protection systems (Sub-system 4)

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Committees responsible for this Published Document

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- Association of Building Engineering
- BRE/LPC Laboratories
- Chief and Assistant Chief Fire Officer's Association
- DETR
- DoH — NHS Estates
- District Surveyors Association
- Fire Safety Development Group
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- Fire Brigades Union
- Fire Service
- London Fire and Emergency Planning Authority

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Foreword

This Published Document (PD) was published under the Fire Standards Policy Committee. Other parts published or about to be published are as follows:

- *Part 0: Guide to design framework and fire safety engineering procedures* (QDR);
- *Part 1: Initiation and development of fire within the enclosure of origin* (Sub-system 1);
- *Part 2: Spread of smoke and toxic gases within and beyond the enclosure of origin* (Sub-system 2);
- *Part 3: Structural response and fire spread beyond the enclosure of origin* (Sub-system 3);
- *Part 5: Fire service intervention* (Sub-system 5);
- *Part 6: Evacuation* (Sub-system 6);
- *Part 7: Probabilistic risk assessment* (Sub-system 7).

These Published Documents are intended to be used in support of BS 7974:2001, *Application of fire safety engineering principles to the design of buildings — Code of practice*.

It has been assumed in the drafting of this PD that the execution of its provisions is entrusted to appropriately qualified and competent people.

Historically, fire detection, alarm and suppression systems have been subject to product orientated prescriptive codes and standards. Research to calculate and predict fire growth and the performance of detection, suppression and smoke control systems is still ongoing. There is much still to be done before the area becomes a mature science.

This document will *not* provide all information necessary to undertake a full fire safety engineering design of fire detection and fire control systems. It will, however, provide a framework and guidance for the design assessment, and will identify other documents that should be referred to, as appropriate.

Drafting of this publication was completed in July 2001.

Acknowledgement is made to the contribution of Mr. N. Smithies of FRS/BRE and Mr. P. Bryant of Kingfell Fire Protection Ltd in the preparation of this publication.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i to ii, pages 1 to 39 and a back cover.

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1 Scope

This Published Document provides guidance on the development, design and application of fire detection systems, and the activation of fire alarm and fire control systems to fulfil a role in the fire safety engineered design for a building. Scientific and engineering principles are used as part of a structured approach. The key elements covered are:

- *detection*: information is provided on the various types of fire detection system and their application for a given set of circumstances, as derived from a qualitative design review, risk assessment and the results of formulae provided by other Sub-systems;
- *activation and control*: once the fire detection system has detected a fire, it activates a series of measures designed to fulfil the requirements of the fire safety engineered design. These measures may include operation of fire warning systems, the remote signalling to emergency services, and the operation of fire alarm, fire suppression and fire control systems. Guidance is given on the methodology and formulae required in ensuring that the appropriate systems are activated in an appropriate manner and within given criteria.

In the context of this document, fire control includes:

- *fire suppression systems*: active systems designed to suppress a fire, temporarily (i.e. control) or permanently (i.e. extinguish). Examples include automatic water sprinkler systems;
- *fire barrier systems*: active systems designed to contain a fire within a given area or separate a fire from another area. Such systems may be regarded as offering similar benefits to passive fire compartments or separations for the duration of their operation. Examples include fire damper systems and door release mechanisms;
- *smoke/heat control systems*: active systems designed to positively control the movement and build up of fire effluents such as smoke, heat and toxic gases. Examples include smoke venting systems and air pressurization systems.

NOTE This document does not contain detailed design and installation instructions for the systems covered. This information may be obtained from other relevant British Standard codes of practice and specifications.

2 Normative references

- BFPSA, COP12, *Code of practice — Category 1 Aspirating Detection Systems*. Issue 1. Available from BFPSA, Neville House, 55 Eden Street, Kingston-Upon-Thames, Surrey KT1 1BW.
- BS 5306-2, *Fire extinguishing installations and equipment on premises — Part 2: Specification for sprinkler systems*.
- BS 5588-4, *Fire precautions in the design, construction and use of buildings — Part 4: Code of practice for smoke control using pressure differentials*.
- BS 5839-1, *Fire detection and alarm systems for buildings — Part 1: Code of practice for system design, installation, commissioning and maintenance*.
- BS 5839-8, *Fire detection and alarm systems for buildings — Part 8: Code of practice for the design, installation and servicing of voice alarm systems*.
- BS EN 54-2, *Fire detection and alarm systems — Part 2: Control and indicating equipment*.
- BS EN 54-3, *Fire detection and alarm systems — Part 3: Fire alarm devices — Sounders*.
- BS EN 54-4, *Fire detection and alarm systems — Part 4: Power supply equipment*.
- BS EN 54-5, *Fire detection and alarm systems — Part 5: Heat detectors — Point detectors*.
- BS EN 54-7, *Fire detection and alarm systems — Part 7: Smoke detectors — Point detectors using scattered light, transmitted light or ionization*.
- BS EN 54-10, *Fire detection and alarm systems — Part 10: Flame detectors — Point detectors*.
- BS EN 54-11, *Fire detection and fire alarm systems — Part 11: Manual call points*.
- BS ISO 14520 (all parts), *Gaseous fire-extinguishing systems — Physical properties and system design*

HAG Report, *A review of the toxic and asphyxiating hazards of clean agent replacements for halon 1301*. Available from The Halon Users National Consortium Limited. Global House. College Street. Petersfield. Hampshire. GU31 4AD.

NFPA 750, *Standard on Water Mist Fire Protection Systems*. NFPA, 1 Batterymarch Park Quincy, MA 02269-9101 USA. <http://www.nfpa.org>

3 Terms and definitions

3.1

alarm receiving centre

continuously manned premises, remote from those in which the fire alarm system is fitted, where the information concerning the state of the fire alarm system is displayed and/or recorded, so that the fire and rescue service can be summoned

NOTE Alarm receiving centres are also called remote manned centres; the term “central station” is sometimes used as a synonym for alarm receiving centre.

3.2

coincidence detection

facility (provided by a fire detection and alarm system) designed so that an output is obtained only when one signal has been received from a fire detector and one or more confirmatory signals are received from the same or other points

3.3

fire suppression system

system designed to control, suppress or extinguish a fire, via the use of water, chemical or inerting gas, or other means

NOTE These systems may be activated manually or automatically

4 Symbols and abbreviations

Symbols and abbreviations are included with the relevant formulae, for purposes of clarity.

5 Design approach

5.1 The principles of fire detection

Although a fire safety engineered approach to the design and construction of buildings can have a major impact on reducing the risk of fire, it is commonly recognized that fire detection will usually play a critical role. It could be argued that all fires will, if allowed to grow, eventually be detected. However, it is the speed of detection of a fire that will influence how effective the subsequent stages of the active components of a fire safety engineering design will be.

The type and extent of detection system to be employed may be determined by a number of considerations, including the primary objectives for the design. For instance, where a fire is likely to be detected by a person before it will adversely impact on any other person in the building, a system making use of only manual call points might be perfectly adequate. In another case, a mostly unmanned warehouse cannot rely upon a manual response and an automatic fire detection system and/or sprinkler system will be warranted.

Historically, the type and extent of fire detection is often dictated by external influences rather than by a measured assessment of the risk and the determination of the most appropriate and effective form of detection. These influences may include the requirements of legislation as enforced by the Fire Authority and Building Control Body, or the requirements of interested parties, such as the Insurer.

The main requirements for a fire detection system are the ability to:

- respond to the likely products of combustion posing a threat to the building, its occupants and/or its processes;
- discriminate between fires posing a threat and non-fires (false alarms);
- provide a signal to activate fire warning or control systems within an acceptable time period;
- be sufficiently available and reliable to perform when required and as intended.

5.2 The principles of activation and control

The detection of a fire is normally the first in a chain of events. Subsequent actions such as the sounding of alarms and the operation of fire suppression systems are normally directly initiated by the fire detection system. In fact, a fire detection system that does not activate other systems is of little benefit. The type, extent and interaction of activated measures will depend on the findings of the QDR and the results of the assessments of other Sub-systems. The end result may be a simple chain of events or may be a complex set of interactions. Figure A.1 in Annex A illustrates how the activated fire control systems interrelate following the detection of a fire. Further guidance is given in Annex A.

5.3 Preparing a fire safety engineering design for detection and control systems

In order to prepare a fire safety engineering design for fire detection and associated active systems, a process should be followed. Typically, forms part of the Qualitative Design Review (QDR) process as described in BS 7974 and could commence with the assessment of the requirements for fire detection. However, there may be just as good an approach by determining the type of fire controls required and working back to determine the most appropriate form of detection to activate those controls. The following process starts with fire detection as this is the way this Sub-system has been structured. Each stage of the process will prompt decisions to be made and will provide a reference for further investigation.

Stage A is shown in Table 1.

Table 1 — Stage A: Fire detection

Step	Title	Detail	Reference(s)
1	Determination of objectives	To determine the requirements for the fire detection system as part of the overall fire safety engineering strategy.	QDR
2	Required time to response	To determine at what stage of fire development the system should respond.	QDR
3	Location and extent of detection	To identify where automatic and/or manual fire detectors are required.	7.1
4	Type of detection	To assess the most appropriate form of fire detectors for each of the areas to be monitored.	7.2
5	Siting and spacing	To determine how and where the chosen fire detectors are to be sited and spaced.	7.3 and 7.4
6	Calculated time to response	To assess the likely time to response for any of the areas fitted with detection. If the period is less or more than that required, Step 3 could be revisited and the siting and spacing of detectors re-assessed.	7.5

Stage B: Fire Control and Warning Systems

Once the fire detection system design has been confirmed, the designer should determine the type of fire control and fire warning systems required. Consideration should also be given to the way in which the systems interact. There might also be a need to re-evaluate the design of the detection system to ensure the extent and type of system(s) proposed is suitable for the subsequent stages of the process. can be used for guidance.

Stage B.1: Determine the type and extent of local and remote fire warning systems and the likely response times of persons within the premises and fire fighting personnel. See Clause 8 for information.

Stage B.2: Fire suppression systems: see Clause 9.

Stage B.3: Fire barrier systems: see Clause 10.

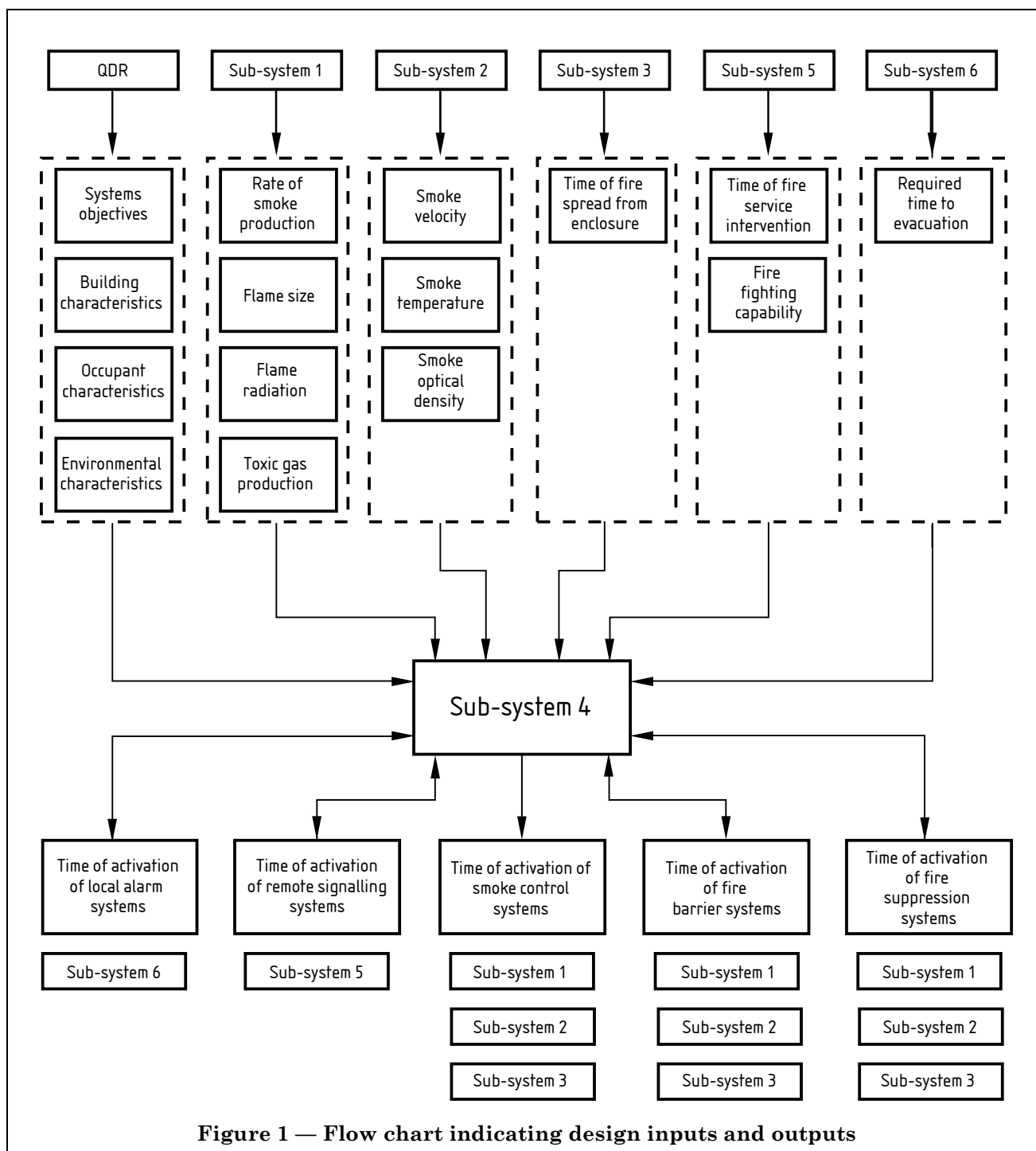
Stage B.4: Smoke control systems: see Clause 11.

Stage C: Review

A thorough review of each of the systems should now be undertaken to:

- ensure that the systems meet with the requirements of the fire safety engineering design;
- ensure that the systems function together as designed and that there are no adverse aspects created by the mutual interaction of any of the systems.

6 Design inputs and outputs



6.1 Design inputs

This design inputs required by other Sub-Systems are as follows (see Figure 1):

- *QDR*: This assessment provides the qualitative framework for determination of the most important parameters involved in the choice, extent and application of both the fire detection systems and the activation of the fire warning, suppression and control systems. Key considerations include the pre-determined objectives and the characteristics of the building, occupancy and environment;
- *Sub-system 1*: The initiation and growth phase of a fire within the enclosure of origin provides details of initial smoke production, heat release rate, flame size and toxic gas production. This information will help to determine the most appropriate fire detection strategy, the likely time to detection and alarm, and the choice and efficacy of fire control and suppression systems;
- *Sub-system 2*: Analysis of the spread of smoke within and beyond the enclosure of origin provides further data to help determine how smoke detection and control can be most effectively applied;
- *Sub-system 3*: Deals with aspects of structural failure and the key output of this Sub-system determines the growth rate outside the enclosure of origin and how detection and control will impact on subsequent growth;
- *Sub-system 4*: The criteria involved in fire service intervention will help to determine the type of remote signalling necessary post detection, and the extent of measures designed to control fire growth until attendance by the fire service and the provision of fire location information to the fire and rescue service;
- *Sub-System 6*: This input focuses on how the detection system should be designed around the occupant and the most appropriate form of alarm warning(s).

6.2 Design outputs

This Sub-system been prepared to help predict the likely time to activation of the following:

- fire warning systems within the building;
- remote signalling systems to external bodies such as the fire service;
- smoke control systems – those systems positively designed to affect smoke movement;
- fire barrier systems – those systems positively designed to prevent or channel fire movement;
- fire suppression systems – those systems designed to suppress and/or extinguish a fire.

Note that fire detection in itself is not an output; it is simply part of a process that can be represented as a time delay between sensing the appropriate fire phenomena and triggering the warning or control system. How the design outputs interact is shown in Figure A.1.

7 Fire detection

7.1 Extent of coverage of detection system

The extent of coverage of a fire detection system within premises will be determined by a number of factors. These factors will include the objectives for the system (life safety, property protection, business protection, or a combination of each objective), and the level of risk from fire found as a result of an assessment of the building.

BS 5839-1 has introduced a system of categories to allow a designer to designate rooms and areas to be fitted with fire detection. The categories are based upon the objectives for the system (i.e. life safety or property protection) and are sub-categorized based on the extent of detection monitoring. BS 5839-1 should be consulted for more information.

An alternative approach is proposed within this Sub-system that allows for a more site-specific assessment by prompting a full analysis of every part of the premises to be monitored. This analysis may allow for life safety and/or property protection objectives but also for the results of a risk assessment of the building and any other factors introduced as part of the fire safety engineering design.

7.2 Choice of detector

7.2.1 General

The performance of a fire detection system is largely dependent upon the choice of detector type and principle. Consequently, a thorough assessment should be undertaken based upon the following:

- the assessment of the building and occupancy as results from the QDR;
- probable fire characteristics and growth within each compartment of origin and beyond (Sub-systems 1 and 2).

Figure 2 provides a set of considerations that will assist with a practical evaluation of the most appropriate types of detector or detection system for any specific application.

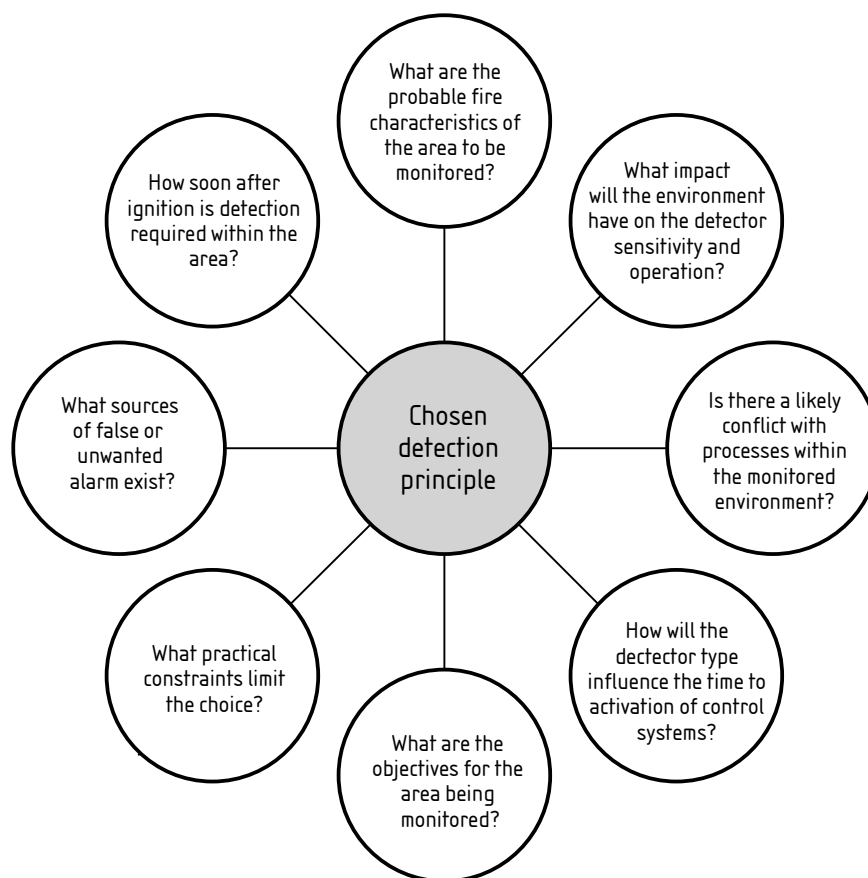


Figure 2 — Fire detection characteristics diagram

7.2.2 The automatic fire detection system

A fire detection system may utilize a number of different types of fire detector or detection system. There may be a number of different control panels located around the protected building, either acting as repeater panels for the main system, or controlling special systems such as aspirating systems. In such cases, it is recommended that all detection functions are signalled back to a central control and indicating point. This control point should be agreed with all parties involved with the fire safety engineering design. By having a central point of reference, a co-ordinated approach to the receipt of one or more alarm events is more likely.

Detailed technical aspects of the fire detection system components and installation should conform to the appropriate parts of the BS EN 54 and BS 5839 series of standards unless otherwise stated by the QDR.

Failure modes: As with all electrical systems, fire detection systems are subject to failure. However the type of failure could have a range of consequences for the overall fire safety engineering design. Examples of typical failure modes with consequences are given in Table 2:

Table 2 — Failure modes for fire detection systems

Failure mode	Consequences
Power supply failure	There is a standard requirement that system should be fitted with standby power supplies. In most cases, this mode should have negligible impact for at least 24 h after the failure.
Failure of panel displays	The appropriate European Standard requires a display configuration where, if one fails there is at least indication of main fire and fault conditions.
Major control panel failure	The consequences may vary from the worst case condition of complete system loss to default activation of warning and/or control systems to no consequence where another panel can automatically take over all functions.
Fault in an individual device	Where a defined fault occurs, there is a requirement that the fault should be indicated within a period as specified by the relevant BS EN 54 and BS 5839 series of standards. If a back-up emergency call-out contract is in place, the consequences are relatively small.
Loop cable failure	Relevant requirements are given in the BS EN 54 and BS 5839 series of standards to limit the consequences of a loop cable failure.

Failure data and the most appropriate corrective actions can often be provided by the relevant suppliers of the equipment.

7.2.3 Point-type smoke detectors

Point-type smoke detectors are the most common form of fire detector. They may be of the ionization type or may use optical means to detect smoke. In most cases for internal building protection, point smoke detectors are highly suitable. They are relatively inexpensive and easy to install, and the more modern devices incorporate sophisticated techniques providing high levels of discrimination against false alarms whilst maintaining high sensitivity to fires. The specification for point-type smoke detectors is BS EN 54-7.

Point smoke detectors rely on the movement of smoke towards the device. Furthermore, research [1] has shown that in order for smoke to enter the detector chamber, the gas (smoke) velocity would need to be at least 0.15 m/s.

The modelling of smoke production and movement from a fire is typically more difficult than for the assessment of heat production and movement. This is especially true for smouldering fires. Consequently, there is little in the way of validated models for the prediction of time to response for smoke detectors and for smoke detector spacing, although guidance is given by some sources [2]. In order to provide an initial assessment of point type smoke detection response time in the pre-flashover stages of a flaming fire, the equation (1) (from DD 240-1) can be used to assess the mass of burnt fuel:

$$f_b = 0.1 \left(\frac{DV_t}{D_m} \right) \quad (1)$$

where

f_b is the mass of burnt fuel (kg)

V_t is the total volume of smoke (m³)

D is the optical density of the smoke (dB/m)

D_m is the mass optical density (m²/kg) – typically, a value of 300 can be used for general building contents

By calculating the mass of burnt fuel at the point at which the optical density, D , of the smoke reaches the detector sensing threshold, the time to response can be assessed, as this will be the time at which the value of f_b is reached. Note that this analysis assumes that the device is in the immediate vicinity of the fire.

Note that, for non-flaming fires, alternative methods will need to be sought. As and when further conclusive data is made available, this Sub-system will be appropriately revised.

When calculating and assessing detection criteria, the most appropriate smoke detector for the combustible materials found should be used. Detectors tested to BS EN 54-7 will have been assessed on their response to a series of test fires. By analyzing this information (usually contained within third party certification test reports), a suitable profile can be drawn up. Note that, as many smoke detector response thresholds can be adjusted in the detector head or via the fire detection system, different response thresholds in different areas may be possible.

A simplified method of predicting smoke detector operation for cases where sufficient heat is generated, uses the basis that the smoke obscuration created by a fire is directly proportional to its rise in temperature. There are obviously many considerations to be made as to the type of smoke and the properties of the smoke detector. Some research has shown that, for ionization detectors responding to wood crib fires, response would be achieved at a temperature rise of 13 °C [3] measured at the detector.

In addition the determination of the overall response time, consideration should be given to potential delays inherent in the detector design. A time lag between smoke arriving at the detector and entering the sensing chamber has been recognized during the course of research. The term “characteristic length” is similar to the RTI measurement of heat sensitive devices (see 7.2.4) and can be represented by a detector time constant as shown in equation (2) [4]:

$$L = \tau U \quad (2)$$

where

L characteristic length, i.e. the distance the smoke would travel at a given velocity before the sensor inside the detector reaches the value outside the detector (m). Note that this would be an inherent property attributed to a detector

τ is the detector time constant (s)

U is the ceiling jet velocity flowing past the detector (m/s)

An approach for estimating the response time of smoke detectors is proposed by Evans [5]. It suggests that, since no analogous method exists to calculate the time lag of smoke concentration below the ceiling to the concentration in the sensing chamber, a smoke detector should be thought of as a heat detector with no thermal lag (an RTI of 0) and with a low activation temperature. The following equation gives a relationship between temperature rise and the smoke optical density necessary for alarm:

$$\frac{D_a}{\Delta T_a} = \frac{3330 \rho C_p m_{\text{eff}}}{Q_g} \quad (3)$$

where

D_a is the optical density necessary to trigger an alarm (dB/m)

ΔT_a is the temperature rise, above ambient, necessary to trigger an alarm (°C)

ρ is the density of air (kg/m³)

C_p is the specific heat of air (kJ/kg·K)

m_{eff} is the mass of smoke effluent produced per mass of fuel consumed (kg/kg)

Q_g is the heat output of the fire (kW)

7.2.4 Point-type heat detectors (including sprinkler head operation)

As with point-smoke detectors, point-type heat detectors are commonly found devices and are either specified where the response to heat is most appropriate for the monitored area or where smoke detection may lead to false alarms. They may utilize the following methods to detect fire:

- the signalling of a fire condition when a pre-determined temperature has been reached;
- the signalling of a fire condition when a pre-determined rate-of-rise of temperature has been reached.

Within the UK, rate-of-rise devices should also incorporate a fixed temperature element, in order to avoid slow fire growth being ignored by the device. The specification for point-type heat detectors is BS EN 54-5. This grades heat detectors on their application temperatures, and requires that the detectors lie within lower and upper response time limits as follows in Table 3 and Table 4:

Table 3 — Response time limits of heat detectors to BS EN 54-5

Rate-of-rise of air temperature K/min	Class A1 detectors				Class A2,B,C,D,E,F and G detectors			
	Lower limit of response time		Upper limit of response time		Lower limit of response time		Upper limit of response time	
	min	s	min	s	min	s	min	s
1	29	0	40	20	29	0	46	0
3	7	13	13	40	7	13	16	0
5	4	9	8	20	4	9	10	0
10	1	0	4	20	2	0	5	30
20		30	2	20	1	0	3	13
30		20	1	20		40	2	25

Table 4 — Heat detectors classification to BS EN 54-5

Detector class	A1	A2	B	C	D	E	F	G
Typical application temperature °C	25	25	40	55	70	85	100	115

BS EN 54-5 should be consulted for detailed information.

Research [6] has shown that point-type heat detectors can play a life-safety role in protecting areas outside the enclosure of origin (e.g. escape corridors). In this case, heat detectors located above the door opening within the enclosure of fire origin will detect and indicate a fire condition before smoke from that fire enters the outside area in quantities likely to impede escape.

Furthermore, heat detectors are sometimes preferred when the detection of smoke is not deemed strictly necessary (such as for premises or areas that do not include sleeping persons). The recognized benefits of additional tolerance over smoke detectors to many non-fire events, whilst being able to respond to the rate-of-rise of temperature associated with many types of fire (where incorporated within the detector), mean that the devices should be seriously considered as the main form of detection, in relevant cases.

The devices rely upon the movement of heat towards the sensing element. The heat would normally arrive at the device as convected or possibly radiated heat, although convected heat transfer should normally be assumed for assessment purposes. The modelling criteria for heat detector spacing and operation time, is more widely accepted than for smoke detectors, as the heat release rate of fires can, in many cases, be more accurately predicted than can smoke production and movement.

As with fixed temperature point heat detectors, sprinkler heads incorporating a heat-sensitive element can be modelled similarly, although there is a difference in that operation of the heat-sensitive element of the sprinkler head will directly lead to water discharge over the protected area without further actions required by a detection system.

When modelling a fire scenario, a fixed temperature heat sensor can be given a rating based on a response time measured under specified test conditions. This is defined as the Response Time Index (RTI) whose units are $\text{m}^{\frac{1}{2}} \text{s}^{\frac{1}{2}}$. This index is applicable to both point-type heat detectors and sprinkler heads although it tends to be much more widely applied to the latter within the UK. The RTI is calculated by exposing the device to a plunge test where it is instantaneously immersed into a flow of hot gas whose temperature and velocity are known.

Using the RTI value in the equation (4) [7], the time t at which the device is likely to operate can be estimated from the following differential equation:

$$\frac{dT_d}{dt} = \frac{\sqrt{u}(T_g - T_d)}{\text{RTI}} - \frac{C(T_g - T_u)}{\text{RTI}} \quad (4)$$

where

T_d is the temperature of the detector sensing element at time t (°C)

u is the instantaneous velocity of fire gases (m/s)

T_g is the temperature of the fire gases at time t (°C)

T_u is the temperature of the ambient area around the detector device (°C)

C is the conductivity factor ($\text{m/s}^{\frac{1}{2}}$)

RTI is the Response Time Index ($\text{m}^{\frac{1}{2}} \text{s}^{\frac{1}{2}}$)

Following on from this, equation number (7) of Sub-system 1 may also be applicable in some cases of controlled room environments as shown:

$$\theta = 6.85 \left(\frac{Q^2}{\left(A_w h_w^{\frac{1}{2}}\right) \left(A_t h_k^{\frac{1}{2}}\right)} \right)^{\frac{1}{3}} \quad [8] \quad (5)$$

where

θ is the temperature rise above ambient in the upper gas layer (°C)

Q is the rate of heat release (kW)

A_w is the area of the ventilation opening (m²)

h_w is the height of the ventilation opening (m)

A_t is the total surface area of the enclosure (m²)

h_k is the effective heat transfer coefficient (kW·m⁻²·K⁻¹)

Referring to equation (5), if a standard fixed temperature heat detector is used, the operating temperature can be entered as θ , enabling the value of Q at the time of detection to be calculated. Note that special conditions and limits apply to the use of equation (5) (see Sub-system 1).

It should be noted that the above formula is suitable for the determination of fixed temperature devices but not for those that also measure the rate-of-rise of temperature. In many cases, the response of the rate-of-rise element is likely to occur prior to the fixed temperature element. It could therefore be assumed that the above provide for worst-case pessimistic detection times.

7.2.5 Point-type multi-sensor/multi-criteria detectors

Point-type multi-sensor and multi-criteria detectors will contain more than one sensing element (e.g. smoke and heat). Such devices are relatively new and are often used as enhanced smoke detectors. No published standard is available at present. Further information is given in BS 5839-1.

7.2.6 Carbon monoxide point-type fire detectors

Carbon monoxide fire detectors are not widely specified at present although their use is increasing. There are no published standards to refer to at this stage although further information is given in BS 5839-1.

As carbon monoxide movement does not necessarily rely on convection currents from a fire (i.e. it may diffuse through the air), there may be some validity in siting devices in places other than on ceilings. However, until more research is conducted, siting should be as recommended by the manufacturer of the device.

For calculation purposes, it can be assumed that rate of CO production is proportional to the rate of burning materials as illustrated by the following equation:

$$m_{CO} = 0.013 m_f \quad [9] \quad (6)$$

where

m_{CO} is the mass rate of carbon monoxide production (kg/s)

m_f is the rate of burning of fuel by mass (kW/s)

Note that the above equation assumes that detection will occur during the growth phase of the fire, where the overall level of carbon monoxide production is increasing with time. As the rate of which CO is converted to CO₂ increases, the equation becomes less appropriate. Typically, devices may be programmed to a range of sensitivities thus affecting detection time, although some manufacturers have used a figure of 40 ppm as a standard threshold value.

7.2.7 Beam smoke detectors

Beam smoke detectors make use of the obscuration property of smoke to detect a fire. They may consist of a combined transmitter and receiver unit with reflective element, or a separate transmitter and receiver unit. They are normally mounted on walls at either side of a monitored area, such that there is a clear line of sight between one unit and the other. Typically, an infrared beam is transmitted along this length. In the event of smoke passing through the beam, the receiver measures the resultant attenuation. The value “C_L”, expressed in dB, is used to identify the reduction in intensity of the light beam, defined by the following equation: