BS 6266:2011

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Fire protection for electronic equipment installations – Code of practice

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Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 52, an inside back cover and a back cover.

Foreword

Publishing information

This British Standard is published by BSI and came into effect on 31 August 2011. It was prepared by Technical Committee FSH/14, *Fire precautions in buildings*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

This British Standard supersedes BS 6266:2002, which is withdrawn.

Relationship with other publications

This British Standard is complementary to BS 7974, which gives a structured method for determining the most appropriate fire protection strategy for a building as a whole.

Information about this document

This is a full revision of the standard, and introduces the following principal changes:

- reduction from five risk categories to four, of which three are addressed in this edition of the standard;
- reinstatement of detection performance tests;
- update of detection technologies, including the classification of aspirating systems;
- update of structural fire protection provisions, taking account of the publication of BS 9999:2008.

Product certification/inspection/testing. Users of this British Standard are advised to consider the desirability of third-party certification/inspection/testing of products and systems installed to achieve conformity with this British Standard. Appropriate conformity attestation arrangements are described in the relevant product standards. Users seeking assistance in identifying appropriate conformity assessment bodies or schemes may ask BSI to forward their enquiries to the relevant association.

Hazard warnings

WARNING. This British Standard calls for the use of substances and/or procedures that can be injurious to health if adequate precautions are not taken. It refers only to technical suitability and does not absolve the user from legal obligations relating to health and safety at any stage.

WARNING. The tests described in this standard give off noxious fumes, and suitable precautions should be taken to protect operators in accordance with appropriate risk assessments.

WARNING. There is a fire hazard associated with these tests and an appropriate type of fire extinguisher should always be to hand when preparing for and undertaking the tests.

WARNING. It is the responsibility of the person carrying out the tests that electrical safety is maintained at all times. The electrical tests described within this standard are functional methods and do not attempt to cover the requirements for electrical safety.

Use of this document

This British Standard is intended for use by persons involved in the specification, design, installation, commissioning and operation of fire protection systems for areas containing electronic equipment.

As a code of practice, this British Standard takes the form of guidance and recommendations. It should not be quoted as if it were a specification and particular care should be taken to ensure that claims of compliance are not misleading.

Any user claiming compliance with this British Standard is expected to be able to justify any course of action that deviates from its recommendations.

BSI permits the reproduction of BS 6266:2011, Table I.1. This reproduction is only permitted where it is necessary for the user to record calculations on the table during each application of the standard.

Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its recommendations are expressed in sentences in which the principal auxiliary verb is "should".

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Contractual and legal considerations

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

Compliance with a British Standard cannot confer immunity from legal obligations.

Introduction

A fire in an electronic equipment installation can lead to extensive physical damage to the electronic equipment and serious interruption of operations and services. The occurrence of a fire in an electronic installation, however, is a rare event, and is more often determined by the presence of sources of ignition or fire hazards other than the electronic equipment itself, such as:

a) supporting electrical equipment and installations, e.g. power supplies;

b) control equipment and switchgear;

c) air-handling equipment;

d) hot works/maintenance;

e) deliberate ignition;

f) poor housekeeping;

g) fire from adjacent areas or premises;

h) availability of combustible materials.

If a fire does occur, its effects can be minimized by appropriate structural fire protection measures, early detection and extinguishing of the fire, either of which might occur automatically (by fixed systems) or manually (by persons on the premises). This British Standard gives guidance on these measures, taking into consideration the characteristics of those environments in which electronic equipment installations are located. The extensive use of fire protection systems in electronic installations arises not from a high probability of fire, nor from a significant hazard to life, but from the consequences of fire loss.

In practice, a wide variation of dependence on electronic equipment is found. At one extreme, a processing operation might be duplicated at a second location, so that there is redundancy. In this case, a fire at either location would not be expected to cause significant interruption to the operation. The fire protection strategy for electronic equipment fires could then be related entirely to the physical damage to the equipment and its surroundings and the associated financial cost.

At the other extreme, a “real-time” facility might be critical to the revenue-earning capacity of an organization, e.g. it might control a major manufacturing process or provide financial dealing information. In such circumstances, even a few minutes’ downtime can result in significant interruption to users. It might be impractical to provide facilities for the restoration of the service at another location in a short time, in which case a sophisticated fire protection system will be necessary.

It is often necessary to consider the potential for business interruption separately from the potential for material damage. It is essential that the level of protection is reviewed periodically to ensure that it remains appropriate to the exposure to loss.

1 Scope

This British Standard gives recommendations for the protection against fire of electronic equipment installations, including the equipment (e.g. computers, servers and systems for communications, design, manufacturing and distribution), and the areas containing such equipment (e.g. computer rooms, internet hosting centres, switching centres and data centres).

It also gives recommendations for the protection against fire in adjacent areas.

This British Standard covers electronic equipment installations categorized as medium, high and critical risk.

Low risk environments are not addressed in this standard. The standard may however be used as guidance for the protection of such environments.

The standard is applicable to new installations; the recommendations may however be used with an existing installation, and when alterations are made to existing areas containing electronic equipment.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Standards publications

BS 476-11, *Fire tests on building materials and structures – Part 11: Method for assessing the heat emission from building materials*

BS 476-20, *Fire tests on building materials and structures – Part 20: Method for determination of the fire resistance of elements of construction (general principles)*

BS 476-21, *Fire tests on building materials and structures – Part 21: Method for determination of the fire resistance of loadbearing elements of construction*

BS 476-22, *Fire tests on building materials and structures – Part 22: Method for determination of the fire resistance of non-loadbearing elements of construction*

BS 5287, *Specification for assessment and labelling of textile floor coverings tested to BS 4790*

BS 5306-2, *Fire extinguishing installations and equipment on premises – Part 2: Specification for sprinkler systems*

BS 5306-4, *Fire extinguishing installations and equipment on premises – Part 4: Specification for carbon dioxide systems*

BS 5306-8, *Fire extinguishing installations and equipment on premises – Part 8: Selection and installation of portable fire extinguishers – Code of practice*

BS 5839 (all parts), *Fire detection and alarm systems for buildings*

BS 5867-2:1980, *Fabrics for curtains, drapes and window blinds – Part 2: Flammabililty requirements – Specification*

BS 5979, *Remote centres receiving signals from fire and security systems – Code of practice*

BS 7176:2007, *Specification for resistance to ignition of upholstered furniture for non-domestic seating by testing composites*

BS 7273-1, *Code of practice for the operation of fire protection measures – Part 1: Electrical actuation of gaseous total flooding extinguishing systems*

BS 7273-2, *Code of practice for the operation of fire protection measures – Part 2: Mechanical actuation of gaseous total flooding and local application extinguishing systems*

BS 7273-3, *Code of practice for the operation of fire protection measures – Part 3: Electrical actuation of pre-action watermist and sprinkler systems*

BS 7273-5, *Code of practice for the operation of fire protection measures – Part 5: Electrical actuation of watermist systems (except pre-action systems)*

BS 7671, *Requirements for electrical installations – IEE Wiring Regulations – Seventeenth edition*

BS 8519, *Selection and installation of fire-resistant power and control cable systems for life safety and fire-fighting applications – Code of practice*

BS 9999:2008, *Code of practice for fire safety in the design, management and use of buildings*

BS EN 3 (all parts), *Portable fire extinguishers* [1)]

BS EN 54 (all parts), *Fire detection and fire alarm systems*

BS EN 140, *Respiratory protective devices – Half masks and quarter masks – Requirements, testing, marking*

BS EN 166, *Personal eye protection – Specifications*

BS EN 1047 (all parts), *Secure storage units – Classification and methods of test for resistance to fire*

BS EN 1363 (both parts), *Fire resistance tests*

BS EN 1364 (all parts), *Fire resistance tests for non-loadbearing elements*

BS EN 1365 (all parts), *Fire resistance tests for loadbearing elements*

BS EN 1634 (all parts), *Fire resistance and smoke control tests for door, shutter and, openable window assemblies and elements of building hardware*

BS EN 12845, *Fixed firefighting systems – Automatic sprinkler systems – Design, installation and maintenance*

BS EN 13501-1:2007+A1:2009, *Fire classification of construction products and building elements – Part 1: Classification using test data from reaction to fire tests*

BS EN 13823, *Reaction to fire tests for building products – Building products excluding floorings exposed to the thermal attack by a single burning item*

BS EN 15004 (all parts), *Fixed firefighting systems – Gas extinguishing systems*

BS EN 62305 (all parts), *Protection against lightning*

BS EN ISO 1182, *Reaction to fire tests for products – Non-combustibility test*

BS EN ISO 1716, *Reaction to fire tests for products – Determination of the gross heat of combustion (calorific value)*

DD 8489-1, *Fixed fire protection systems – Industrial and commercial watermist systems – Part 1: Code of practice for design and installation*

DD 8489-7, *Fixed fire protection systems – Industrial and commercial watermist systems – Part 7: Tests and requirements for watermist systems for the protection of low hazard occupancies*

[1)] This standard also gives an informative reference to BS EN 3-7:2004+A1:2007.

Other publications

[N1]FIRE INDUSTRY ASSOCIATION. *Code of practice for design, installation, commissioning and maintenance of aspirating smoke detector (ASD) systems*. Hampton, Surrey: Fire Industry Association, 2006.[2)]

3 Terms and definitions

For the purposes of this British Standard, the following terms and definitions apply.

3.1 aspirating smoke detector (ASD)
automatic fire detector which uses a fan or pump to draw samples from the atmosphere in a protected space into a smoke detector that can be remote from that protected space

3.2 coincidence detection
facility designed so that an output is obtained only when at least two independent inputs are present at the same time

NOTE 1 For example, an output suitable for triggering a fire suppression system is obtained only after a detector has detected a fire, and at least one other independent detector covering the same protected space has confirmed the existence of the fire.

NOTE 2 Also referred to as "coincidence connection".

3.3 competent person
person, suitably trained and qualified by knowledge and practical experience, and provided with the necessary instructions, to enable the required task(s) to be carried out correctly

3.4 electronic equipment area
room, or rooms, containing machinery and electronic equipment that requires protection from fire

3.5 fire load
quantity of heat that would be released by the complete combustion of all the combustible materials in a volume of a room or area, including the facings of all bounding surfaces

3.6 fire resistance
ability of an item to fulfil for a stated period of time the required stability and/or integrity and/or insulation from the heat of a fire and/or other expected duty specified in a standard fire resistance test

NOTE BS 476, BS EN 1364, BS EN 1365 and BS EN 1366 give guidance on fire resistance.

3.7 fire risk
product of the following parameters:

- probability of the occurrence of a fire, to be expected in a given technical operation or state; and
- consequence or extent of damage to be expected following the occurrence of the fire

[2)] This document is undergoing revision at the time of publication of BS 6266:2011.

3.8 fire-stopping
sealing or closing an imperfection of fit between elements, components or construction of a building, or any joint, so as to restrict penetration of smoke and flame through the imperfection or joint

3.9 hypoxic fire prevention system
system that maintains air with a reduced oxygen content in the enclosed volume to inhibit a fire from starting

3.10 limited combustibility
material performance specification that includes non-combustible materials and for which the relevant test criteria are:

a) (national classes) by reference to the method specified in BS 476-11; or

b) (European classes) in terms of performance when classified as class A2-s3, d2 in accordance with BS EN 13501-1:2007+A1:2009, when tested to BS EN ISO 1182 or BS EN ISO 1716 and BS EN 13823

3.11 non-combustible
not capable of undergoing combustion under specified conditions
[BS EN ISO 13943]

3.12 pre-alarm
indication that conditions are approaching a full fire signal

NOTE This is distinct from an early warning signal, which indicates that conditions have deviated from what are considered as normal.

3.13 protected space
area or volume protected by a fire detection and/or suppression system

3.14 staged alarm
alarm system in which two or more stages of alarm are given within a specific area

3.15 stakeholder
party with a direct or indirect interest in the life cycle of an electronic equipment area

NOTE The interest might be:

- *financial, e.g. owner or insurance company;*
- *as a customer (internal or external);*
- *as an authority having jurisdiction, e.g. building control officer, fire authority;*
- *in a professional capacity as an adviser to one of the parties, e.g. architect, fire engineer, building service engineer; or*
- *in a contractual capacity, e.g. a manufacturer, installer or maintainer of equipment.*

3.16 total flooding
discharge of an extinguishing agent into an enclosed volume in order to achieve a uniform concentration of the agent within that volume sufficient to extinguish a fire

4 Risk assessment

4.1 General

Prior to establishing the specification for the electronic equipment installation, the building and environment in which the equipment will be sited, and the design of fire protection systems, an appropriate risk assessment should be undertaken.

Risk assessment should be an ongoing process as changes and modifications are made to the equipment, its environment, its use, recovery plans etc.

The risk assessment should be carried out by competent persons.

NOTE This is not the same as the risk assessment for the building associated with fire safety legislation in the UK.

4.2 Risk assessment categories

4.2.1 General

The criticality of most electronic equipment areas can be categorized subjectively, based on the following factors:

- equipment redundancy and replacement availability;
- business continuity plans;
- tolerance to system downtime;
- environmental operational requirements specific to an individual system.

The categories are:

- low;

  NOTE Examples include CAD offices, call centres, small PABX rooms, etc. Low risk categories are not covered in this standard).
- medium;
- high;
- critical.

The medium, high and critical categories of risk are typified by having dedicated equipment rooms and centralized server/computer facilities.

These categories of risk should be used to determine the type and level of fire prevention and protection deemed appropriate. In order to choose a category, the criteria given in **4.2.2**, **4.2.3**, and **4.2.4** should be used.

4.2.2 Medium category risk

Typical features are as follows:

a) equipment is standard but not immediately replaceable;

b) operations are transferable to another location;

c) there is a need for files to be backed up periodically on a remote server;

d) interruption to business operations can be tolerated in the medium term.

An example of medium risk electronic equipment installations is call centre communication facilities, where alternative call centre operations exist.

4.2.3 High category risk

Typical features are as follows:

a) equipment is non-standard and is not replaceable in the short term;

b) operations are not easily transferable without robust contingency plans;

c) there is a need for files to be backed up frequently on a remote server;

d) interruption to business operations can be tolerated in the short term.

Examples of high risk electronic equipment installations are: main IT facility; major telecommunication facility; production control computers.

4.2.4 Critical category risk

Typical features are as follows:

a) equipment is high value or purpose-built and is not easily replaceable;

b) operations are not easily transferable;

c) there is a need for data to be backed up on a continual basis on a remote server;

d) interruption to business operations is likely to have serious consequences.

Examples of critical risk electronic equipment installations are: financial dealing computer operations; internet hosting centres; air traffic control facilities; nuclear and chemical plant control facilities.

5 Fire detection and fire protection strategy

The application of fire detection and fire suppression systems should be based on the risk category as identified in Clause **4**. Similarly, the fire protection strategy should be formulated taking into account fire safety management strategies (see Clause **11**) and recovery plans (see Clause **12**).

Typically, the higher the risk category, the greater the sophistication of the fire detection and suppression systems. The level of detection and suppression can vary from simple fire alarm systems and the availability of portable fire extinguishers, to an extensive fire detection system and automatic fire suppression.

The final choice should take into account the following factors, and should be fully documented:

a) the findings of the risk assessment (see Clause **4**);

b) the type and layout of the building in which the electronic equipment installations are located;

c) the effects of the environment and processes on the efficacy of detection and suppression systems in and around the electronic equipment installations;

d) fire and rescue service attendance time;

e) practical and commercial restrictions on detection and suppression system choice;

f) the type and number of persons in the area;

g) the availability of persons who would be able to provide the necessary manual actions, where manual intervention is part of the strategy.

NOTE Typical features of fire detection and suppression systems that might be found for each of the risk categories are given in Table 1.

Table 1 **Typical features of fire detection and suppression systems for each risk category**

Risk category	Fire detection system	Fire suppression/inhibition system
Medium	A smoke detection system as part of the main building system (see **8.3.2.3** and Annex A)	Automatic fixed fire suppression/inhibition (see **9.1**) where early fire-fighting action is unlikely Portable fire extinguishers as first aid fire-fighting (see **9.2**)
High	A smoke detection system interfaced with the main building system (see **8.3.2.2** and Annex A) High sensitivity smoke detection (e.g. Class A aspirating smoke detection) to monitor air flows returning to the air-conditioning	Automatic fixed fire suppression/inhibition (see **9.1**) unless there is a robust recovery plan (see Clause **12**) Portable fire extinguishers as first aid fire-fighting (see **9.2**)
Critical	A smoke detection system interfaced with the main building system (see **8.3.2.2** and Annex A) High sensitivity smoke detection (e.g. Class A aspirating smoke detection) to monitor air flows returning to the air-conditioning	Automatic fixed fire suppression/inhibition (see **9.1**) Portable fire extinguishers as first aid fire-fighting (see **9.2**)

6 Separation and construction of electronic equipment areas

6.1 Separation and location of electronic equipment areas

Electronic equipment should be separated from other operations, such as offices, storage, unrelated processes and ancillary accommodation (see **6.5**). Separation should be achieved by enclosing the electronic equipment area using fire-resisting construction that has a fire resistance appropriate to the risk and the fire load in the adjacent area.

When tested in accordance with BS 476-20, BS 476-21 BS 476-22, or the relevant parts of BS EN 1363, BS EN 1364, BS EN 1365 or BS EN 1634, as appropriate:

a) the construction for medium risk installations should have a fire resistance of not less than 30 min;

b) the construction for high and critical risk installations (without automatic fire extinguishing or suppression systems) should have a fire resistance of not less than:

   1) 60 min when the remainder of the building has a low fire load, e.g. offices or factories involved in processes involving wet or non-combustible materials;

   2) 120 min when the remainder of the building has a medium fire load, e.g. metalworking premises where there is a limited quantity of combustible materials;

   3) 240 min when the remainder of the building has a high fire load, e.g. warehouses containing a large quantity of combustible materials.

Where automatic sprinklers or other automatic fire extinguishing or suppression systems giving an equivalent level of protection are installed in the adjacent area, the fire resistance of the enclosure may be reduced by 30 min, subject to a minimum of 30 min.

Electronic equipment should not be sited where fire-fighting could be impeded or where there is a risk of flooding from fire-fighting operations.

6.2 Construction of the electronic equipment area

The number of openings in any construction enclosing an electronic equipment area should be kept to a minimum. Any openings should be fitted with fire- and smoke-resisting doors, shutters or hatches with the same fire resistance as the wall in which they are fitted.

Fire-resisting walls and partitions separating the electronic equipment area should fill the space between a structural floor and the underside of the structural floor or roof above.

Any glazing in a separating and enclosing wall, or in a dividing partition, should normally be fire-resistant in terms of both integrity and insulation. Where radiation through the glazing in the event of an external fire is unlikely to be a hazard, e.g. where there is no electronic equipment or other combustibles in close proximity to the glazing, integrity-only glazing may be used.

NOTE Some types of integrity fire-resistant glass allow heat transmission at a sufficient level to cause smoking and smouldering of materials and fittings on the non-fire side (without ignition). The risks of smoke contamination and damage to the equipment might therefore need to be taken into account in the risk assessment. Where this risk is considered unacceptable then it might be necessary to use an integrity rating for the specified time together with a supplementary insulation classification at 15 min (e.g. 30 min integrity, 15 min insulation).

Ventilation ductwork or service ducts serving other parts of the building should normally not pass through an electronic equipment area. Where it is not practicable to avoid this, the ductwork should be enclosed within a fire-resisting construction in accordance with BS 9999:2008.

Linings to walls, partitions, soffits, ceilings and voids should be made of materials which are of limited combustibility.

6.3 Raised floors within an electronic equipment area

Where raised floors within an electronic equipment area are constructed of combustible materials, the floor should be faced on the underside with non-combustible material.

Where modular raised floors are installed, appropriate lifters should be provided that are easy to locate and readily accessible.

6.4 Suspended ceilings within an electronic equipment area

Suspended ceilings within an electronic equipment area should be made of materials that are of limited combustibility. Such materials should not give rise to the production of decomposition particles, nor of corrosive or toxic fumes, in the event of a fire.

If a filling is inserted above ceiling tiles (e.g. for acoustic or air balancing reasons), it should either be non-combustible (e.g. mineral fibre or glass fibre), or, if combustible, be sealed in non-combustible bags.

Where a suspended ceiling is designed to provide a specified fire resistance, the ceiling should be installed in accordance with the manufacturer’s instructions.

6.5 Walls and partitions within an electronic equipment area

Due to the high property value and potential for interruption to operations, it is recommended that additional subdivision of electronic equipment areas is provided. Suitably designed lightweight partitions can limit the spread of smoke during the early stages of a fire, thus reducing the extent of damage in terms of both the area affected and the severity of damage to equipment. Such partitions should be installed from floor to soffit and all penetrations sealed in order to form effective smoke barriers.

The detection system should be designed to take into account any partitioning. If an area is protected by a gaseous extinguishing system, the walls or partitions surrounding the area should fill the space between a structural floor and the underside of the structural floor or roof above in order to maintain room integrity, and suitable provision for pressure relief should be provided.

Ancillary accommodation within an electronic equipment area or processes with a higher fire risk, e.g. IT personnel offices, printer rooms, and data-storage and other media storage, should be separated from the rest of the electronic equipment area by a suitably rated fire-resisting partition that is sealed against smoke penetration. This separation should comprise the following measures:

a) 30 min fire- and smoke-resisting construction for small offices with limited fire load and areas having similar fire risk, e.g. the partitions between the main server room and the communications room, or between processing and data-storage equipment;

b) 60 min fire- and smoke-resisting construction for data preparation areas, data-storage media rooms, service rooms and working stationery stores, which typically contain a higher than normal level of ordinary combustible materials.

Joints between fire-resisting walls, floor and ceilings should be stopped with suitable fire-resisting materials.

6.6 Cable and service penetrations

All penetrations created for the passage of cables, ducts and pipework should be fire-stopped in accordance with BS 9999:2008, **33.5**. Service ducts, pipes and shafts should conform to BS 9999:2008, **33.4**.

NOTE 1 Where there are multiple penetrations (e.g. for aspirating smoke detection systems), it is good practice to use intumescent seals in addition to the provisions recommended in BS 9999:2008.

In designing provision for cable and service penetrations, facilities should be provided to satisfy any reasonably foreseeable future need to install additional cables.

NOTE 2 Proprietary fire-stopping systems are available that facilitate ready modification to accommodate new cables.

6.7 Storage

6.7.1 Storage of combustible materials

Storage facilities for combustible materials not required for immediate use, and for waste material, should be provided outside the electronic equipment area. Metal or non-combustible bins with self-closing lids for paper waste, etc. should be provided within the electronic equipment area itself.

*NOTE See also **11.2.2**.*

6.7.2 Storage of recorded data

The quantity of data-storage media held within the electronic equipment area should be kept to the minimum required for efficient operations. This is intended to minimize exposure of the electronic equipment to fire in the storage media and to protect data in the event of a fire elsewhere in the room.

Where there is a need to protect data from exposure to fire, then it should be stored in a fire-rated container, cabinet or data room conforming to BS EN 1047.

To protect the electronic equipment itself against fire originating in data stores, the following precautions should be taken.

a) Stored data media should be located in an area separated from the main electronic equipment area by fire- and smoke-resisting construction of either 30 min or 60 min as appropriate (see **6.5**).

b) Where the fire load of the stored data is high, i.e. requiring 60 min fire- and smoke-resisting construction (see **6.5**), additional provisions should be made as necessary to protect the data and/or the building and adjacent areas, e.g. early warning smoke detection systems and/or a fire suppression system.

c) Automatic storage and retrieval carousels used for storage of media should be provided with smoke detection within the carousel. A fixed fire suppression system should also be installed if protection of the data, the building or adjacent areas is required.

6.8 Furniture and furnishings

Combustible fittings and furniture should be kept to a minimum.

Upholstered furniture should meet the requirements for the medium hazard resistance classification specified in BS 7176:2007, Table 1.

Fabrics and fabric assemblies used for curtains, drapes and window blinds should be made of materials which are classified as type C in accordance with BS 5867-2:1980.

Textile floor coverings should be made of materials which have a low radius of effects of ignition in accordance with BS 5287.

7 Building engineering services for electronic equipment areas

7.1 Air-conditioning

7.1.1 Design

Air-conditioning systems should meet the following recommendations.

a) A separate air-handling plant should be provided for the electronic equipment area.

b) Positive air pressure should be provided within the electronic equipment area relative to adjacent areas.

c) Wherever possible, an intake for the air-handling system for the electronic equipment area should be situated in an area where it is unlikely to draw in smoke or other contaminants from fires and/or damaging fumes from nearby processes. Where this is not possible, smoke detection should be installed in the make-up air-handling unit and used: either to shut down the air intake or to act as a reference detector for the smoke detection system (see **8.3.1.5**).

d) Surfaces of air filters, air attenuators and similar components of ventilation systems exposed to the airflow should be inherently non-flammable, or so treated as to make them non-flammable for the duration of their recommended working life. Viscous fluids in air filters should have a flash point of not less than 177 °C.

e) Combustible material should not be used for ductwork.

f) Where flexible connections are used in the air-handling ductwork, they should conform to BS 9999:2008, **33.4.14**.

g) The inter-relationship between the air-conditioning and fire detection systems is critical, and in consequence the system should provide appropriate interfaces for interaction with the fire detection system (see **8.2.4**).

h) The shutdown procedure for the system should be designed to take into account the susceptibility of the equipment to changes in temperature and/or atmosphere.

NOTE The following three situations are the most common.

- *Where the tolerance of the electronic equipment is such that it is possible to power down ventilation for some considerable time without significant ill-effects, it is appropriate to do so on the first operation of a detection system.*
- *Where ventilation is essential for the correct functioning of the electronic equipment, as is likely to be the case with high and critical category electronic equipment installations, shutting down ventilation at an early stage following operation of fire detection in the electronic equipment area is likely to be undesirable. In these cases, it is appropriate for ventilation shutdown to be initiated only following confirmation of the fire, e.g. by a second stage Class B alarm from the air return or by coincidence detection.*
- *If it is important to maintain a supply of cool air throughout an incident, it is appropriate for ventilation to be continued. If it is necessary to continue ventilation during a fire, the system may be configured so that following activation of the suppression system, recirculation is maintained but fresh air make-up is shut down. This will serve to improve the hold time of rooms protected by gaseous extinguishing systems and to take advantage of the benefits of mechanical mixing of gas and air within the room.*

i) Where hypoxic fire prevention systems are used, air-conditioning should be designed such that the inward leakage of air (fresh air intake) does not affect the operation of the hypoxic fire prevention system.

j) Provision should be made for the detection of products of combustion emanating from within the air-conditioning plant, to prevent the spread of smoke into the electronic equipment area.

Self-contained air-conditioning units eliminate the need for ductwork and dampers at the electronic equipment area boundary, but can present an additional fire hazard within the electronic equipment area. They should be designed and installed to minimize the risk of fire and smoke and should have the features described in a) to j) above.

7.1.2 Fire dampers

Fire-resisting dampers should be selected and installed in accordance with BS 9999:2008, **33.4.5**.

Dampers should be positioned to allow for maintenance and easy resetting after operation. Controls should be clearly labelled and accessible.

Dampers held in the open position should fail safe, i.e. in the event of a fault the dampers should close.

7.1.3 Air-conditioning plant rooms

Plant rooms should be fitted with automatic fire detection and be enclosed by 60 min fire-resisting construction.

7.1.4 Insulation of ductwork

Thermal or acoustic insulation for ductwork, whether located internally or externally, should be in accordance with BS 9999:2008, **33.4.13** and should not give rise to the production of decomposition particles, nor of corrosive or toxic fumes, in the event of a fire.

7.2 Electrical installation

The electrical installation should be in accordance with BS 7671.

Wherever practicable, facilities should be provided for a phased shutdown and emergency power-down of equipment by authorized personnel.

Where continuity of service from the electronic equipment is required for life safety reasons or to prevent unacceptable interruption to operations (i.e. high and critical category installations), power cables should conform to the appropriate category selected from BS 8519.

Data cables that need to continue to function after a fire is detected should be protected against the effects of fire wherever they run within the building. This should be achieved either by using cables with inherent fire resistance, or by enclosing the cables in a fire-resisting construction, e.g. a fire-resisting duct.

7.3 Lightning protection

A risk assessment should be carried out in accordance with BS EN 62305-2. If found to be necessary, lightning protection should then be provided in accordance with the relevant part(s) of BS EN 62305.

8 Fire detection and alarm systems

8.1 General

The vulnerability of electronic equipment areas to fire damage necessitates very early and effective action to detect and suppress a fire. An automatic fire detection system should be installed in all electronic equipment areas.

Areas adjoining the risk should generally be protected by automatic fire detection in accordance with BS 5839-1. For critical category installations, protection of adjacent areas with a fixed fire suppression system might also be appropriate (see **9.1**).

The design of the fire detection system is closely linked to the fire protection and recovery strategies (see Clause **5** and Clause **12**), and a structured response to any alarm or warning signal is essential.

*NOTE See also **11.3**.*

Each electronic equipment area should be considered individually, and the detailed design and testing of the fire detection system should be carried out by competent persons.

8.2 Design of fire detection and alarm systems

8.2.1 General

Fire detection systems for electronic equipment areas should be designed in accordance with this clause and BS 5839-1. The choice of suitable fire detectors (**8.3**), their sensitivity (**8.4**) and their positioning within the electronic equipment area (**8.5**), bearing in mind the airflows within the area, are the most important factors influencing the prompt detection of fire and the avoidance of false alarms.

It is important to ensure there is coordination between all parties involved in the design of the electronic equipment area, so that relevant information relating to anticipated airflows is provided to the designer of the fire detection system.

The following factors should be taken into consideration when designing fire detection and alarm systems.

a) Computer cabinets within electronic equipment areas are continually increasing their power handing capability, which means that the air-conditioning systems serving the spaces require increased airflow and velocities.

b) Positioning of the point detectors and/or sampling points is critical due to the very high airflows through the room. While an even distribution of devices is often assumed to be preferred, in many cases strategic positioning is advantageous (see **8.2.5** and Annex A).

c) The high velocity of airflow through plenum voids necessitates detectors to be placed in the most advantageous position to detect any smoke.

   NOTE The recommendations given in BS 5839-1:2002+A2:2008, ***22.3****f) might not apply in these instances.*

d) Hot or cold aisle containment, whereby physical partitioning is introduced between the cabinet air entry (cold aisle) and the air exit (hot aisle), creates a further enclosure within the space, effectively an extension of the floor (or ceiling) plenum, which needs appropriate detection.

e) The detection strategy in relation to the air flows and cooling requirements in the area needs to be clearly defined: in particular, whether the air-conditioning is to remain operational after the first alarm signal, or whether it is be shut down to facilitate confirmation of the alarm by a detection system at the ceiling and/or to prepare the area for activation of automatic suppression.

f) The operational procedures, the expected number of personnel in the area, and the time required for competent action to commence will determine the strategy for alarm and warning signals.

8.2.2 Alarms

The automatic fire alarm system should operate alarms within the electronic equipment area and in other areas where action is to be taken. Where a staged alarm is adopted, it is important that appropriate audible and/or visual warnings are provided to indicate inside a protected space the stage that the alarm has reached.

Warning should be given in the electronic equipment area, and other areas deemed appropriate, of fire from outside the electronic equipment area, by, for example, the use of the building fire alarm system and the provision of detectors in adjacent areas.

If alarms are monitored at a continuously manned location, summoning of the fire service by personnel is sufficient. If not, a reliable method of automatically transmitting alarms to the fire service should be used, e.g. via an alarm receiving centre.

8.2.3 Indicators

Information regarding the location of a fire should be provided in an appropriate position for those responding to a fire signal. In the case of concealed point detectors, e.g. in voids with no air flows, there should be an accurate means of identifying the location of the detector that has operated. This can be achieved, for example, by the use of remote indicators, an illuminated mimic at the entrance to the area, or the use of an addressable system in conjunction with a plan of detector locations. It should also be understood that, where there are high airflow within these areas, the location of the device activation is unlikely to be adjacent to the location of the incident (see Annex A for further information).

8.2.4 Interaction with other systems

Detection systems can be used additionally for the following purposes:

a) to isolate the power supply or initiate programmed shutdown of the electronic equipment (early action can prevent fire from starting);

b) to shut down recirculating air-conditioning (if appropriate);

c) to shut down any fresh air input into the space.

d) to initiate the release of fire suppression media;

e) in hypoxic fire prevention systems, to warn of decomposing material through heat (pyrolysis) even though a fire cannot start.

Where any of these actions could result in disruption of operations or other serious inconvenience, careful consideration should be given to steps that are necessary to reduce the possibility of false operation. Systems should include the use of coincidence detection and the initiation of different actions at different stages of alarm. For example, a high sensitivity fire detection system with different output levels depending on the level of smoke detected could be configured so that:

1) early indication of an incipient fire initiates a staff alarm, requiring that the cause of the alarm be investigated;

2) when a higher level of alarm (full fire) is reached, equipment may (if appropriate) be powered down, fresh air input ventilation is shut down and an evacuation signal sounded;

3) when the higher level signal is confirmed by coincidence detection using a second detection system utilizing normal sensitivity detectors, an automatic fire suppression system is released.

The designer of the fire detection system should discuss the response required in the electronic equipment area with all stakeholders to ensure that the detection system design is appropriate.

The release of fire suppressants such as extinguishing gas should be dependent on fire detection in the form of coincidence detection in accordance with BS 7273-1.

NOTE In environments where the air-conditioning cannot be disabled on the first alarm, the operation of normal sensitivity point detectors can still be impaired by high dilution, resulting in unacceptable delays in the triggering of a suppression system. In such cases, the second input to a coincident detection system may be *provided by a ceiling-mounted ASD system configured with a sensitivity less than normal (e.g. 2 × Class C threshold) to compensate for the cumulative effect of smoke entering multiple sampling holes.*

Where fire-resisting shutters or fire doors are normally controlled by an electromagnetic release mechanism, these should be released on the raising of an alarm within the electronic equipment area and/or an adjacent area. A smoke detector should be sited on the ceiling on each side of the wall opening to trigger the release mechanism.

8.2.5 Positioning of detectors

Fires can originate in the electronic equipment, in associated equipment such as the air-handling plant, within the room or voids, or in another part of the building. Detectors should be positioned to take into account all these possibilities.

Early warning of a fire condition is most often achieved by positioning high sensitivity (Class A) detection at the air return vents to the air-conditioning system and using normal sensitivity point-type or ASD sampling holes at the ceiling. The ceiling-mounted system provides detection when the air-conditioning is off and, where appropriate, provides confirmation that significant smoke concentrations are present in such quantities that automatic extinguishing systems should be activated. The ceiling-mounted system can also provide an early warning signal in addition to a normal sensitivity alarm signal.

Positioning of detectors and/or sampling points should be undertaken only with full knowledge of the air flows in the protected area.

Where fixed fire suppression is provided for the protection of individual cabinets (see **9.1.1**), cabinet detection should be provided.

See Annex A for further advice on the positioning of detectors.

Early warning can be achieved by siting detectors or sampling points to protect individual equipment cabinets in addition to the general room area. Cabinet detection is essential if automatic cabinet fire suppression (see **9.1.1**) is to be used.

8.3 Type and selection of detectors

8.3.1 Types of detector

8.3.1.1 Point-type fire detectors

NOTE Point-type fire detectors can incorporate one or more different sensing technologies responding to different fire combustion products, e.g. smoke, heat or specific gases.

8.3.1.1.1 Smoke detectors

Smoke detection is often the most appropriate form of detection for electronic equipment areas as this ensures the earliest time to detection. Where point-type smoke detectors are used, they should conform to BS EN 54-7:2001.

NOTE Optical smoke detectors are sensitive to optically dense smoke, but are less sensitive to the small particles found in clean burning fires that produce little visible smoke. Ionization chamber smoke detectors are particularly sensitive to smoke containing small particles, such as are produced in rapidly burning flaming fires, but might be less sensitive to the larger particles found in smouldering fires, including those involving overheated PVC. Both optical and ionization chamber smoke detectors conforming to BS EN 54-7:2001 have a sufficiently broad response to the early stages of fire to be suitable for use in electronic equipment areas. The risk assessment, however, might find that one type is more suitable, in respect of either sensitivity to the type of fire that is anticipated, or resistance to false alarms.

8.3.1.1.2 Heat detectors

Point-type heat detectors should not be used as the principal detection system within electrical equipment areas, because their response is considerably slower than that of smoke detectors.

8.3.1.1.3 Multi-sensor fire detectors

Where a multi-sensor detector is used, it should conform to the appropriate part of BS EN 54 (see BS 5839-1:2002+A2:2008, **11.1**).

NOTE 1 In a fire detection system incorporating multi-sensor detectors, each multi-sensor fire detector contains more than one sensor, each of which responds to a different physical and/or chemical characteristic of fire. The purpose of combining sensors in this way is to enhance the performance of the system in detection of fire, or its resistance to at least certain categories of false alarm, or both. Further guidance can be found in the FIA guidance note on point type multi-sensor fire detectors [1].

NOTE 2 Additional parts of BS EN 54, relating to specific types of multi-sensor detectors, are in preparation.

To ensure early detection, at least one sensor should always be suitable for detecting pyrolysis and electrical fires.

NOTE 3 Examples include the use of multi-sensors relying on carbon monoxide in combination with heat (CO/heat), which are unsuitable because neither sensor is suitable for early detection of electrical fires; and the effect of air movement upon the heat-sensing properties of combined optical smoke/heat detectors, reducing the performance to below that of a standard optical smoke detector.

8.3.1.2 Combustion gas detectors

Combustion gas detectors respond to one (or more) of the gases produced by a fire. Combustion gas detectors used to protect electronic equipment areas should be specifically designed to provide early detection of electrical fires and overheating cables.

Detectors that rely on carbon monoxide to detect fires should not be used in electronic equipment areas.

NOTE 1 This is because carbon monoxide is not produced in detectable quantities where pyrolysis of material, rather than self-sustained combustion, occurs (i.e. overheating of circuits and plastics).

NOTE 2 Gas detectors can be used to detect gases other than combustion gases, independent of the fire alarm system.

8.3.1.3 Optical beam-type smoke detectors

Optical beam-type smoke detectors are typically associated with detecting smouldering fires at a normal level of sensitivity. They are often applied in high and inaccessible areas. Where they are used, they should conform to BS EN 54-12.

8.3.1.4 Line-type heat detectors

Line-type heat detectors can give early warning of a problem when used as an over-temperature detector and installed in close proximity to selected risks, e.g. cable ways, fan motors and power supply equipment. Where they are used, they should conform to the appropriate part of BS EN 54.

8.3.1.5 Aspirating-type smoke detectors

Aspirating smoke detectors are particularly suitable for use in electronic equipment areas. When used they should conform to BS EN 54-20:2006 and be used in accordance with the FIA *Code of practice for design, installation, commissioning and maintenance of aspirating smoke detector (ASD) systems* [N1].

NOTE 1 BS EN 54-20:2006 defines three sensitivity classes. On Class C, normal sensitivity systems, each individual sampling orifice is capable of detecting the test fires used to test point-type smoke detectors. Thus they may be used as an alternative to point-type detectors. Class B, enhanced sensitivity systems, are used where increased sensitivity is needed to overcome some dilution effects such as high ceilings or moving air flows. Class A, high sensitivity systems, are used for areas with high smoke dilution or where the earliest warning is required for the protection of business-critical or high-value processes or objects.

In cases where a high sensitivity aspirating smoke detector is used and there is potential for the fresh air system to introduce pollution into the space, the risk of false alarms should be mitigated by using a reference aspirating smoke detector in the fresh air system. This is in order to adjust the sensitivity of the detectors within the room(s) when pollution is present.

NOTE 2 Aspirating-type smoke detectors can incorporate sensors that detect phenomena other than smoke, which can be effective in mitigating particular risks (e.g. hydrogen build-up in battery charging rooms) or might provide input to an environmental control system (e.g. hypoxic systems).

8.3.1.6 Flame detectors

The earliest stages of a fire in electronic equipment are unlikely to involve flame, so detectors responding to radiation from flames should not be used in electronic equipment areas.

NOTE Flame detectors incorporated with other sensing technologies might be suitable.

8.3.1.7 Emerging technologies

Fire detection technologies are always developing, and emerging technologies might be suited for use in electronic equipment areas. Such technologies and their performance benefits should be subject to appropriate risk assessment and product testing.

NOTE Examples include video smoke detection techniques, multi-criteria technologies and gas-sensing technologies. The former are based on advanced processing of video images, while the latter might incorporate sensors targeted at gases produced during pyrolysis of the materials present in the protected environment.

8.3.2 Selection of detectors

8.3.2.1 General

Where the risk assessment (see Clause **4**) does not clearly identify a single method of sensing, a mixture of suitable sensors of each type should be provided.

Where the activation of suppression systems is required, the activation should be triggered by one or more of the following detection sources:

- conventional detectors on separate detection circuits;
- addressable detectors (on a single addressable loop);
- multi-sensor detectors;

- aspirating smoke detectors;
- optical beam type detectors.

NOTE Guidance on the use of coincident connection is provided in BS 7273-1.

Regardless of the detection technique used, the detection system should be capable of passing the detection performance tests listed in **14.3.1**.

8.3.2.2 High and critical category installations

For high and critical category installations, a smoke detector system capable of passing test fires TF2A, TF3A and TF5A as defined in BS EN 54-20:2006 should be installed to provide the earliest possible indication of a fire. The planned response to this early warning signal should be clearly defined in the overall response strategy and does not necessarily have to result in an evacuation.

NOTE 1 A Class A aspirating smoke detector is commonly used in these areas.

NOTE 2 The cumulative effect associated with ASD systems makes them particularly appropriate for detecting smoke that is diluted through a space.

The Class A detection system may comprise the sole means of fire detection in the monitored area and provide additional alarm signals when higher smoke concentrations trigger alarms to initiate an escalating response to the incident, or it may be provided as a supplement to a standard sensitivity system.

NOTE 3 In the latter case, the early warning system typically monitors for small traces of smoke in the return air to the air-conditioning system, and is additional to a detection system monitoring smoke at the ceiling, which is provided in case the air-conditioning is not operational.

If the air-conditioning is fundamental to the operation of the electronic equipment area and is designed with appropriate power back-up systems to operate 24/7 (minimum 24 h according to BS 5839-1), a high sensitivity smoke detection system in the return air to the air-conditioning system may be used as the sole means of detection.

NOTE 4 Increasing the density of normal sensitivity detectors by decreasing the spacing between them is not an alternative to Class A detection.

8.3.2.3 Medium category installations

For medium category installations, the Class A detection described in **8.3.2.2** should be used if the local environment is likely to adversely affect the operation of standard sensitivity systems, e.g. where airflows are counter-directional to the airflows produced by natural buoyancy.

Normal sensitivity smoke detection systems conforming to BS EN 54-7:2001, BS EN 54-12 or BS EN 54-20:2006, Class C may be used in medium risk electronic equipment areas where the airflows and operational environment allow for the use of such detection.

8.4 Sensitivity of detectors

8.4.1 General

The following factors should be taken into account when determining the required sensitivity of the detection system:

a) susceptibility of the equipment to non-thermal damage;

b) the speed of response when an alarm is raised;

c) the nature and effectiveness of that response, i.e. manual fire-fighting means or automatic fire suppression systems;

d) the need to minimize false alarms.

When a facility is manned continuously, there can be value in installing a higher sensitivity detection system, as this can give an early indication of a potential fire and thus lead to early manual intervention.

NOTE 1 The overriding factor affecting the overall sensitivity of a fire detection system within an electronic equipment area is that of high airflows necessary as part of the air-conditioning used to cool equipment. Such airflows might be in the region of 10 to 100 air changes per hour at velocities greater than 1 m/s, and sometimes run counter-directionally to airflows produced by natural buoyancy (e.g. where air is extracted at low level with inlets at high level). These airflows are also complicated by localized high heat output from equipment which generates convection currents. These factors can result in a reduction in the speed of response of fire detectors, because the smoke might be diluted or fail to reach ceiling-mounted detectors.

NOTE 2 The sensitivity of fire detection systems covers a wide range. A highly sensitive system can detect an incipient fire condition when, for example, PVC cable has just begun to overheat. If action is taken at this stage, to extinguish the fire or to prevent further overheating (e.g. by powering down), damage to the electronic equipment is minimal. Normal sensitivity systems are likely only to detect a fire when it has reached a sustained smouldering or flaming stage producing appreciable products of combustion, when fire and smoke might already have caused some damage to sensitive equipment. At this stage, if the fire is not extinguished in a relatively short time, it can grow rapidly to spread to the whole room or area.

8.4.2 Sensitivity of aspirating smoke detectors

The intended sensitivity of an aspirating smoke detector should be specified by clearly stating the class required (see **8.3.1.5** and BS EN 54-20:2006), taking into account the following points.

- The class of an ASD relates to the sensitivity of the sampling holes, not to the sensitivity of the detection unit.
- It is important to check that the capability of the particular type or model of ASD is suitable for the application and can provide the number of sampling holes required.

  NOTE 1 Some ASD systems are capable of providing a few sampling holes (e.g. <5) while others are capable of providing many sampling holes (e.g. >30) of a particular class.
- ASD systems are able to detect low density smoke dispersed by the airflows within an electronic equipment area because of the cumulative effect whereby smoke of a lower concentration will generate an alarm if it enters more sampling holes.

More specifically:

- when used to detect smoke in the return airflow from the room, a Class A system should be used to provide early warning;
- when used to detect smoke within a cabinet or enclosure, a Class A or B system should be used to provide early warning;
- when used to detect smoke at the ceiling of the room or within a floor or ceiling void, a Class A or B system should be used when the air-conditioning is to remain operational.

NOTE 2 A Class C system may be used when the air-conditioning can be switched off.

8.5 Detector spacing and location

Detector spacing and location should be in accordance with Annex A.

8.6 Detector zoning

Detector zones in electronic equipment areas should generally be in accordance with BS 5839-1.

NOTE To assist in the rapid identification of the location of a detector responding to a fire, a smaller or more discrete zone might be useful, e.g. by separately zoning voids in larger installations (typically room areas greater than 100 m^2), or by separately zoning special equipment or special areas.

9 Fixed systems and other fire-fighting equipment

9.1 Fixed fire-fighting equipment

9.1.1 General

A fixed fire suppression system should be provided if it is identified during the risk assessment (see Clause **4**) as being necessary. The need for such a system will be determined by the value of the electronic equipment and the potential for business interruption in the event of fire.

NOTE Guidance on the use of suppression systems is given in BS 5306-0.

If a fixed fire suppression system is to be installed, the system should be designed to minimize hazards to personnel and equipment, as well as to satisfy the fire suppression needs. These needs might be to suppress an incipient fire in any part of the protected space, including within cabinets; to prevent a fire from spreading outside the protected space; or a combination of these.

The following solutions are available.

a) **Total flooding systems**, where protection should normally extend throughout the equipment area and any floor and ceiling voids in that area. Exceptionally, protection may be restricted to, for example, the floor void, or omitted from the ceiling void. This should only be considered where the voids have no connection between them, have adequate fire resistance, and can withstand the expected room pressure fluctuations upon the suppression system discharge.

b) **Cabinet systems**, where a suitable fire suppression agent is injected directly into one or more cabinet(s), provided that suitable engineering safeguards are undertaken (see **9.1.2**). Cabinet suppression coupled with cabinet detection (see **8.2.5**) can provide a higher level of protection that can not only respond earlier, but can be limited to the specific cabinet on fire and thus minimize disruption to the electronic equipment facility. There are, however, certain limitations with cabinet suppression when used as the sole form of fixed fire suppression, because it pre-supposes that the only hazard to the equipment is a fire within the equipment itself. Additional protection of the surrounding areas should be provided where necessary.

9.1.2 Fire suppression systems using gaseous extinguishing agents

Gaseous systems are the most commonly employed fire suppression systems for electronic equipment rooms. These systems should be designed, installed and maintained in accordance with BS EN 15004 for halocarbon and inert gas systems, or BS 5306-4 for CO_2 systems.

NOTE 1 Further guidance relating to gaseous extinguishing systems is given in the Loss Prevention Council publication LPR 6 [2].

Release mechanisms of gas systems should be in accordance with BS 7273-1 or BS 7273-2 as appropriate.

Where gas is used as an extinguishing agent, at least the following factors should be taken into account when designing the system.

a) **Health and safety of personnel in the protected space**. In general, extinguishing systems are designed to have no significant effect on people who might be in the protected space when the system discharges. An exception to this is CO_2, which is lethal at normal extinguishing concentration, and so should not be used in normally occupied areas. In general, gaseous extinguishing systems should be left in the "Automatic" condition at all times.

b) **The integrity of the enclosure**. Protected spaces should be reasonably airtight to prevent dilution. An integrity test is necessary to establish this. The type design and operating principles of the air-conditioning systems should be available.

c) **The need for pressure relief venting**. A discharge might produce small but significant changes in pressure within the protected space, which might require pressure relief venting.

d) **The need for post-discharge venting**. Following a discharge, it will be necessary to ventilate the space to remove the extinguishing agent and the products of combustion.

   NOTE 2 Further guidance is given in the FIA guidance note on venting of gas systems [3].

e) **Storage space for the extinguishing agent containers**. The amount of space required depends on the agent used and the size of the protected space. The storage space is normally in or very close to the protected space. The maximum distance between the protected space and the storage space depends on the type of extinguishing agent and the storage pressure.

f) **Access for installation**. The size of pipe work depends on the quantity of extinguishing agent and the amount of agent being delivered. Large pipes might require mechanical handling equipment.

g) **Safety and effectiveness**. A clear statement is needed of the sequence of events which will precede a discharge, to ensure that the area remains safe for occupants and contents, and to ensure that the suppression system is effective in suppressing the fire.

h) **Operating procedures**. Procedures are needed to ensure the safe and effective operation of the system and to prevent accidental discharge.

i) **Thermal effects on electronic equipment**. Prior to discharge, the air-conditioning might need to be shut down. See **7.1.1**h).

j) **The need for hold-off or abort controls**. In some instances there might be a need to temporarily or permanently stop a discharge, e.g. to prevent accidental discharge, to allow actions to be completed or to allow for evacuation.

k) **The location of control and indicating equipment, signage and manual releases**. Further information is given in BS 7273-1 and BS EN 15004-1.

With cabinet gas systems, the following additional factors should be taken into account.

1) The methods of operation, control and shutdown should take into account electrical interference arising from the insertion of pipework into the cabinet, and the effects of chilling in the cabinets.

2) The design calculations for the system should compensate for leakage of extinguishing agent where necessary.

3) Extinguishing equipment within cabinets should be engineered to ensure, as far as is reasonably practicable, that discharge gases do not directly impinge on sensitive components during discharge.

4) If carbon dioxide is used as the extinguishing gas discharged into cabinets, the system designer should either prove by calculation that the final concentration of carbon dioxide that can be generated within any adjacent occupied area does not exceed 2% by volume, or, if this value would be exceeded, apply full safety features in accordance with BS 5306-4.

Where cabinet protection is automatically operated, care should be taken to ensure that leakage of the gas from the protected cabinet does not cause unwanted operation of further gaseous extinguishing systems.

9.1.3 Watermist fire suppression systems

Watermist systems use limited quantities of water, can be used in occupied spaces, and may be used for the protection of some electronic equipment areas.

NOTE There is some concern regarding the use of water on sensitive electronic equipment, and watermist cannot penetrate cabinets in the same way as a gas.

Where watermist systems are installed in an electronic equipment area, they should be in accordance with DD 8489-1 and DD 8489-7.

9.1.4 Automatic sprinklers

Automatic sprinkler systems are likely to be considered for protection of electronic equipment areas only where the entire building is sprinkler-protected.

NOTE 1 There is some concern regarding the use of water on sensitive electronic equipment, and sprinklers cannot penetrate cabinets.

Where sprinklers are installed in the electronic equipment area, they should be designed, installed and maintained in accordance with BS EN 12845, and quick response heads with a low temperature rating of 57 °C should be used.

*NOTE 2 Automatic sprinklers installed in electronic equipment areas provide protection to the building structure and prevent a fire spreading to adjacent equipment. If sprinklers are installed in areas adjoining the electronic equipment area, it is possible to reduce the degree of fire separation of the electronic equipment area (see **6.1**). Sprinkler systems in the electronic equipment area are particularly appropriate if the rest of the building is protected by a sprinkler system.*

Release mechanisms of pre-action sprinkler systems should be in accordance with BS 7273-3.

9.1.5 Condensed aerosol systems

Due to the potential for damage to sensitive electronic equipment, the use of condensed aerosol systems is not recommended for the protection of such equipment.

9.1.6 Foam systems

Due to the potential for damage to sensitive electronic equipment, the use of foam systems is not recommended for the protection of such equipment.

9.1.7 Hypoxic fire prevention systems

Hypoxic fire prevention systems maintain the oxygen at a reduced concentration to inhibit fire. Such systems can have implications for the health of persons working in the area, due to the reduced oxygen content in the atmosphere. If such systems are used, early warning fire detection is recommended, as pyrolysis (material breakdown through heat) can occur.

NOTE There are currently no UK standards for hypoxic systems, but work is under way to produce appropriate standards in Europe.

9.2 Portable fire-fighting equipment

Portable fire extinguishers of the carbon dioxide (CO_2) type conforming to BS EN 3 should be provided near the electronic and associated equipment, positioned in accordance with BS 5306-8.

In medium risk installations, the selection of portable fire extinguishers should be in accordance with BS 5306-8.

In high and critical risk installations, more extinguishers should be provided than the number recommended in BS 5306-8 for normal workplaces. The recommended numbers of fire extinguishers per floor area in such installations are given in Table 2. The travel distance from any point to the nearest of these extinguishers should not exceed 15 m.

Table 2 **Recommended numbers of portable CO_2 extinguishers per floor area for electronic equipment areas**

Area	Number of extinguishers [A)]
1 to 50 m^2	2 [B)]
51 to 100 m^2	2
101 to 151 m^2	3
Over 150 m^2	3 plus 1 for each additional 100 m^2, or part thereof, over 150 m^2

A) Based on a 2 kg CO_2 (21B) extinguisher as defined in BS EN 3-7:2004+A1:2007.
B) This may be 1 if another extinguisher is easily accessible on the same floor.

Where there are Class A combustible materials (see BS EN 2), e.g. paper, present in the electronic equipment area, a water-based extinguisher capable of passing the 35 kV test in BS EN 3-7 should also be provided immediately outside the electronic equipment room.

Powder fire extinguishers should not be provided for use near sensitive electronic equipment, as the powder can cause equipment damage.

NOTE Guidance on the suitability of using various kinds of portable extinguishers as means of extinction, and the precautions to be taken in their use, is given in BS 5306-8.

Personnel working in the electronic equipment area should be trained in the safe use of all available fire-fighting equipment (see **11.3**).

10 Smoke control

Where a smoke control system is deemed to be necessary, it should be designed in accordance with BS 9999:2008, Clause **28**.

Smoke control should not be confused with extinguishing agent venting or over-pressure venting associated with gaseous extinguishing systems.

NOTE Provision to extract smoke from an electronic equipment area is not always necessary. In many cases, it is intended that smoke control is achieved by limiting fire size rather than by removing smoke from a fire. In critical risk installations and windowless accommodation, however, such systems are beneficial in reducing damage and allowing safe access for fire-fighting personnel.

Where gaseous and similar suppression systems are used, extraction systems might also be necessary to remove the agent after release and remove combustion products after a fire to allow the safe return of personnel to the area.

Smoke control systems include one or more of the following functions:

a) smoke and/or heat removal to minimize damage to equipment;

b) smoke removal to assist fire-fighting;

c) smoke clearance to aid clean-up, recovery and the removal of gaseous extinguishing agents where used. In such cases, low-level extract points could be required in addition to high-level extract points used for smoke extraction.

In areas protected by an extinguishing or suppression system, care should be taken to ensure that the smoke control system does not compromise the effectiveness of the extinguishing or suppression system.

11 Fire safety management for electronic equipment areas

11.1 Responsibility

A person of suitable seniority should be made responsible for the operation of fire precautions for the electronic equipment and the electronic equipment area. Such persons should also be made responsible for liaison with the fire and rescue service.

NOTE Further guidance is given in BS 9999:2008.

11.2 Prevention of fire

11.2.1 General housekeeping

Procedures should be adopted to:

a) ensure that all facilities are maintained in good working order;

b) prevent the accumulation of unwanted and unnecessary equipment; and

c) ensure that escape routes and access routes to essential equipment and controls are kept clear of obstruction.

A regular programme of fire safety inspection is recommended.

*NOTE Further guidance is given in BS 9999:2008, **42.2** and Annex V.*

11.2.2 Waste management

Procedures should be adopted to prevent the accumulation of combustible waste, and should include but not be limited to:

a) the regular removal of combustible waste, such as waste paper and rubbish. Typically this would be at the end of the working day or shift, but it should be more frequent where significant quantities are produced;

b) ensuring that general waste and combustible waste are not stored in or close to the protected area;

c) general cleaning routine, including inspection and cleaning of normally inaccessible places such as cabinets, voids, plant rooms and ventilation plant.

11.2.3 Storage of combustible materials

Combustible materials should not normally be stored within an electronic equipment area. Where it is necessary to acclimatize paper or magnetic media before use, quantities within the area should be kept to a minimum and should not exceed one shift's supply.

Any flammable liquids necessary for operations such as cleaning of magnetic media should be held in sealable containers. Only minimal quantities, sufficient for day-to-day use, should be held in an electronic equipment area. Wherever practicable, flammable liquids should be replaced with less hazardous alternatives.

*NOTE See also **6.7.1**.*

11.2.4 Electrical installations

All electrical installations should be inspected by a competent person at least every three years. Portable electrical appliances should be inspected annually.

11.2.5 Smoking

Smoking should not be permitted in any electronic equipment area.

11.2.6 Arson

To minimize the risk of arson, attention should be paid to site security and housekeeping, including adjacent outdoor areas.

*NOTE Further guidance is given in BS 9999:2008, **10.3.4**.*

11.2.7 Hot work

Hot work, such as welding and grinding, should be avoided within electronic equipment areas wherever possible. Where hot work cannot be avoided, it should be controlled by an appropriate permit to work system.

*NOTE Further guidance is given in BS 9999:2008, **48.2** and Annex U.*

11.2.8 Cooking and heating equipment

Portable cooking and heating appliances should not be taken into electronic equipment areas.

11.2.9 Actions to be taken when premises are left unoccupied

Where the premises are not permanently occupied, clear instructions should be provided regarding the actions to be taken by personnel before leaving the premises. Items that should be checked include, but are not necessarily limited to, ensuring that:

a) all doors and hatches between rooms are closed;

b) all waste paper has been removed;

c) any automatic fire suppression system is on automatic control;

d) any hypoxic fire prevention system is operating correctly;

e) any intruder alarm system is activated;

f) any areas where building, engineering or maintenance operations are being carried out are made safe and vacated.

Where premises are to be left unoccupied, and are not provided with a high sensitivity smoke detection system linked to an alarm at a constantly attended location, procedures should be put in place to make sure that the area is regularly visited during the unoccupied periods by a security patrol.

11.3 Training

All personnel should receive, as a minimum, elementary fire safety training. This should include, but not be limited to, fire prevention, action to be taken on finding a fire and procedures to be followed in the event of an alarm.

All personnel in the vicinity of the protected area should be provided with training on the fire protection measures specific to the protected area. The training should include, as a minimum:

a) the principles behind the fire protection strategy;

b) the meaning of any audible and visual warning and the procedures to be followed;

c) procedures to be followed for fire prevention, action in the event of a fire and recovering from a fire; and

d) health and safety issues associated with any fire suppression system.

Personnel with special responsibilities should be trained, where appropriate, on:

1) first aid fire-fighting;

2) controlled shutdown of equipment in the event of fire;

3) the purpose, function and interrelationship between the fire detection and extinguishing systems, any ventilation and air-conditioning, and the smoke extraction systems;

4) the sequence of actions necessary to operate the fire protection systems, including fire suppression systems, isolation controls for electricity, and controls for ventilation, air-conditioning and smoke extraction systems;

5) routine checks and tests of fire detection and extinguishing systems, ventilation, air-conditioning and smoke extraction systems;

6) post-incident procedures;

7) recovery plan;

8) search procedures;

9) security and access control;

10) management of contractors;

11) management of hot work.

NOTE Further guidance is given in BS 9999:2008, Annex O.

11.4 Building works and alterations

Any alterations in the electronic equipment area layout or the siting of equipment therein should be carefully pre-planned in conjunction with all stakeholders.

All building works and alterations in and around electronic equipment areas should be covered by appropriate permit to work systems, including procedures for partial or total shutdown of fire detection and protection systems. Such procedures should include as a minimum:

a) ensuring that systems are isolated only when necessary and returned to service in the shortest possible time;

b) ensuring that any control panels, valves etc. that are closed, isolated or otherwise impaired are tagged with a notice highlighting the impairment;

c) ensuring that appropriate precautions are taken while the impairment continues.

Personnel carrying out any building works and alterations should be made aware of fire procedures and instructed not to introduce uncontrolled fire hazards.

*NOTE Further guidance is given in BS 9999:2008, Clause **48**.*

11.5 Action in the event of fire within electronic equipment areas

A clearly defined procedure, compatible with the general fire plan for the building, should be established for action in case of fire in the electronic equipment area.

A single person or clearly defined team should be responsible for developing this procedure, which should define the interaction between all appropriate systems, including early warning systems, fire detection and alarm systems, air-handling systems, extinguishing systems and all notification systems (e.g. notifications to local and/or remote staff, to all personnel in the area and to the fire and rescue service).

Such a procedure should include:

a) notification/signalling and action to be taken by staff in response to an early warning alarm;

b) raising the alarm and calling the fire and rescue service;

c) evacuating the area;

d) operation of fire suppression systems (where provided);

e) use of portable fire extinguishers;

f) notifying key personnel;

g) shutdown and isolation of equipment in the protected area;

h) operation of air-conditioning (see **7.1**), ventilation and smoke control systems;

i) ability of emergency team personnel to gain access to all parts of the electronic equipment areas.

> **WARNING**. Entry to the protected area after a fire or the operation of a gas extinguishing system should not be permitted before the area has been made safe and declared safe by a responsible person.

*NOTE Further guidance is given in BS 9999:2008, Clauses **44** to **46**.*

Where a fire detection system including an early warning facility is installed, personnel should be appointed to immediately investigate any early warning alarm.

12 Protection of information: contingency and recovery measures

12.1 General

A formal system should be implemented to protect data and software. The extent of the system should be in proportion to the criticality of the data, the risk category of the installation, and the risks and operational consequences associated with loss of data.

The system should cover:

a) protection of data and software;

b) development of contingency measures, including availability of replacement equipment;

c) a recovery plan, containing all the information required to facilitate the process through which operations can be restarted.

12.2 Protection of data

Back-up procedures are normally required for ongoing operations or archive purposes. They are, however, also essential to the continuation of most operations after a fire incident. Such procedures should therefore prepared in conjunction with the planning of the fire protection strategy.

The amount of data kept within the electronic equipment area should be minimized, and the data media should be kept in fire-resisting cabinets.

Whenever any changes are made to hardware, the data protection processes and procedures should be reviewed.

12.3 Contingency and recovery planning

12.3.1 General

Provision should be made for loss of critical equipment through fire, particularly where interruption to operations is not tolerable, or where replacement times for equipment are beyond an acceptable period of interruption to operations.

NOTE 1 At its simplest, the contingency/recovery plan can be a copy of equipment specifications, purchase orders and details of equipment suppliers.. In other cases, it might be appropriate to provide redundant equipment, where one spare piece of equipment is always available. As an alternative, organizations might separate their operations so that a proportion of the equipment is located in a separate fire area.

Where replacement of equipment is likely to be required, contingency arrangements should be made in advance to obtain such equipment in the event of an emergency, e.g. through the provision of a fully equipped facility, or the delivery of mobile recovery centres to the site.

Contingency arrangements should also be made with cleaning and equipment recovery specialists.

The recovery plan should take into account the actions needed in the period immediately after a fire occurs, and should include:

a) details of the action to be taken to minimize damage to equipment from non-thermal damage associated with the fire and fire suppression agents, including procedures for clearance of smoke, extinguishing agents and dehumidification;

b) procedures to ensure that fire protection systems are restored immediately after the fire has been extinguished.

NOTE 2 Requirements for business continuity management are specified in BS 25999.

12.3.2 Documentation

Contingency and recovery plans should be fully documented, including contact details. Copies of the plan(s) should be in the possession of all persons responsible for fire safety and for the electronic equipment itself.

Duplicate copies should be held off site.

12.3.3 Testing contingency and recovery plans

Contingency and recovery plans should be tested and should be modified as necessary in the light of experience.

The following three tests should be undertaken as necessary:

a) a paper exercise, which should involve a team reviewing the procedures and plans for dealing with an incident;

b) a recovery exercise, which should involve going through the process of recovery without affecting the users of the system;

c) a full recovery and restoration exercise, which should involve the whole site or part of the site putting the recovery plan into action and operating without their full electronic systems for a specified period of time.

The paper exercise might include a workshop or role-play exercise, and is designed to familiarize staff with the contingency and recovery plan and to identify areas where additional planning is required. The frequency at which this test is conducted should relate to the criticality of the electronic equipment. Personnel involved in implementing the contingency and recovery plans should participate in the exercise at least once a year.

The recovery exercise might include recovering data from a back-up store and loading it onto a system, to identify any potential bugs in the system, or testing standby equipment. The frequency of implementing the exercise should be related to the criticality of the risk. The exercise should be undertaken at least every two years.

The full recovery and restoration exercise involves significant planning and resources, and is only essential for major installations. A full recovery and restoration exercise is, however, the only way of fully testing a contingency and recovery system to ensure that it works in the event of a major incident.

13 Business-critical ancillary facilities

Ancillary facilities on which the functioning of the critical electronic equipment depends should have fire precautions to at least the same level as those of the areas with which they are associated.

NOTE Such facilities include generators, electrical switchgear, transformers and UPS equipment, real-time communication facilities (including communications circuits within the building) and mechanical plant (including that associated with air-conditioning and chilled water supplies).

Each major ancillary facility should be individually assessed, taking account of the nature of the fire hazard, the effect of a fire on the principal critical facilities that are supported, the potential effects of a fire on business continuity, and the contingency plans for loss of the ancillary facility.

14 Inspection, testing and commissioning

14.1 General

Ensuring that the fire protection measures integrate into an effective whole requires:

a) inspection to ensure that all the measures are in place;

b) the setting to work of particular components, equipment and systems; and

c) full testing of each component, equipment and systems in conjunction with others;

to the satisfaction of the relevant stakeholders.

It might be acceptable to trigger and test devices and subsystems individually, such as by triggering a point type smoke detector using artificial smoke, particularly in medium risk applications, where the limitations of such testing can be justified.

Testing of subsystems may be performed at different times, e.g. the cooling capacity of the air-conditioning system is often validated by arranging electric heaters through the facility to simulate the maximum heat load and running the air-conditioning to ensure that it is capable of removing this amount of heat. Other systems such as the power back-up/emergency generator may be similarly tested at maximum load to verify their operation.

14.2 Electrical installation

Power supplies and electricity supplies to the fire detection system should be checked to ensure conformity to BS 7671.

14.3 Fire detection and alarm

14.3.1 General

The fire detection and alarm system should be inspected, tested and commissioned in accordance with the system specification, BS 6266 and the appropriate parts of BS 5839. This should include but not be limited to:

a) a visual inspection of the as-fitted installation;

b) testing of the cause and effect matrix;

c) testing of all components (including but not limited to detectors, call points, sampling pipes, power supplies, audible and visible alarm devices).

Wherever possible, a performance test should be carried out to verify that the fire detection system will operate appropriately in good time within the environment, unless the airflows are very small (e.g. <0.5 m/s) or the protected volume is very small (e.g. <50 m^3), in which case a functional test is sufficient.

In situations where live smoke testing is impractical, a performance-based design (PBD) approach may be used to provide sufficient confidence that enough smoke will travel to, and trigger, the detectors.

NOTE 1 A PBD approach would use fire models and computational fluid dynamics (CFD) to predict the movement of smoke within the space.

Where aspirating fire detection systems are installed, the recommendations of the FIA *Code of practice for design, installation, commissioning and maintenance of aspirating smoke detector (ASD) systems* [N1] should be followed.

Table 3 presents a matrix of performance tests according to the desired response of the system (Class A, Class B or Class C) and the type of detection systems used. This table should be used to select the most appropriate performance test as described in Annexes B to H.

NOTE 2 Attention is drawn to the hazard warnings in the Foreword.

14.3.2 Performance testing for critical and high risk installations

Early warning Class A detection systems as recommended for critical and high risk installations should be tested using one of the hot wire tests (see Table 3 and Annex E), and should meet the relevant pass criteria.

Where in-cabinet detection is provided, the detection systems should be tested using the overheating resistor test (see Annex F) and should meet the relevant pass criteria.

Normal sensitivity detection systems (which are used to trigger the suppression system) should be tested with the air-conditioning running in the operational mode expected using the smoke pellet test, polyurethane mat test or potassium lactose test (see Annexes B, G and H), and should meet the relevant pass criteria.

NOTE These tests produce significant quantities of smoke sufficient to trigger a normal sensitivity system, and can be used to verify that an extinguishing system will be triggered in operational mode.

14.3.3 Performance testing for medium risk installations

In medium category installations with normal sensitivity detection and low air flow rates and/or small volumes (see **8.3.2.3**), it is reasonable to assume that smoke will reach the detectors in good time, and a performance test is not necessary. For all other situations, an appropriate performance test should be carried out as determined in Table 3.

NOTE Production of smoke in quantities needed to trigger normal sensitivity (Class C) systems is often not desirable in electronic equipment areas, due to the risks associated with smoke or particulate damage to the installed systems. In such cases it might be practicable to generate less smoke during the performance test and only require a sufficient response from the detector (e.g. a 15% increase in signal relative to the full alarm threshold). Such an approach requires convenient observation of the detector's "analogue value" and might not be appropriate for some detection technologies.

Where the fire detection and alarm system is connected to an alarm receiving centre, this should be tested in accordance with BS 5979.

Table 3 **Performance tests for detection systems**

Detection location	Application	Performance test [A)]		
		Response Class A (high sensitivity)	**Response Class B (enhanced sensitivity)**	**Response Class C (normal sensitivity)**
At the return air vents to the air conditioning	Ceilings ≤3 m	2 m PVC wire (**E.2**)	1 m PVC wire (**E.1**)	7 g to 9 g pellet (Annex B, test B.1)
	Ceilings >3 m	1 m PVC wire (**E.1**)	7 g to 9 g pellet (Annex B, test B.1)	13 g to 18 g pellet (Annex B, test B.2)
At the ceiling of the protected area	Low ceilings (<3 m)	2 m PVC wire (**E.2**)	1 m PVC wire (**E.1**)	7 g to 9 g pellet (Annex B, test B.1) Poly' mat [B)] (Annex G) Pot' lactose [C)] (Annex H)
	Normal ceilings (up to 20 m)	7 g to 9 g pellet (Annex B, test B.1)	13 g to 18 g pellets (Annex B, test B.2)	2 × 13 g to 18 g pellets (Annex B, test B.3) Poly' mat [B)] (Annex G) Pot' lactose [C)] (Annex H)
	High ceilings (>20 m)	N/A	2 × 13 g to 18 g pellets (Annex B, test B.3)	Pot' lactose [C)] (Annex H)
Within an equipment cabinet	Vented/ cooled	2 × 12 Ω for 80 s (Annex F, test F.3)	2 m PVC wire (**E.2**)	1 m PVC wire (**E.1**)
	Unvented ≥3 m^3	12 Ω for 70 s (Annex F, test F.2)	2 × 12 Ω for 80 s (Annex F, test F.3)	2 m PVC wire (**E.2**)
	Unvented <3 m^3	12 Ω for 8 s (Annex F, test F.1)	12 Ω for 70 s (Annex F, test F.2)	2 × 12 Ω for 80 s (**E.3**)

NOTE 1 Where a PVC wire test (Annex E) is recommended, an appropriate length of the alternative LSF cable may be used (see Annex E) or, if the detection technology requires it, the enamel wire test (Annex D) may be used.

NOTE 2 Where the smoke pellet test (Annex B) is recommended, and the detection technology requires it, the paper burn test (Annex C) may be used.

A) The cross-references in parentheses are to the test procedures in Annexes B to H.
B) Polyurethane mat.
C) Potassium chlorate/lactose.

14.4 Active fire protection measures

Where possible, subsystems activated by the fire detection and alarm system should be tested together to verify the interconnections between the fire detection system and all the subsystems.

NOTE Guidance on the actuation of various fire protection measures is given in the relevant parts of BS 7273.

14.5 Fire suppression systems

Where used, fire suppression systems should be inspected, tested and commissioned in accordance with the system specification, BS 6266, BS EN 15004, DD 8489-1, BS 5306-2, BS EN 12845 and the relevant parts of BS 7273, as appropriate.

14.6 Portable fire-fighting equipment

Portable fire-fighting equipment should be inspected, tested and commissioned in accordance with the system specification, BS 6266, BS 5306-3 and BS 5306-8.

14.7 Passive fire protection

All structural fire protection measures in and around the protected space, including fire-stopping, should be inspected for conformity to Clause **6**.

Annex A (normative) Spacing and location of aspirating sampling holes, point smoke detectors and optical beam smoke detectors

COMMENTARY ON ANNEX A

Detectors or sampling points need to be sited in optimum positions and in sufficient numbers to best detect smoke from a fire whilst in its early stages. In the case of electronic equipment installations, the environment and processes can pose special problems.

With the air-conditioning system units switched on, smoke is drawn to the intake vents (returning air from the protected area to the air-conditioning), particularly during the incipient stage of the fire before any significant heat is generated. The first indications of a fire are therefore best detected at the return vents to the air-conditioning. With the air-conditioning switched off, however, or when the fire is established and generating significant heat, smoke is best detected using detection located on the ceiling.

When air-conditioning is switched on, the operation of ceiling-mounted detectors is impaired because the two-dimensional spread of smoke across the ceiling (which occurs in still air) does not happen. Instead, smoke which reaches the ceiling is driven predominately in one direction. To compensate for this streamlining effect it is necessary to increase the density of detectors (i.e. reduce the spacing between detectors). The higher the airflow, the greater is the density of detectors required.

Where airflows are particularly high or where individual items of equipments are particularly valuable, detection within or at the air outlet of individual cabinets may be specified. Such detectors may be used to trigger cabinet suppression systems.

Predictions of how smoke will move within the protected area using computational fluid dynamics (CFD) are possible. CFD predictions need to be considered as indicative rather than absolute, but they are a useful tool for determining the optimum position for detectors within electronic equipment installations.

*The most effective way to confirm the anticipated smoke movement, and therefore the operation of the detectors within the environment, is by performance testing. See **14.3.1**.*

A.1 Position of sampling holes on the air return vents

It is important to provide sufficient numbers of sampling holes across each return vent to the air-conditioning, to ensure that flows from any part of the room covered by each particular vent are appropriately sampled. The performance tests recommended in **14.3.1** are intended to confirm this, but the following guidance is also provided.

- Each sample point at an air return vent should have a maximum area coverage of 0.4 m^2 of the air vent. At least three sampling holes should be provided.
- The sensitivity of each sampling hole should be confirmed to be Class A.
- A single ASD system may draw samples from holes located on more than one vent.
- The manufacturer's recommendations should be followed.

Where a reference ASD is provided [see **7.1.1**c)], a similar sampling arrangement across the fresh air intake vent is recommended.

NOTE For further guidance on positioning of sampling holes at return vents, see the FIA Code of practice for design, installation, commissioning and maintenance of aspirating smoke detector (ASD) systems [N1].

Point-type detectors in air streams, especially those containing fresh air make-up, should be avoided.

A.2 Position of detectors (or sampling holes) on ceilings and in floor and ceiling voids

*COMMENTARY ON **A.2***

As a general rule, the spacing between normal sensitivity point-type detectors (or Class C sampling holes) needs to be reduced in high airflow environments to facilitate effective detection of smoke. This is to address the possibility of smoke being transported in air-streams that pass between the detectors, but also to overcome the inevitable dilution of smoke as it is transported away from the fire at a faster rate than occurs in still air.

Where air-conditioning is to be shut down in response to early warning detection at the air return vents, it might be argued that the spacing of detection at the ceiling could be in accordance with BS 5839-1. As it takes time for the air-conditioning to shut down, however, and as it is possible that the return vent detection could fail, it is possible that the risk assessment might result in a requirement for higher than normal density of detection.

Where the direction of airflow within the room, floor or ceiling is well defined and consistently in one direction, it is reasonable to arrange for the greatest density of detectors (or sampling points) perpendicular to the main direction of flow (i.e. across the streamlines).

Smoke produced by a small fire or overheating component will spread through the space in three dimensions.

- *In the vertical direction, the rate of rise will depend on the heat provided to the smoke by the fire or overheating component. It will also depend on any vertical flows induced by the air-conditioning. For example, if there is a mean downward flow because cool air enters at the ceiling and is extracted at the floor, then the vertical rate of rise of smoke to the ceiling will be reduced – perhaps even reversed.*
- *In the horizontal plane, the smoke will predominately travel in the direction of the induced flow, but due to turbulence will spread out perpendicular to the direction of flow as well. The ratio between the two will depend on the horizontal velocity and amount of turbulence present.*

In the worst case, smoke could be diluted and streamlined between detectors to such an extent that the smoke density at each location is not sufficient to trigger the detector at an early stage. Detectors therefore need to be positioned closer to each other and, as the horizontal air velocity increases, the advantage of spacing detectors asymmetrically increases.

Where more sensitive detectors are used, the dilution caused by the high air flow rates is to some extent compensated so the density of detection can be reduced slightly. In addition, where the detector is an integrating type (e.g. optical beam or ASD), the smoke dilution is further compensated because of the cumulative effect of being detected and integrated over many locations. The density of detection of such systems may also be reduced slightly.

When coincident detection is required to trigger an automatic suppression system, it is important to ensure that the density of detection is adjusted according to the coincident arrangement. In particular, where the coincidence is zonal (as with a conventional point-based system, or systems employing optical beam or ASD), the density of detection needs to be increased slightly. In contrast, when the coincidence is based on activation of any two point-type detectors in the room (as is possible with an addressable point-type system), then there is no need to increase the density, as any next adjacent detector can provide the second coincident input, so triggering of the system is not dependent on the direction in which the smoke is spreading.

*Recommendations for general spacing are given in **A.2.1**.*

*In addition to these general principles of detecting smoke in high airflows, there are a number of other detailed considerations with regard to avoiding specific locations where detection is likely to be impaired. Examples are provided in **A.2.2**.*

A.2.1 General spacing

NOTE 1 A description of the approach for determining the maximum detection coverage is given in Annex I.

Detectors within the electronic equipment installation should be spaced such that the effective area coverage of each point or sampling hole is 25 m² or less.

Adjustments to this maximum area should be made as follows. More than one adjustment can be applied for a given application.

a) Reduce by:
   1) 5 m² if airflows >1 m/s and ≤4 m/s are present in >25% of the space;
   2) 10 m² if airflows >4 m/s are present in >25% of the space.

b) Increase by 10 m² if the air-conditioning is to be shut off by early warning detection at the air return vents.

c) Increase by 5 m² if asymmetric spacing of the detectors/holes is provided whereby a greater density of point/holes is provided across the prevailing direction of flow.

d) Increase by 5 m² if the detection system deployed has enhanced sensitivity (e.g. a sensitivity equivalent to a Class B ASD sampling hole).

e) Increase by 5 m² if the detection system used is an integrating type detector (i.e. ASD or optical beam).

f) Reduce by 5 m² if coincident detection is provided based on detectors in two zones operating (as opposed to any two addressable detectors).

g) For floor and ceiling voids (up to 1.5 m high), adjust as follows according to the level of ventilation present.
   1) Reduce by 5 m² for floor and ceiling voids which are ventilated or which are used as part of the ventilation system.
   2) For floor and ceiling voids without ventilation (i.e. airflow = 0):
      i) increase by 5 m² for voids with a smooth ceiling ;
      ii) reduce by 5 m² when the void has very shallow beams (e.g. <5% of the void height);
      iii) reduce by 10 m² when the void has shallow beams (e.g. between 5% and 10% of the void height).

NOTE 2 In accordance with BS 5839-1, voids greater than 1.5 m in depth should be treated as a room.

For areas that are adjacent to or linked with the electronic equipment installation, the location and spacing of detectors should be in accordance with BS 5839-1.

NOTE 3 Where the adjacent areas contain support equipment which is critical to the operation of the electronic equipment area, it is likely that the risk assessment will identify a need for enhanced detection, either in terms of sensitivity or in terms of detector spacing, to ensure the earliest possible indication of fire in these areas.

A.2.2 Specific locations/considerations

Installation of detectors in still air regions in corners, by intake or exhaust ducts, etc., should be avoided.

In particular:

a) *Air inlets through perforated ceilings*
Perforations should be sealed off for a minimum radius of 0.6 m around each detector or ASD sampling hole [see Figure A.1a)]. Detectors for room monitoring should not be installed in the path of the fresh air current from air-conditioning and ventilation systems.

b) *Air inlets producing horizontal airflows*
Point-type detectors should be located a minimum of 1.5 m away from the opening and up to 3 m if the flow prevents smoke reaching the detector. In areas where there is strong ventilation, deflectors or shutters should be used to direct the forced airflow away from detectors [see Figure A.1b)].

c) *Airflow through ceiling fittings*
Point detectors (and beam detectors) should be sited in the turbulent areas between fittings [see Figure A.1c)] and, where possible, should be positioned symmetrically.

When installing detectors in floor and ceiling voids, the following recommendations should be met.

1) Detectors should be accessible for maintenance and regular testing.

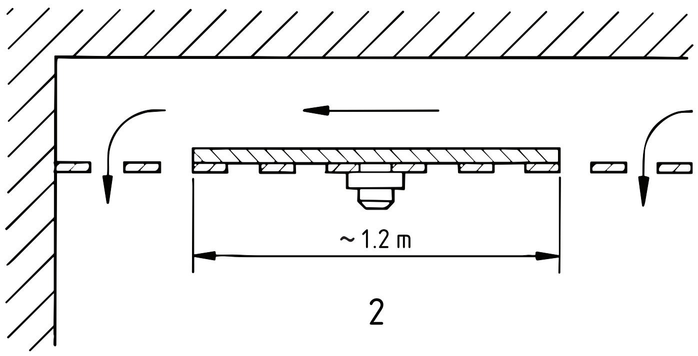
2) Detectors in unventilated voids should be located in accordance with BS 5839-1.

3) Where detectors or sampling holes are located in voids used as airflow plenums:

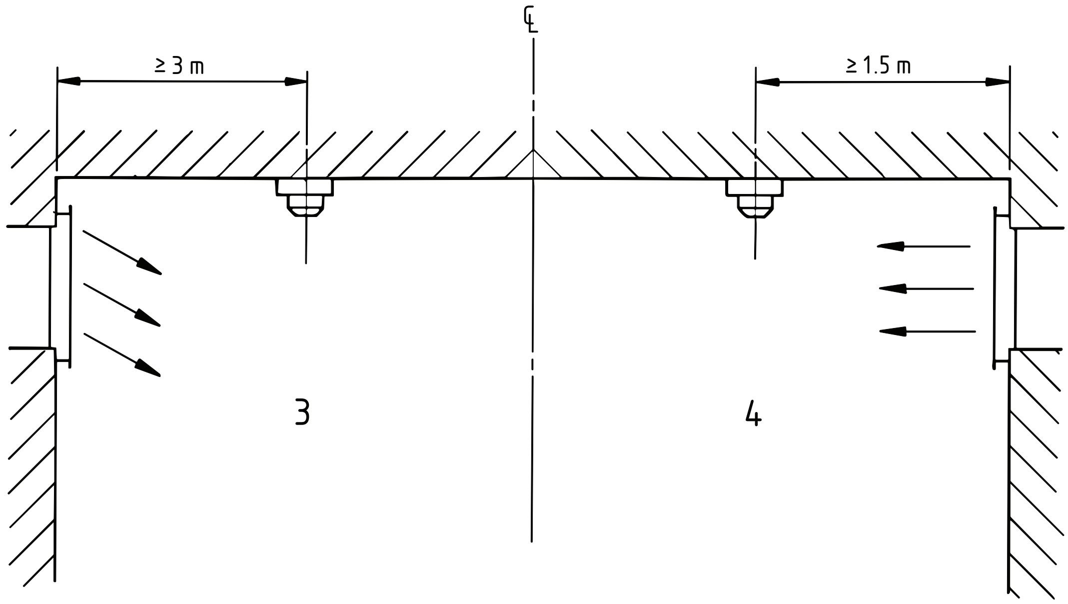
   - they should be positioned within the airflow (not at the top of the void);
   - they should be orientated to facilitate maintenance and in accordance with the manufacturer's recommendations (they do not have to be in the pendant position).

NOTE BS 5839-1 does not cover ventilated voids. For ventilated voids, the recommendations given in list item 3) above take precedence over those in BS 5839-1.

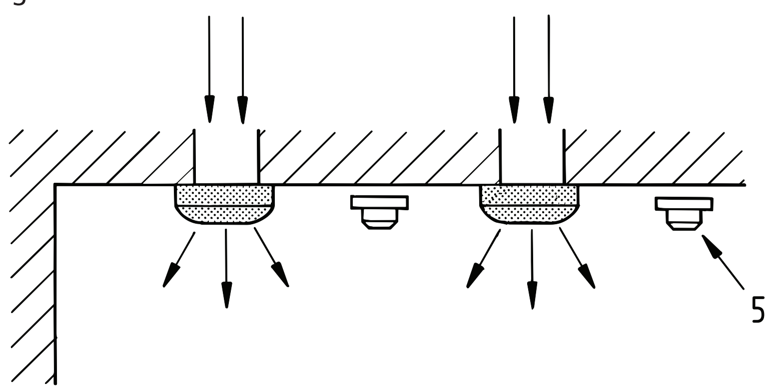
Figure A.1 **Location of detectors in electronic equipment rooms**



a) Air inlet through perforated ceilings – sealing a perforated ceiling



b) Air inlets producing horizontal air flows



c) Detector positions with point-type fresh air ceiling inlets (diffusers, etc.)

Key

1 Direction of air flow

2 Sealed off perforations

3 Strong ventilation

4 Weak ventilation

5 Detector

A.3 Position of detectors for cabinet protection

Where detection is required for the detection of fire in individual cabinets, the following recommendations should be met.

a) Detectors or sampling holes should be located where smoke is more likely to migrate. For example, in an unventilated (i.e. sealed) cabinet, detection should be within the top 10%, whereas in a ventilated cabinet, detection should provided where the ventilation exits the cabinet. In a naturally vented cabinet, this will be the upper ventilation vent.

b) Multiple detectors or sample points should be provided where the cabinet has multiple or very large outlet vents.

c) Detectors with enhanced sensitivity should be used when the ventilation rates are such that dilution of the smoke is likely to render normal sensitivity detectors ineffective.

d) Where cabinets are fitted with in-cabinet suppression systems, the detection system should provide an alarm signal for each cabinet (or group of cabinets if the suppression system is to be released into several cabinets simultaneously).

NOTE Where in-cabinet suppression is not fitted, a single detection zone may cover several cabinets.

Recommendations are given in **14.3.1** for the performance tests that should be used to confirm the operation of detectors intended to protect cabinets.

Annex B (normative) Smoke pellet performance test

B.1 Apparatus

B.1.1 *Butane gas burner* (or equivalent electrical heater) with an output of 5.8 KW.

NOTE A 5.8 KW burner burns 10 g of butane in 70 s.

B.1.2 *Metal platen*, at least 200 mm square.

B.1.3 *Metal chimney*, 2 mm to 6 mm thick, formed into a cylinder of at least 100 mm diameter and at least 150 mm high. Either the base of the chimney or the metal plate should have holes to provide ventilation for the chimney.

B.1.4 *Calibrated stop clock or stop watch*, capable of measuring in 1 s intervals.

B.1.5 *Smoke pellets* of 7 g to 9 g and of 13 g to 18 g.

B.2 Procedure

B.2.1 Place the metal platen upon the burner and place the pellet(s) centrally on the platen. Use the appropriate weight and quantity of pellets as follows:

a) test B.1: one pellet of 7 g to 9 g;

b) test B.2: one pellet of 13 g to 18 g;

c) test B.3: two pellets of 13 g to 18 g.

B.2.2 Place the chimney centrally around the pellet.

B.2.3 Ignite the burner and start the timer when the pellet starts producing smoke.

B.2.4 Operate the burner for the appropriate length of time as determined by Table B.1.

B.2.5 When the determined time (see Table B.1) has elapsed, extinguish the burner.

NOTE The pellet will continue to produce smoke when the burner has been extinguished (typically 30 s to 60 s) but thermal lift will not occur.

Table B.1 **Burner operation times**

Height of ceiling	**Burner operation time**				
	Temperature differential <3 °C [A)]	**Temperature differential (3 to 6) °C** [A)]	**Temperature differential (6 to 9) °C** [A)]	**Temperature differential (9 to 12) °C** [A)]	**Temperature differential (12 to 15) °C** [A)]
m	s	s	s	s	s
3 to 5	3	6	9	12	17
5 to 10	7	13	20	27	34
10 to 15	10	20	30	40	51
15 to 20	13	27	40	54	67

NOTE 1 No heat input is needed for applications with a height of less than 3 m when conducting these tests.

NOTE 2 The times in this table are based upon 5.8 KW burner.

A) Temperature differential is the temperature difference between the level at which the test is conducted and the level at which the aspirating sampling points are mounted.

B.3 Pass/fail criteria

The system is deemed to have passed the test if the detection system registers a response within 180 s of the burner being switched off.

The response should be a full fire condition unless agreed otherwise by the relevant parties, e.g. a response (equivalent to at least a 15% increase in smoke reading over the background level, where 100% is the fire threshold) sufficient to signal a pre-alarm or warning.

Annex C (normative) Paper burn performance test

NOTE The paper burn test is normally used for performance-based testing of specialized ASD systems based on cloud chamber technology. This test is used where thermal lift might be expected.

C.1 Apparatus

C.1.1 *Butane gas burner* (or equivalent electrical heater) with an output of 5.8 KW.

NOTE A 5.8 KW burner burns 10g of butane in 70 s.

C.1.2 *Metal chimney*, 2 mm to 6 mm thick, formed into a cylinder of at least 50 mm diameter and at least 300 mm high. The chimney should be capped with a removable metal mesh on the top to prevent the embers from being lifted into the air. The mesh size should be less than 10 mm.

C.1.3 *Calibrated stop clock or stop watch*, capable of measuring in 1 s intervals.

C.1.4 *A4 sheet of white paper* (80 g/m^2).

C.2 Procedure

C.2.1 Roll the sheet of A4 paper lengthways and place it inside the chimney so that the paper contacts with the sides of the chimney.

C.2.2 Place the chimney centrally on the burner so that the flames (when lit) surround the chimney.

C.2.3 Fit the mesh cap to the chimney.

C.2.4 Ignite the burner and start the timer when the paper starts producing smoke.

C.2.5 When a further 180 s has elapsed, extinguish the burner.

NOTE Thermal lift will occur during the whole test.

C.3 Pass/fail criteria

The system is deemed to have passed the test if the detection system registers a response within 60 s of the burner being switched off.

The response should be a full fire condition unless agreed otherwise by the relevant parties, e.g. a response (equivalent to at least a 15% increase in smoke reading over the background level, where 100% is the fire threshold) sufficient to signal a pre-alarm or warning.

Annex D (normative) Overheated enamel wire performance test

NOTE The overheated wire test is used for performance-based testing of specialized ASD systems based on cloud chamber technology. This test is used where no thermal lift might be expected.

D.1 Apparatus

D.1.1 *Isolated a.c. variable power supply*, capable of supplying 100 A at 8 V.

D.1.2 *Fire-resistant board* with insulators for supporting the wire.

D.1.3 *Calibrated voltmeter and ammeter*.

D.1.4 *Calibrated stop clock or stop watch*, capable of measuring in 1 s intervals.

D.1.5 *Enamel coated wire*, 18 AWG.

D.2 Procedure

D.2.1 Connect the two ends of the appropriate length of wire (see Annex A) to the terminals of the power supply, and route them around the insulators on the fire resistance board. The wire should form a single path without any kinks or crossovers. The wire should be suspended and should not touch the fire resistance board.

D.2.2 Switch on the power supply and adjust it within the first 10 s of the test to provide 4 V a.c.

D.2.3 When 180 s has elapsed, switch off the power supply.

D.3 Pass/fail criteria

The system is deemed to have passed the test if the detection system registers a response within 120 s of the power supply being switched off.

The response should be equivalent to at least a 15% increase in smoke reading over the background level (where 100% is the fire threshold) sufficient to signal a pre-alarm or warning.

Annex E (normative) Overheated PVC/LSF wire performance tests

E.1 System performance test using electrically overloaded PVC-coated wire (1 m)

E.1.1 Principle

NOTE This method is suitable for the testing of high sensitivity (Class A) and enhanced sensitivity (Class B) fire detection systems.

To simulate the early stages of a fire, a length of wire is electrically overloaded so that smoke or vapours are driven off.

> **WARNING.** This test produces sufficiently high temperatures to generate small quantities of hydrogen chloride. Test personnel are, however, unlikely to be exposed to concentrations of hydrogen chloride that exceed the short term exposure limit (see HSE publication EH40 [4]) of 5 parts per million[3] in a 15 min period unless they are directly exposed to the smoke plume. It is recommended that where it is impractical to arrange for remote switching of the transformer, or where multiple tests are required, or where personnel stand within the immediate vicinity (e.g. 2 m) of the smoke source, personnel should wear appropriate protective equipment such as an E1 respirator conforming to BS EN 140 and goggles without ventilation conforming to BS EN 166.

E.1.2 Apparatus

E.1.2.1 *Wire*, either:

- 1 m in length, of ten 0.1 mm strands insulated with PVC to a radial thickness of 0.3 mm, the cross-sectional area of the conductor being 0.078 mm^2; or
- 2 m in length of single strand low smoke and fume (LSF) ethernet 24 AWG cable.

E.1.2.2 *Transformer*, 240 V to 6 V, capable of supplying at least 15 A.

E.1.2.3 *Insulating board*, of non-combustible material, of minimum size 600 mm × 600 mm.

E.1.2.4 *Stop clock or stop watch*, capable of measuring in 1 s intervals.

E.1.2.5 *Arrangement to shield the overheating cable from the cooling effects of high airflows*, where present.

E.1.3 Procedure

E.1.3.1 Connect the wire to the 6 V output terminals of the transformer.

E.1.3.2 Ensure that the wire is laid on the insulating board so that there are no kinks or crossovers.

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3) 5 parts per million (ppm) = 5×10^{-6}.

E.1.3.3 Connect 240 V mains electricity supply to the primary terminals of the transformer for a period of 60 s.

NOTE After this period, most of the insulation is expected to have been burnt off.

E.1.4 Pass/fail criteria

The system is deemed to have passed the test if the detection system registers a response within 120 s of the power supply being switched off.

The response should be equivalent to at least a 15% increase in smoke reading over the background level (where 100% is the fire threshold) sufficient to signal a pre-alarm or warning.

E.2 System performance test method using electrically overloaded PVC-coated wire (2 m)

E.2.1 Principle

NOTE This method is suitable for the testing of high sensitivity (Class A) fire detection systems.

To simulate the early stages of a fire, a length of wire is electrically overloaded so that smoke or vapours are driven off. Unlike the tests described in **E.1** and **E.3**, hydrogen chloride vapour is unlikely to be produced due to the relatively low temperatures reached.

E.2.2 Apparatus

E.2.2.1 *Wire*, either:

- 2 m in length, of ten 0.1 mm strands insulated with PVC to a radial thickness of 0.3 mm, the cross-sectional area of the conductor being 0.078 mm^2; or
- 2.5 m in length of single strand low smoke and fume (LSF) ethernet 24 AWG cable.

E.2.2.2 *Transformer*, 240 V to 6 V, capable of supplying at least 15 A.

E.2.2.3 *Insulating board*, of non-combustible material, of minimum size 600 mm × 600 mm.

E.2.2.4 *Stop clock or stop watch*, capable of measuring in 1 s intervals.

E.2.2.5 *Arrangement to shield the overheating cable from the cooling effects of high airflows*, where present.

E.2.3 Procedure

E.2.3.1 Connect the wire to the 6 V output terminals of the transformer.

E.2.3.2 Ensure that the wire is laid on the insulating board so that there are no kinks or crossovers.

E.2.3.3 Connect 240 V mains electricity supply to the primary terminals of the transformer for a period of 180 s.

NOTE After this period, the insulation is expected to be scorched but largely intact.

E.2.4 Pass/fail criteria

The system is deemed to have passed the test if the detection system registers a response within 120 s of the power supply being switched off.

The response should be equivalent to at least a 15% increase in smoke reading over the background level (where 100% is the fire threshold) sufficient to signal a pre-alarm or warning.

E.3 System performance test using electrically overloaded PVC-coated wire (2 m × 1 m)

E.3.1 Principle

NOTE This method is suitable for the testing of high sensitivity (Class A) and enhanced sensitivity (Class B) fire detection systems.

To simulate the early stages of a fire, a length of wire is electrically overloaded so that smoke or vapours are driven off.

WARNING. This test produces sufficiently high temperatures to generate small quantities of hydrogen chloride. However, test personnel are unlikely to be exposed to concentrations of hydrogen chloride that exceed the short term exposure limit (see HSE publication EH40 [4]) of 5 parts per million[4] in a 15 min period unless they are directly exposed to the smoke plume. It is recommended that where it is impractical to arrange for remote switching of the transformer, or where multiple tests are required, or where personnel stand within the immediate vicinity (e.g. 2 m) of the smoke source, personnel should wear appropriate protective equipment such as an E1 respirator conforming to BS EN 140 and goggles without ventilation conforming to BS EN 166.

E.3.2 Apparatus

E.3.2.1 *Two wires*, each 1 m in length, of ten 0.1 mm strands insulated with PVC to a radial thickness of 0.3 mm, the cross-sectional area of the conductor being 0.078 mm^2.

E.3.2.2 *Transformer*, 240 V to 6 V, capable of supplying at least 15 A.

E.3.2.3 *Insulating board*, of non-combustible material, of minimum size 600 mm × 600 mm.

E.3.2.4 *Stop clock or stop watch*, capable of measuring in 1 s intervals.

E.3.2.5 *Arrangement to shield the overheating cable from the cooling effects of high airflows*, where present.

E.3.3 Procedure

E.3.3.1 Connect the wires in parallel to the 6 V output terminals of the transformer.

E.3.3.2 Ensure that the wires are laid on the insulating board so that there are no kinks or crossovers.

E.3.3.3 Connect 240 V mains electricity supply to the primary terminals of the transformer for a period of 60 s.

NOTE After this period, most of the insulation is expected to have been burnt off.

E.3.4 Pass/fail criteria

The system is deemed to have passed the test if the detection system registers a response within 120 s of the power supply being switched off.

The response should be equivalent to at least a 15% increase in smoke reading over the background level (where 100% is the fire threshold) sufficient to signal a pre-alarm or warning.

[4] 5 parts per million (ppm) = 5 × 10^{-6}.

Annex F (normative)

Overheated resistor performance tests

NOTE 1 Overheated resistor performance tests are suitable for the testing of ASD systems used for the protection of cabinets containing electronic/electrical equipment such as computer servers or electrical switchgear. The tests are used in these applications in preference to the hot wire tests, because the latter are too bulky and generate large volumes of smoke relative to the confined environment of a cabinet.

NOTE 2 As a general guide, test F.2 produces about three times more smoke than test F.1, and test F.3 produces about three times more smoke than test F.2.

> **WARNING**. These tests produce small quantities of noxious fumes which disperse quickly. However, where it is impractical to arrange for remote switching of the transformer, or where multiple tests are required, or where personnel stand within the immediate vicinity (e.g. 2 m) of the smoke source, then it is recommended that personnel wear appropriate protective equipment such as an E1 respirator conforming to BS EN 140 and goggles without ventilation conforming to BS EN 166.

F.1 Apparatus

F.1.1 *Resistors*, 12 Ω, 0.25 W carbon film (one for tests F.1 and F.2; two for test F.3).

F.1.2 *Transformer*, 240 V to 6 V, capable of supplying at least 15 A.

F.1.3 *Two ceramic terminal blocks*, mounted 25 mm to 35 mm apart on a non-combustible board (at least 50 mm × 50 mm) to support and connect the resistors.

F.1.4 *Shielding tube*, consisting of a pipe (approx. 90 mm diameter and approx. 100 mm long) with eight 4 mm holes around the base and a cap perforated with twelve 8 mm holes.

F.1.5 *Stop clock or stop watch*, capable of measuring in 1 s intervals.

F.2 Procedure

F.2.1 Connect the resistor(s) to the ceramic terminal blocks. Use one resistor for tests F.1 and F.2, and two resistors in parallel for test F.3.

F.2.2 Ensure that the resistors are not touching anything other than the connections to the terminal blocks.

F.2.3 Place the shielding over the resistors to shield them from airflows within the cabinet.

F.2.4 Energize the resistor(s) as follows

a) test F.1: energize one resistor for a period of 8 s;

b) test F.2: energize one resistor for a period of 70 s;

c) test F.3: energize both resistors for a period of 80 s.

F.3 Pass/fail criteria

The system is deemed to have passed the test if the detection system registers a response within 60 s of the power supply being switched off.

The response should be equivalent to at least a 15% increase in smoke reading over the background level (where 100% is the fire threshold) sufficient to signal a pre-alarm or warning.

Annex G (normative) Polyurethane mat performance test

NOTE This test produces dark smoke and significant thermal lift, and is particularly suitable for open areas with ceiling heights greater than 5 m.

G.1 Apparatus

G.1.1 *Polyurethane mat(s)* of non-fire-retardant expanded polyurethane foam (500 mm × 500 mm × 20 mm), meeting the requirements for category TF4 in BS EN 54-7:2001.

NOTE Under normal circumstances, only one mat needs to be used.

G.1.2 *Tray*, constructed of non-combustible material, lined with aluminium kitchen foil.

G.1.3 *Support*, of non-combustible material, to insulate the test fire from the supporting surface calibrated timer.

G.2 Procedure

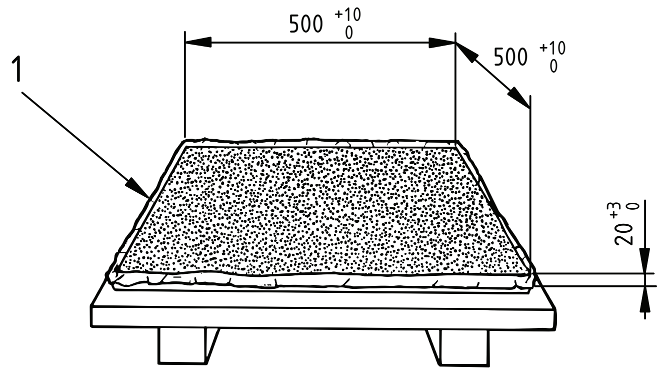
G.2.1 Position the mat(s) on the aluminium kitchen foil in a tray on the non-combustible support (see Figure G.1) and ignite a corner of each mat with a match.

WARNING. The burning of polyurethane foam generates toxic gases.

G.2.2 Renew the aluminium kitchen foil after each test.

Figure G.1 **Test mat on its support**

Dimensions in millimetres



Key

1 Tray lined with aluminium kitchen foil

G.3 Pass/fail criteria

The system is deemed to have passed the test if the detection system registers a response within 180 s of the ignition of the mat.

The response should be a full fire condition unless agreed otherwise by the relevant parties, e.g. local alarm, pre-alarm.

Annex H (normative) Potassium chlorate/lactose performance test

H.1 Principle

NOTE 1 This test is used for the performance testing of Class B and C systems.

Fire is simulated by mixing and igniting two volatile powder chemicals to create white smoke with a strong thermal buoyancy. The mixture burns with an intense heat and is not suitable for confined areas.

NOTE 2 Attention is drawn to the Control of Substances Hazardous to Health Regulations 2002 [5] in respect of chemicals in storage and transport. Attention is also drawn to the Control of Substances Hazardous to Health Regulations (Northern Ireland) 2003 [6].

H.2 Apparatus

H.2.1 *Potassium chlorate*.

H.2.2 *Lactose powder*.

H.2.3 *Steel container*.

H.2.4 *Insulating board or wood battens*.

H.2.5 *Calibrated timer*.

H.2.6 *Long taper*.

H.2.7 *Matches/lighter*.

H.2.8 *Calibrated 15 g measuring spoons*.

H.3 Procedure

H.3.1 Thoroughly mix together the appropriate amount of lactose and potassium chlorate, as determined by Table H.1, in the steel container.

Table H.1 **Lactose and potassium chlorate quantities**

Height of ceiling m	**Lactose** g	**Potassium chlorate** g
<5	30	20
5 < 10	45	30
10 < 20	90	60
20 < 30	135	90

NOTE These quantities are suitable for ambient temperatures ranging from 5 °C to 25 °C. Temperatures outside these conditions may require additional amounts to accommodate the effects of excessive cooling (colder areas) or thermal stratification (warmer areas).

H.3.2 Place the steel container on the heat insulating board or wooden battens, to prevent heat damage to the floor or supporting surface.

NOTE High temperatures are generated as part of the test to create thermal lift.

H.3.3 Ignite the mixture using a long taper or long-handled lighter.

WARNING. The mixture should be ignited with extreme caution at arm's length. These chemicals are very volatile when mixed together.

H.4 Pass/fail criteria

The system is deemed to have passed the test if the detection system registers a response within 180 s of the ignition of the mixture.

The response should be a full fire condition unless agreed otherwise by the relevant parties, e.g. local alarm, pre-alarm.

Annex I (informative) Description of the approach for determining the maximum detection coverage recommended in Annex A

NOTE The purpose of this annex is to provide clarification and examples on how to apply the recommendations given in Annex A for general spacing of detection. A sample form to assist is also provided.

I.1 General

The fundamental approach (see **A.2.1**) is to start with a coverage per detector of 25 m² and then increase or decrease this in accordance with particular characteristics of the environment or of the detection solution used.

Multiple adjustments can be made so the coverage can be increased up to 55 m² or reduced to 5 m². For the majority of installations, however, such extremes are unlikely to be applicable. Most importantly, in practical terms, this approach consolidates and simplifies all the guidance given in previous editions of this standard. The advantage of the new approach is that all necessary information is presented conveniently and precisely in one clause.

Table I.1 may be used to assist with determining and recording the maximum coverage of a single detector or sampling point. The table also summarizes the adjustments presented in **A.2.1**. Examples of specific calculations are given in **I.2** to **I.4**.

*NOTE Where adjustments are mutually exclusive, only one cell is provided for entering an adjustment. For example, it is not possible to adjust for a still void with shallow beams [**A.2.1**g2iii)] and a ventilated void [**A.2.1**g1)].*

I.2 Example 1

In a room containing electronic equipment which has a cooling system that results in an airflow speed of about 0.8 m/s, where there is a Class A ASD located at the air return which shuts down the AHU when triggered, then point detectors or ASD holes positioned on the ceiling would be spaced to give 35 m² coverage per detector. Thus the detectors or holes would be positioned about 5.9 m from each other on a square grid.

*NOTE In this example, only **A.2.1**b) is relevant, giving a calculation of 25 m² + 10 m² = 35 m².*

Table I.1 **Summary of adjustments in A.2.1 and calculation of maximum coverage**

Ref. from A.2.1	Description	Short-form	Adjustment	Calculation A)
			m^2	m^2
	Starting point for calculation	—	—	25
a1)	Airflows >1 m/s (and ≤4 m/s) are present in >25% of the space	>1m/s	–5	
a2)	Airflows >4 m/s are present in >25% of the space	>4m/s	–10	
b)	Air-conditioning is to be shut off by early warning detection at the air return vents	AHU off	+10	
c)	Asymmetric spacing of the detectors/holes is provided whereby a greater than normal density of point/holes is arranged across the prevailing direction of flow	Asymmetrical	+5	
d)	The detection system deployed has enhanced sensitivity (e.g. a sensitivity equivalent to a Class B ASD sampling hole)	Class B	+5	
e)	The detection systems used is an integrating type detector (i.e. ASD or optical beam)	Integrating	+5	
f)	Coincidence detection is provided based on detectors in two zones operating (as opposed to any two addressable detectors)	Coincidence	–5	
g1)	The detection system is in a void which is ventilated or is used as part of the ventilation system	Ventilated void	–5	
g2)	The detection system is in a void which has no ventilation/air flow still air and:			
g2i)	has a smooth ceiling	Still void	+5	
g2ii)	has very shallow beams (e.g. <5% of the void height)	Very shallow beams	–5	
g2iii)	has shallow beams (e.g. between 5% and 10% of the void height)	Shallow beams	–10	
	End point for calculation (total maximum coverage)	—	—	

A) The starting point for the calculation is 25 m^2. Where a characteristic in **A.2.1** is applicable to an application, enter the value from the adjustment column in the calculation column, sum the calculation column, and enter the final value in the bottom right-hand box.

I.3 Example 2

In a room containing electronic equipment which has a cooling system that results in an airflow speed of about 2.5 m/s, where there is a Class A ASD located at the air return which shuts down the AHU when triggered, then either:

a) point detectors or ASD holes positioned on the ceiling would be equally spaced about 5.4 m from each other (to give 30 m² coverage per detector); or

b) if the point detectors or ASD holes are positioned asymmetrically (with a greater density of detectors perpendicular to the direction of flow), they could be spaced with 35 m² coverage per detector. Thus they could be positioned about 5.0 m from each other across the flow and 7.0 m from each other along the direction of flow.

*NOTE In this example, **A.2.1**a1) and b) are relevant, giving a calculation of 25 m² – 5 m² + 10 m² = 30 m², and additionally **A.2.1**c) if the detectors/holes are spaced asymmetrically, giving a calculation of 25 m² – 5 m² + 10 m² + 5 m² = 35 m².*

I.4 Example 3

In a 0.8 m high void which is used as a return air plenum with airflow rates in excess of 4 m/s, the detector spacing would be about 3.1 m, giving a coverage per detector of 10 m².

*NOTE In this example **A.2.1**a2) and g1) are relevant, giving a calculation of 25 m² – 10 m² – 5 m² = 10 m².*

I.5 Example 4

If the void in example 3 was protected using a Class B ASD system with asymmetrical spacing of the sampling holes, then the coverage per sampling hole could be increased to 25 m². Thus the sampling holes could be positioned about 4.5 m from each other across the flow and 5.5 m from each other along the direction of flow.

*NOTE In this example **A.2.1**a2), c),d) ,e) and g1) are relevant, giving a calculation of 25 m² – 10 m² + 5 m² + 5 m² + 5 m² – 5 m² = 25 m².*

Bibliography

Standards publications

For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 476 (all parts), *Fire tests on building materials and structures* [5)]

BS 5306-0, *Fire extinguishing installations and equipment on premises – Part 0: Guide for the selection of installed systems and other fire equipment*

BS 7974, *Application of fire safety engineering principles to the design of buildings – Code of practice*

BS 25999 (both parts), *Business continuity management*

BS EN 2, *Classification of fires*

BS EN ISO 13943, *Fire safety – Vocabulary*

Other publications

[1] FIRE INDUSTRY ASSOCIATION. *Guidance note – Application guidelines for point type multisensor fire detectors*. Hampton, Surrey: Fire Industry Association, 2010.

[2] LOSS PREVENTION COUNCIL. *Gaseous fire protection systems*. LPR 6. Borehamwood: Loss Prevention Council, 2000. [6)]

[3] FIRE INDUSTRY ASSOCIATION. *Guidance note – Guidance on the pressure relief and post-discharge venting of enclosures protected by gaseous fire-fighting systems*. Hampton, Surrey: Fire Industry Association, 2010.

[4] HEALTH AND SAFETY EXECUTIVE. *Workplace exposure limits*. EH40. London: Health and Safety Executive, 2005.

[5] GREAT BRITAIN. Control of Substances Hazardous to Health Regulations 2002 and subsequent amendments. London: The Stationery Office.

[6] GREAT BRITAIN. Control of Substances Hazardous to Health Regulations (Northern Ireland) 2003 and subsequent amendments. London: The Stationery Office.

5) Parts 11, 20, 21 and 22 are cited individually as normative references.

6) Available from the Fire Protection Association at www.fia.uk.com.

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