Code of

Practice

Fire Industry Association

Leading Excellence in Fire Since 1916

Design, Installation, Commissioning & Maintenance of Aspirating Smoke Detector (ASD) Systems Code of Practice

CONTENTS

FOREWORD

Publishing information

This FIA Code of Practice is published by the FIA and came into effect in February 2026. It was prepared by the Aspirating Task Group under the direction of the Fire Detection and Alarms (FD&A) Council. A list of members represented on this task group can be obtained on request from the FIA.

Supersession

This document supersedes the FIA Code of Practice for ASD systems Issue 1, dated February 2012, which is withdrawn.

Information about this document

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

- Update to recommendations for using ASD in warehouses with high rack protection, in the light of results from an FIA sponsored research project
- Introduction of a design/risk spreadsheet/template for the protection of warehouses
- Recommendations for lifts updated following consideration of a number of European codes, particularly in relation to multilevel detection and accessibility.
- Alignment with the latest revision of BS 5839-1 (published in April 2025)
- Incorporating the latest FIA guidance "Fire Detection in High Air Flow Environments" issued June 2020
- Site testing methods reviewed. The paper bin test was extended to make it suitable for Class B & Class A testing in high areas
- Update to the section on product standards and marking requirements (CE and UKCA)
- Rapid attendance ceiling heights removed (in alignment with their removal from BS 5839-1:2013 in 2017)
- Clarification of coincidence (not to be confused with redundancy)
- Additional advice on using ASD for in-cabinet detection
- New section discussing options for multi-sensors in ASD
- Additional advice on the flammability of sampling pipes is provided

Product certification/inspection/testing

Users of this Code of Practice should, wherever possible use product and suppliers/installers which have undertaken third-party certification/inspection/testing. Appropriate conformity attestation arrangements are described in the relevant product standards and certification schemes. Users seeking assistance in identifying appropriate conformity assessment bodies or schemes may ask the FIA for advice.

Competence

It is essential that personnel responsible for designing, installing, commissioning and testing of ASD systems have received suitable training from the manufacturer of the system and test equipment and are adequately equipped to undertake the tasks safely. Prior to starting work, a risk assessment should be carried out.

Where necessary, personnel should wear appropriate Personal Protective Equipment (PPE)

Use of this document

This Code of Practice is intended for use by persons involved in the specification, design, installation, commissioning, maintenance and operation of Aspirating Smoke Detectors.

As a Code of Practice, it provides 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 Code of Practice is expected to be able to justify any course of action that deviates from its recommendations.

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, notes and general informative material are presented in smaller italic type and do 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 Code of Practice cannot confer immunity from legal obligations.

Hazard warnings

WARNING: This Code of Practice 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 Code of Practice 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 to ensure that electrical safety is maintained at all times. The electrical tests described within this Code of Practice are functional methods and do not attempt to cover the requirements for electrical safety.

1 SCOPE

This Code of Practice provides recommendations for the planning, design, installation, commissioning, and maintenance of Aspirating Smoke Detection systems. It identifies categories of ASD systems and typical applications where such systems are used. It also provides specific design rules on common applications and guidance on good practice. However, it does not consider the benefits (or otherwise) of using alternative technologies in the applications described.

A series of performance tests are provided, with guidance on how and where they should be used.

A number of forms are provided in the appendices to be used as checklists to ensure that the correct information is transferred through each stage of the process (Planning, Design, Installation, Commissioning & Maintenance).

This Code of Practice does not define the sampling device (e.g. pipe hole sizes or pipe diameters), which must be specified in-conjunction with the specific manufacturer's design tools.

2 REFERENCES

BS 5839-1:2025	Fire detection and fire alarm systems for buildings - Part 1: Design, installation, commissioning and maintenance of systems in non-domestic premises – Code of Practice
BS 6266:2011	Code of practice for fire protection for electronic equipment installations
BS 4422:2024	Fire – Vocabulary
BS 7671+A4:2026	Requirements for Electrical Installations (18th Edition)
CEA 4022 12/1999	Specifications for fire detection and alarm systems – requirements and test methods for aspirating smoke detectors
EN 54-20:2006	Fire detection and fire alarm systems – Part 20: Aspirating smoke detectors
VdS 2095:2022-06	VdS-Richtlinien für automatische Brandmeldeanlagen – Planung und Einbau (German)
VdS 6036:2024-07	Design Software for Sampling Devices of Aspirating Smoke Detectors
VDE 0833-2:2022-06	Alarm systems for fire, intrusion and hold up (German) Part 2: Requirements for fire alarm systems
APSAD R7 *(2021)*	Règle d'installation - Détection automatique d'incendie (French)
EN 54-2:1997/A1:2006	Fire detection and fire alarm systems – Part 2. Control and indicating equipment
EN 54-4:2001/A2:2006	Fire detection and fire alarm systems – Part 4. Power supply equipment
EN 54-7:2018	Fire detection and fire alarm systems – Part 7. Smoke detectors – Point detectors using scattered light, transmitted light or ionization
EN 54-27:2015	Fire detection and fire alarm systems – Part 27. Duct smoke detectors
FIA Guidance (2020)	Fire Detection in High Airflow Environments
FIA Guidance (2026)	IP connectivity and remote services
FIA CoP DSD (2012)	FIA Code of Practice for Design, Installation, Commissioning & Maintenance of Duct Smoke Detector (DSD) Systems
CDM Regulations (2015)	Construction (Design and Management) Regulations 2015 (Published by Health & Safety Executive - UKgov)

3 TERMS, DEFINITIONS AND ABBREVIATIONS

3.1 Aspirating Smoke Detector (ASD)

A unit consisting of one or more smoke sensing elements, an aspirator, one or more flow sensors and necessary controls/electronics, typically housed in a single enclosure, forming the main part of an ASD system, but excluding the sampling device.

Note: *This does not match the definition in EN54-20 for ASD which specifically includes the sampling device. This distinction is useful for the purposes of providing separate recommendation for the ASD "unit" and the pipework which is the most common arrangement of ASD systems.*

3.2 ASD System

A smoke detection system, in which air and aerosols are drawn through a sampling device and carried to one or more smoke sensing elements by an integral aspirator (e.g. fan or pump).

3.3 Balanced System

An ASD in which there is an equal air flow and thus equal detection sensitivity at each sampling point. (see Section 9.3.4)

3.4 Capillary Pipe

An extended sampling pipe where the diameter is significantly smaller than the main pipe.

3.5 CIE - Control and Indicating Equipment

Equipment in accordance with EN 54-2.

3.6 Coincidence

An arrangement designed so that an output is obtained only when at least two independent input triggering signals are present at the same time [see BS 5839-1:2025 clause 3.10].

Note: *For example, an output suitable for triggering a fire extinguishing 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 fire.*

Note: This is not to be mistaken for "double knock", which is a colloquial term often used for an arrangement whereby an output is given only when two successive signals are received from the same device. [see BS 5839-1:2025 clause 3.10]

3.7 Condition Warning (including early warning)

The status of an ASD (usually reflected as a change of signal at the control equipment), which indicates there has been a significant departure from normal conditions.

Note: a Condition Warning may indicate an approaching alarm condition (see Section 3.17 Pre-alarm) or a significant departure from normal conditions which should be investigated (see Section 8.4.2.2).

3.8 Cumulative Effect

Where combustion aerosols enter more than one sampling point, their combined effect results in the ASD being more responsive than if aerosols enter only one sample point.

3.9 Duct Smoke Detector (DSD)

A detector intended for installation in ventilation ducts for the purpose of controlling the spread of smoke in a building.

Note: DSDs are typically tested to EN 54-27. Further guidance for their use is given in the FIA Code of Practice for DSD.

3.10 Electronic Data Processing (EDP)

Machinery and equipment necessary to receive or transmit data, to process it and either to record or print the output results or to feed the output directly to controlled processes.

3.11 Electronic Equipment Area (EEA)

A room, rooms or areas, containing machinery and electronic equipment that requires protection from fire.

Note: This definition replaces the traditional reference to EDP (Electronic Data Processing) areas to be in line with BS 6266:2011 for Electronic Equipment Installations – i.e. not restricted to Data Processing applications

3.12 Escape Route, Protected

Escape route that is adequately enclosed and is separated by fire-resisting construction from a fire in adjoining accommodation.

[SOURCE: BS 4422:2024]

3.13 Extended Sampling Pipe

A length of pipe extended (i.e. branched or tee'd) from the main pipe with a similar diameter to provide sampling a short distance away from the main pipe.

3.14 Main Pipe

A length of pipe which, together with sampling holes makes up the most common form of sampling device and transports the samples to the ASD unit from the protected space.

3.15 Maintenance Test Point

A test point, at an accessible location, provided beyond the last sampling point, to test the integrity of the pipework.

Note: Such a maintenance test point is closed in normal operation and could have a transport time in excess of the maximum permissible transport time (see Section 9.3.3).

3.16 Maximum Transport Time

The maximum time in the ASD system for aerosols to transfer from the furthest sampling point to the smoke sensing element.

3.17 Pre-alarm Warning

Early warning of conditions which might (or might not) represent a fire, but indicate an approaching alarm condition.

[SOURCE: BS 5839-1:2025 & BS 4422:2024]

3.18 Primary Sampling

An ASD system utilising the air flow created by the air conditioning and ventilation system to carry the sampled air to the sampling points.

3.19 Power Supply Unit (PSU)

Equipment in accordance with EN 54-4

3.20 Referencing

A technique used to counteract the effects of external pollution into the protected area.

3.21 Response Time

The time between the generation of combustion aerosols at their source and the indication of their presence at the ASD.

Note: This includes the propagation time for the smoke to travel from the source to the sampling point(s), transport time through the pipe and the analysis time within the ASD. It is normally associated with performance testing.

3.22 Sampling Device

A component, series of components or dedicated device (e.g. a single sampling pipe, network of sampling pipes, dedicated duct probe or hood) which transfers samples of air to the ASD.

3.23 Sampling Point

Any point at which an air sample is drawn into the sampling device.

3.24 Secondary Sampling

A system where the sampling points are sited and spaced as if they are point-type smoke detectors.

Note: The term secondary sampling is used because such systems are generally located on the ceiling and rely on smoke rising rise to (and moving across) a ceiling to enter a sampling, as opposed to primary sampling which utilises the air conditioning to carry the smoke to the sampling and generally responds sooner.

3.25 Transport Time

The time for aerosols to transfer from a sampling point to the smoke sensing element.

[SOURCE: EN 54-20:2006]

Note: This does not include the analysis time within the ASD or any alarm delays, nor the propagation time for the smoke to travel from the source to the sampling point(s) – see Section 3.21 Response Time.

4 INTRODUCTION TO ASPIRATING SMOKE DETECTORS

The use of ASDs has significantly increased since their introduction and the publication of the 1996 BFPSA Code of Practice for Category 1 Aspirating Systems. Their incorporation into many national installation codes including; BS 5839 Part 1, BS 6266, NFPA 72, NFPA 76 and various European codes demonstrate that ASDs are now accepted as a solution to a wide range of fire detection problems.

The ASD system is often an integral part of the overall fire detection & alarm system particularly when used as an alternative to other detection technologies. When this is the case, the ASD system designer must still maintain compliance to national installation codes, especially for area of coverage, fault monitoring, zoning, battery standby etc.

There are many reasons and motivators for using ASDs. This Code of Practice is intended to describe most of the challenges of specific applications and to provide practical guidance on how to engineer reliable smoke detection solutions using ASD systems.

4.1 Reasons for using Aspirating Smoke Detectors

4.1.1 Very Early Warning

For the earliest indication of smoke so that evasive measures can be initiated *before* any significant damage is incurred in areas containing high value, critical or strategically important artefacts or operations.

4.1.2 Enhanced Smoke Sensitivity

For reliable smoke detection in applications where smoke is difficult to detect (e.g. to combat smoke dilution where there is high air flow or where the ceiling is higher than normal).

4.1.3 An Alternative To Point-type or Beam-type Smoke Detectors

As an alternative to point-type or beam-type smoke detectors for a variety of physical reasons e.g. maintenance access, building deflection, dilution of smoke, and obstructions to the line of sight.

4.2 Other Common Motivators

4.2.1 Extreme Environments

Challenging environments (e.g. high airflows, extreme temperatures, humidity, contamination etc).

4.2.2 Restricted/Difficult access

Future access for maintenance will be difficult or even impossible after installation.

4.2.3 Exceptional Ceiling Heights & Heat Barriers

Stratification, dispersion and dilution issues are present as well as access restrictions.

4.2.4 Aesthetics

Architectural or aesthetic requirements preclude mounting services on the ceiling.

4.2.5 Risk of Mechanical Damage

Operational damage is anticipated (e.g. in racking & storage systems).

4.2.6 Anti-vandal Systems

Vandalism may be an issue, so discreet and/or robust detection is required.

4.2.7 Hazardous Environments

The risk is hazardous e.g. explosive, chemical, high EMF or radioactive environments etc.

5 DEFINITION OF ASD SYSTEMS

As described in Section 4, there are many reasons for using ASD systems. The detection sensitivity of such systems is frequently tailored to the particular application to achieve the performance capability desired without being susceptible to unwanted alarms.

This section describes a means to define any ASD system encompassing all the essential elements in such a way that any individual system can be described in a single unambiguous phrase. The definition takes into account:

- Class of the detector (as defined in EN 54-20)
- Type or method of sampling (e.g. primary or secondary sampling)
- Compliance route (either prescriptive or performance-based)
- Prime motivators for using an ASD system

Table 2 in this section is provided to assist in the correct specification of the ASD system to be deployed and relates to the performance tests presented in Appendices A to H.

Several typical example ASD definitions are given in 5.4.

5.1 Sensitivity Classes

For the purposes of definition there are 3 sensitivity classes which relate directly to those specified in EN 54-20:2006.

Note: *The sensitivity class relates to the "ASD system" (see Section 3.2) and includes any dilution due to the "sampling device". It is not the sensitivity of the detector without dilution.*

Class A - Very High Sensitivity

An ASD system with very high sensitivity that is capable of providing very early warning of a potential fire condition. Such systems are particularly relevant for high-risk areas where staged responses to the multistage alarm conditions are justified to ensure minimum down time of the protected area that may result from any fire-related incident

Class B - Enhanced Sensitivity

An ASD system with enhanced sensitivity, for applications where an additional degree of confidence is required for the protection of a particular risk. The enhanced capability of such systems is often required to compensate for other risk factors in the protected area such as unusually high ceilings or significant air flows.

Class C - Normal Sensitivity

An ASD system designed to give equivalent performance to standard point-type smoke detection systems, meeting the requirements of EN 54-7.

These sensitivity Classes are defined by a number of test fires and for the purposes of illustration the end-of-test conditions for TF2 are included in Table 2.

5.2 ASD Sampling Types/Methods

For the purposes of definition, there are five different approaches to sampling types of ASD.

5.2.1 Primary Sampling

Primary Sampling is arranged to sample from specific locations in the protected area where smoke is most likely to travel or accumulate. Typically this is at the air intake grilles of Air Handling Units (AHUs) or pressure relief vents (PRVs), but sampling may be arranged where smoke is likely to travel. This type of system is usually regarded as supplementary to other forms of detection where its response capability is dependent on external systems such as the air movement provided by AHUs. However, where such conditions exist it is generally acknowledged that ASD systems arranged for Primary Sampling provide the earliest possible warning of a fire condition. Given the fact that Primary Sampling is generally installed to provide early warning or to overcome the challenge of air movement in a particular area, it is recommended that Class A systems should be used with this sampling method. However, in some small or "dirty" applications, a Class B system may be specified.

5.2.2 Secondary Sampling

Secondary Sampling is arranged such that the air sampling points are sited and spaced as an alternative to point-type smoke detectors. Sampling holes are therefore positioned in accordance with prevailing national or international standards. However, it should be noted that these are maximum spacing requirements which are normally bettered when using ASD as a result of performance-based designs. Some example standards are shown in Table 1.

Table 1 – Example standards for sampling hole positioning

Sampling hole positioning in accordance with established standards for point-type detectors		
Country	Standard for normal environments	Standard for high-risk environments
United Kingdom	BS 5839-1	BS 6266
Germany	VdS 2095	VdS 2095 (appendices)
France	R7 Rules	-
USA	NFPA 72	NFPA 76

Where such systems are installed and intended to be in accordance with the appropriate standard, it is important to ensure that the installed performance of each hole (or group of holes if more than one hole is specified to be equivalent to a point-type smoke detector), is equivalent to (or exceeds) the minimum performance requirements of a point-type smoke detector.

The sensitivity of each individual air sampling point (assuming that all sampling points have been designed to provide a balanced system) can be estimated using the following simple calculation:

Individual Sampling Point Sensitivity = Smoke Sensing Element Sensitivity x Number of Sampling Points

For example, a detector with a 0.1 %obscuration/m sensitivity smoke sensing element and a total of 40 balanced sampling points, can be estimated to have a sensitivity at each sampling point equivalent to a 4 %obscuration/m point-type smoke detector.

Where each sampling point is protecting separate compartments, the response of the ASD system may (in crude terms) be considered to be equivalent to a 4% obscuration/m point-type smoke detector.

However, in open areas where smoke can enter more than one sampling point, the response of the ASD system would be significantly better than 4 %obscuration/m. This is known as the cumulative effect and is an inherently beneficial feature of ASD systems.

Note: *The estimation method given above is not sufficient to ensure the performance of the ASD system is equivalent to a point-type smoke detector. Such assurance can only be given through product testing and approval by an appropriate authority against the relevant standard.*

5.2.3 Localised Sampling

For Localised Sampling, the pipework and air sampling points are arranged to monitor specific pieces of equipment within an open area. The method of design can only be established by ASD specialists and test simulations. The sensitivity (Class A, Class B and Class C) of such localised systems can only be determined during the full design considerations by the specialist /manufacturer and may be influenced by any background pollution within the environment. While it is generally the case that the risk will justify the use of an enhanced, Class B, system or very high sensitivity, Class A, system this is not always the case.

5.2.4 In-cabinet Sampling

For In-cabinet Sampling, the pipework and air sampling points are arranged to monitor specific pieces of equipment and are distinct from the use of Localised Sampling systems in that the protected volume is small, generally self-contained and has some distinct challenges and risk associated with the cooling of critical electronic and electrical equipment.

Specific performance tests for such systems are given in this document (see Section 10.4) and it is generally considered that enhanced Class B or very high sensitivity Class A systems are appropriate to meet these performance tests.

5.2.5 Duct Sampling

In some cases, the ASD can be arranged to sample from within a duct. There are two basic applications for such an approach:

- to trigger a control system to prevent smoke being transferred through a building.
- to provide early warning of fire in the area (or equipment) from which the air is being extracted.

The underlying reason for smoke detection in the duct should be clearly stated.

In either case, an earlier warning using a higher sensitivity detector is possible using an ASD system and is often cited as a reason for using an ASD system as an alternative to passive-type duct detectors.

ASD systems can be used for DSD installations dependent on the risk and application. They do not rely on the duct airflow to pass any smoke samples through the detector because of the integral aspirator or fan.

Note: *See the FIA Code of Practice for Duct Smoke Detector (DSD) systems for further information*

In areas that are less than 100m^2 (e.g. detention cells) duct sampling may be at a similar smoke sensitivity to replace point-type smoke detectors i.e. ~4.0 %obscuration/m.

In larger areas the smoke sensitivity would have to be increased to cater for either the increased duct airflow or the larger risk area. Manufacturer's recommendations should be sought to determine the optimum position in the duct for the intake & exhaust pipes and the maximum duct airspeeds (see Section 10.9 for specific application guidance).

When used in a duct sampling application, the maximum floor area covered by one duct-mounted ASD should not exceed 2000m^2 or one fire detection zone under BS 5839-1: 2025 clause 3.23.

Note: When an ASD is used in a duct sampling application to provide early warning of a fire condition the area protected should also be monitored by secondary detection to provide protection in the event of the duct airflow shutting down.

5.3 Route to Compliance (Prescriptive or Performance-based)

The decision as to whether performance tests should be conducted during commissioning depends on the classification of the ASD system being deployed. Generally, there are only a few situations where a performance test can be omitted and that is when, an approved ASD system is deployed (and is fully compliant with the specific requirements of the product approval) and when, sampling hole spacing falls within the full requirements of the relevant installation code (see Table 1). This "prescriptive" situation is highlighted in shaded cells shown in Table 2 below. In all other situations it is recommended that a suitable performance test be specified and carried out during commissioning to verify the system performance. Refer to Section 14.

Table 2 – Sensitivity Classes vs. Detection Requirements

Class (EN 54-20)→	Class A Very High Sensitivity	Class B Enhanced Sensitivity	Class C Normal Sensitivity
TF2x end-of-test condition→	0.05dB/m	0.15dB/m	2dB/m
Description→ ASD Sampling Type↓	Smoke is not visible due to low quantity of smoke and/or high dilution caused by air movement.	Smoke is visible but insufficient to be detected by point-type or beam technologies according to EN 54 Part 7 or 12	Smoke visible and sufficient to be detected by point-type or beam technologies according to EN 54 Part 7 or 12
Primary Detection: - sampling where smoke is likely to travel	Best	Appropriate (small areas only)	Not normally appropriate
Secondary Detection: - positioning sampling holes according to the codes for point-type smoke detectors	For early warning applications	For challenging applications	Appropriate
Localised Sampling: - custom protection of specific equipment	Appropriate for high risk	Appropriate for low risk	Not normally appropriate
In-cabinet Sampling: - localised sampling	Appropriate for high risk	Appropriate for low risk	Not normally appropriate
Duct Sampling: - sampling from an air duct	Appropriate for high risk	Appropriate for low risk	Not normally appropriate
Other Motivators (see Section 4.2) • extreme environments • restricted/difficult access • exceptional ceiling height • heat barriers	• aesthetics • risk of mechanical damage • anti-vandal systems • hazardous environment		

Key:

– dark shaded block indicates where prescriptive design is often used

– light shaded block indicates where prescriptive design may be used – e.g. in high ceiling applications see Section 8.3.2

5.4 Summary and Examples

In summary the ASD definition encompasses:

- Detector Class A, B or C.
- Type/method of sampling – Primary, Secondary, Localised, In-cabinet or Duct.
- Primary Motivation – to clearly identify the principal reason for using ASD.
- Requirements for compliance – by referring to *prescriptive* standards or a *performance-based* test.

This recommended approach to defining the ASD system is illustrated by the following examples:

The ASD system shall be a....

- Class A system providing primary sampling within high airflow area to BS 6266 spacing.
- Class A system providing primary sampling for very early warning to meet Test E.2
- Class B system providing localised sampling of equipment X to BS 6266 spacing.
- Class C system providing secondary sampling for an area with restricted access to BS 5839 spacing.
- Class C system providing duct sampling of a return air duct as part of a smoke containment system to detect a 7-9g pellet according to Appendix A.

6 EXCHANGE OF INFORMATION, PLANNING AND RESPONSIBILITIES

6.1 Exchange of Information

The user or purchaser of the ASD system, or an appointed representative, should ensure that there is consultation at, or prior to, the system design stage with all relevant interested parties. The responsibility for each of the following stages should be clearly defined:

- System Planning
- System Design
- Installation
- Commissioning
- Maintenance

The information relevant to each stage should be clearly recorded. Example forms are in Appendix H reflecting the guidance in this Code of Practice.

6.2 Planning

The system planning stage should provide a clear indication of the ASD system definition (see Section 5) and include details of the environmental conditions to be anticipated, proposed processes and the system performance test proving requirements. On the basis of consultations, documents should be prepared; these may include, but are not limited to:

- Details of the installation proposed, including the ASD system definition.
- Any special accommodation required for the equipment.
- Any special structural provision required for the equipment or its associated pipework such as chases, ducts or supports.
- Any link to the main fire alarm system or any other interface with the "house" fire detection and fire alarm system, equipment such as automatic extinguishing systems, air handling units or building management systems.
- Actions in the event of an alarm.
- Any environmental conditions and processes which may affect detection or have the potential for unwanted alarms
- Any functional/performance tests for the system.
- Any future maintenance access requirements.

6.3 Definitions of Responsibilities

It is desirable that, at the contract stage, one organisation should be designated to take overall responsibility for the performance of the ASD system, and that responsibility is clearly defined in the documentation. Where an ASD system is to be interfaced with another system that is the responsibility of another organisation, the responsibility of each organisation should be clearly defined and documented.

Consideration should be given at the contract stage to ensure that the continued support, corrections or modifications throughout the expected life of the system are subject to the initial design criteria.

Care must be taken by the user or purchaser to monitor for any changes at the location that could adversely affect the ASD system operation as identified by the manufacturer/specialist.

6.4 Action in the Event of an Alarm

To a large extent the design of the fire alarm system will depend on the actions required after the alarm has been given. An ASD system with multiple alarm levels may be required to provide a different action at each level. It is thus essential these actions are pre-planned and the subject of early discussions. (see Section 8.4.2.2)

6.5 Consultations

The interested parties who should also be consulted on behalf of the user or occupier may include the following:

- The manufacturer of the ASD system
- The installer, commissioning and maintenance provider(s)
- The supplier of any 3rd party equipment that the ASD system reports to
- The building services manager/consultant
- The heating and ventilation design contractor

6.6 Multi-occupancy Buildings

If the building is under the control of more than one occupant, then any new processes or changes to the building structure and/or air movement within one occupancy may adversely affect the operation of any ASD system installed elsewhere in the building. It is important that consultations take place with those interested parties early in the planning stage of any ASD system, and throughout the whole life of the system.

7 VARIATIONS FROM THE RECOMMENDATIONS OF THIS DOCUMENT

This document is a Code of Practice and, as such, its contents take the form of recommendations rather than requirements. The recommendations are primarily based on recognised good practice in the design, installation, commissioning and maintenance of ASD systems.

In certain circumstances variations from the recommendations may be necessary, even though in general, the user, purchaser, enforcing authority or insurer requires quite strict compliance with this Code of Practice. These variations refer to aspects of the design that were appropriate and intentional, although not in adherence with one or more recommendations of the Code of Practice.

It does not, however, imply that the designer or installer has the freedom to ignore the recommendations of this Code of Practice under circumstances in which a user, purchaser, enforcing authority, or insurer seeks compliance with it. Variations always need to be the subject of specific agreement amongst all interested parties and must be clearly identified in all relevant system documentation.

Note: The example forms in Appendix I include space to record (or cross-reference to) any variations.

8 DESIGN CONSIDERATIONS

When designing ASD systems, two main aspects require consideration; the design of the ASD system itself (including the sampling device) and the operation/function of the ASD system in the context of a reporting/response system that is often (but not always) an integral part of the overall fire detection and alarm system.

8.1 General

When designing ASD systems to provide smoke detection in accordance with National installation guidelines, the zoning requirements for detectors must be followed (e.g. BS 5839-1:2025, clause 12). ASD systems typically provide alarm indication relating to the general area covered by the sampling device. However, some ASD systems can be designed or configured to give an indication of the location of the relevant sampling point or group of sampling points (see Section 8.2.4).

When the ASD gives a condition warning there should be no confusion about the zone from which it was received. To facilitate responses provided by persons, the zone information should be such that the source of the problem can be rapidly located.

Under normal circumstances, the area covered by a single aspirating detector should not exceed the maximum area of a fire detection zone (e.g. 2000m^2 BS 5839-1:2025 clause 12). This is to ensure that failure of any single aspirator/fan or other critical component within an ASD system has a limited consequence/extent. However, this requirement does not preclude a single aspirating detector from covering multiple (smaller) detection areas within a single compartment/alarm zone/evacuation area.

When operating as a high (Class A) or enhanced (Class B) sensitivity system, the source of the alarm may not be readily visible, leading to an erroneous conclusion that the alarm is “false”. Special training should be provided where required to acquaint security personnel with the abilities of these systems to detect combustion aerosols at an early stage, before there is a visible fire condition.

Where ASD systems are used, especially when monitoring supply and extract ducts, great care must be taken as such systems are likely to be influenced by air movement between areas within a building. Thus, smoke may not be constrained to the area defined by a detection zone. Consideration should be given to monitoring branch ductwork from limited parts of the building and not the main return ducts or plenum.

8.2 ASD Technology

An ASD commonly incorporates a sensor of much higher sensitivity than that used in a point-type smoke detector conforming to EN 54-7 and can respond to much lower levels of products of combustion, or even particles produced before full combustion occurs.

ASD systems rely on three main areas of technology:

- The smoke and flow sensing element(s)
- The air mover such as a fan or aspirator
- The sampling device or pipework system between the area to be protected and the sensors

8.2.1 The Smoke and Flow Sensing Elements

ASD smoke sensors use various technologies to measure the levels of combustion products in air passing through a sensor chamber. Some ASDs use sensitive versions of the technologies used in point-type smoke detectors. Other types of ASD use a laser or other bright source and optimised detection of light-scattering technique, while others use focused laser beams and cloud chamber techniques to determine the level of combustion products within an air sample. Similarly, ASD flow sensors are based on a number of different technologies.

Manufacturers' literature explains the sensor technology they use together with the particular benefits or advantages as applied to particular applications.

8.2.2 The Method of Aspiration

The common method of aspirating the detector is by using a pump, fan or aspirator situated close to the sensor (often in the same enclosure). This causes the air (and combustion products) to flow through the sampling device to the ASD and then presents all, or a proportion of this sampled air to flow through the sensor(s). Most ASDs also incorporate a degree of physical filtering of the air samples appropriate to the sensing technologies used and the intended application.

8.2.3 The Sampling Device

The aspirator draws air into several sampling points in the area to be protected (typically through holes in a pipework system). The correct design of the pipework system is essential to ensure that the air and combustion products are efficiently transported from the protected area to the sensor. Manufacturers provide design rules and/or design software, which are used to ensure the suitable design of the pipework systems.

8.2.4 Multi-channel Detectors

Some ASD systems can identify the individual sampling pipe generating an alarm condition, either by incorporating individual detectors for each sampling pipe or by sampling from individual pipes. In the latter case, the scanning operation can either be performed continuously (with each pipe being sampled sequentially), or sampling may be arranged from all pipes with a scan sequence only being initialised when smoke is detected.

The important factors to consider when applying these types of detectors are:

1. That the detector is approved and has been type-tested to demonstrate that the first alarm is declared within the times allowed in the type testing standards.
2. That, after the signalling of the first alarm, no pipe or channel is left un-sampled for a period greater than 3 minutes.
3. That all areas protected are sub-zones within a single detection zone.

8.3 Sampling Point Spacing and Positioning

As an underlying principle, sampling points need to be positioned where smoke is expected to travel .

8.3.1 Horizontal Spacing in Normal Environments

For prescriptive based designs (see Section 5.3), the requirements of national or international standards should be followed. Specifically, the spacing of the sampling points should follow the recommendations for the spacing and positioning of point-type smoke detectors. Such standards generally specify the area (or radius) of coverage for individual points depending on particular building conditions such as ceiling height, structural beams and pitched roofs. (e.g. 7.5m radius of coverage for each sampling point in BS 5839-1:2025 clause 21).

For performance-based designs, the prescriptive standards provide a very good foundation as a minimum requirement which can be enhanced by taking into account other factors identified during the risk assessment or site survey (such as air flows and obstacles). Often the performance of the system is verified by an agreed test (See Appendices A to H).

Whether a prescriptive or performance-based approach is adopted it is important to take into account any air flows (e.g. as a result of air conditioning) and to provide primary sampling where necessary (see Section 8.3.3).

8.3.2 Ceiling Height Limits

Most national standards prescribe maximum ceiling heights for standard point-type smoke detectors. Increasingly maximum ceiling heights for other detection techniques (including ASD) are also provided.

Historically, the maximum ceiling heights for ASD (according to BS 5839-1 and other European codes) were based on the height recommendations for point-type smoke detectors. As such they were very conservative and there is increasing evidence that satisfactory systems can be installed covering higher ceiling heights – up to 40m. This is largely due to the high sensitivity of the ASD needed to support multiple holes and the cumulative effect resulting from smoke entering multiple sampling holes.

Independent testing[1] has confirmed that a Class C ASD system with 20 sampling holes at a height of 43m can detect relatively small fires (<500kW) for the space. In view of this experience, the recommendations given in Table 3 and the following list are provided. These recommendations have been adopted into some national codes and may be used as a basis for a variation from national codes which do not reflect the above. In all situations where a variation exists the risk should be assessed, and performance tests considered to verify the system response.

[1] see FIA Fact File #45 – Smoke Detection in High Spaces using ASD

Table 3 – Recommended Ceiling Height Limits for ASD

Detector type	Generally applicable maximum ceiling height	10 % of ceiling height no greater than
Any ASD system approved to Class A, B or C (at least 2 holes - see 10.1.1)	10.5m	12.5m
ASD system with: at least 5 Class C holes or at least 2 Class B holes	15m	18m
ASD system with: at least 15 Class C holes or at least 5 Class B holes	25m	28m
ASD system with: at least 15 Class B holes	40m	43m

The following recommendations are provided in addition to the limits specified in Table 3:

a. The ASD holes should be located close to the ceiling (typically within 600mm) and spaced in accordance with the maximum areas specified in national codes (e.g. 7.5m radius in BS 5839-1:2025)

b. An enhanced response can be achieved by using an ASD with increased Class capability. For example, a Class A detector with at least 5 holes will provide enhanced detection in spaces up to 25m.

c. An enhanced response can also be achieved by using a higher density of sampling holes. For example, a Class B system with 10 holes at half the spacing (e.g. 5m as opposed to 10m) will provide enhanced detection in spaces up to 25m

d. Where possible, spacing of sampling holes should be in 2 dimensions (covering an area as opposed to a single line of sampling holes).

e. If multi-channel ASD systems which identify the source pipe are used, the minimum number of holes (15 or 5) should be on each identifiable sub-zone/pipe.

f. The recommendations given assume that there is no stratification and that smoke rises to the ceiling unimpeded by thermal gradients. Where stratification occurs, detection may be delayed until the heat produced by the fire is sufficient to penetrate the stratification layer. Where there is significant stratification or a requirement to detect smaller fires, the provision of vertical sampling should be considered (see Section 8.3.4).

g. Any air flows (e.g. from air conditioning) should be considered and taken into account by the provision of primary sampling where necessary (see Section 8.3.3).

h. The limits given in Table 3 are for high open areas, and are not intended for vertical or flue-like structures, such as lift shafts and stairwells, but may be adapted for such structures. (see Section 10.8)

In applications where; the risk of stratification is minimal, the likelihood of cross flow from ventilation is very small and the ASD system is within the limits recommended in the Table 3 above, then a performance test is unnecessary.

In applications where stratification or cross-flows are indeterminate it is recommended to undertake a performance test. For practical reasons it is often necessary to limit the amount of smoke released into the space. Yet, it is necessary to simulate a realistic fire that has sufficient heat output to carry the smoke to the ceiling. Some standard performance test methods are provided in annexes B, C and G.

8.3.3 Sampling in High Airflow Environments

Protection in high airflow environments is a very common application for ASD systems, and the following sections provide recommendations on how such areas are protected.

8.3.3.1 Primary Sampling Considerations

Generally, the earliest warning of a fire event in high airflow environments is provided by primary sampling, whereby sampling points cover AHU return air grilles. Consider also the need for primary sampling on pressure relief vents, which are a necessary feature of systems that use an external fresh air make up. For primary sampling, the following design points must be considered:

a. The full air intake grille should be adequately covered by several sampling points.

b. It is generally recommended that each sample point should have a maximum area coverage of $0.4m^2$ of the air grille. However, in more complex or particularly large arrangements, there is often pressure to relax this recommendation for practical or economic reasons. Such a relaxation compromises the potential to detect any smoke and should be treated as a variation from these recommendations (and from BS 6266).

c. 3 or more sampling holes should be used to cover a single air intake.

d. Where large airflows into the grille are encountered (e.g. >4m/s) special arrangements may be necessary such as positioning the pipe away from the grille using stand-off brackets.

e. It is generally the case that airflows into the grille follow the louvres (where fitted) the pipe should be positioned in the main airstream.

f. Sampling holes are typically positioned at an angle of 30-60° off-centre, into the airflow.

g. Maintenance access to the air-handling unit should not be restricted by the sampling pipe. Convenient removal of the pipe should be accommodated.

h. Internal mounting of the pipe is sometimes desirable but require special consideration due to the internal operation of the air-handling unit (internal dampers and louvres) and the increased negative pressures relative to the pressure in front of the air return grille.

i. The exit point of a Containment Aisle (often referred to as the “extraction hoods”) can also be a suitable location for primary sampling to add enhancement to the localisation of the fire event. See Section 10.2 and the FIA Guidance document for Fire Detection in High Airflow Environments.

When mounting the sampling pipe, it is generally recommended that the samples are taken upstream of any filtration to avoid the high negative pressures and the possibility of the filters removing smoke before it reaches the ASD system. See Section 10.2 (Electronic Equipment Areas) and Section 10.9 (Duct detection).

8.3.3.2 Secondary Detection Hole Spacing in EEA/High Airflow Environments

To combat the effects of high airflow and subsequent smoke dilution, prescriptive design standards, such as BS 6266:2011 and VDE 0833-2:2022-10 Annex E, specify closer spacing of point-type smoke detectors mounted on the ceiling or in voids. These spacing rules are generally intended for point-type smoke detectors and may be used where the ASD is being installed to meet the prescriptive design goals because each sampling hole has the same coverage as a standard point-type smoke detector. However, in many cases these closer spacing requirements are not directly applicable to ASD and the latest revision of BS 6266 provides some useful adjustments that may be applied to the area covered by each sampling hole. For convenience these adjustments are reproduced below:

BS 6266:2011 (Annex A) recommendations state:

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 airflow.

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 coincidence 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).

8.3.4 Spacing for Vertical Sampling Systems

Where a high risk of stratification has been identified, ASD systems can be engineered to provide three-dimensional volume protection. The pipework and air sampling points can be arranged to provide sampling at lower levels in addition to the top-level horizontal plane (near the ceiling). This can be achieved in practice by using; vertical pipe runs, horizontal pipe runs at different heights, or individual drop pipe or capillaries from the ceiling runs.

For applications where it is only practical to install vertical pipes at the walls of a space (e.g. an aircraft hangar or open warehouse) consideration should be given to alternative means of detection (e.g. Video Smoke or Optical beams) to supplement the ceiling mounted ASD.

However, where such supplemental detection is not practical, it is suggested that for ASD vertical coverage, sampling points are located at 3.0-8.0m intervals in the vertical plane (or 2°C increments of ambient temperature rising through the building, if this is known).

ASDs with sampling points arranged at regular vertical intervals within shafts, flues and tower-like structures are frequently used to give enhanced detection to particular risks or overcome maintenance and access restrictions.

8.4 Reporting, Signalling and System Integration

This section deals with the operation/function of the ASD system in the context of it being part of a reporting/response system which is often (but not always) an integral part of the overall fire detection & alarm system.

8.4.1 Stand-alone Systems

Where the ASD does not report into a CIE, then it is deemed to be a stand-alone system. In this case it may be connected to other equipment directly to perform certain actions under different conditions – such as a BMS system or automatic shutdown of process plant. In such cases, the recommendations for integrated systems (below) should be *considered* in association with the risk and intended operation and should not be applied indiscriminately.

8.4.2 Integrated Systems

8.4.2.1 Visual Alarm Signals

A clearly identified Fire signal should be transmitted to the CIE and clearly indicated at the ASD system itself as a red indicator. The alarm condition should be latched at the CIE until reset. Generally, the local indication should also be latched until reset from the CIE or reset locally at the ASD system.

ASD systems can provide several condition warnings that are intended to be treated as fire warnings, these visual alarm signals should be clearly distinguishable from any signals provided by other devices used on the premises. They should draw attention to the need to investigate the condition in accordance with the action plan (see Section 6.4).

The condition warnings may also cause an audible and/or visual signal at the CIE, which should give a distinctive sound, which is different to the sound given to indicate a Fire condition.

8.4.2.2 Multiple Alarm Thresholds

In certain premises utilising an ASD, which is integrated within a Fire Alarm System, it may be desirable to notify limited staff within special areas for the need to investigate a potential alarm. Three stages of alarm could be as follows:

- First stage (early warning) raising a local signal only for personnel working in an area to investigate.
- Second stage raising a pre-alarm condition at the CIE, which alerts security personnel to investigate.
- Third stage “Fire” alarm raising a fire condition at the CIE to initiate evacuation procedures.

In some systems a fourth stage alarm is available which may be interfaced into an automatic extinguishing system. For more detail see Section 8.7.

Clearly the intent of each alarm stage must be carefully matched to the sensitivity (response threshold) and building operation.

8.4.2.3 System Interfacing

When the ASD system is interfaced to a CIE, the interfacing can either be through relay contacts (direct to a dedicated zone input or direct to an interface module) or through a systems protocol interface compatible with the control system. Any cables that are not within the enclosure or physically protected by short conduit runs between adjacent enclosures should be monitored for open or short circuit faults.

8.4.2.4 Networking

Many ASD systems support networking of individual detectors to allow for remote display, signalling, reference detection, maintenance and interrogation. Such networking/remote capabilities are particularly useful for detectors that are in remote or inaccessible locations such as roof and floor voids or those installed on remote sites such as pumping stations or telecommunication facilities.

Where remote access is provided – either on the same site or from remote sites via modem (or similar) - it is essential that the appropriate access levels are maintained. For example, any changes to the detector settings should only be possible through access level 3 (as defined in EN 54-2). Further guidance on “IP connectivity and remote services” is available on the FIA website

While networks specific to the ASD may be used to transmit the primary fire signals to the CIE, for example, by providing relays local to the CIE but remote from the ASD, the integrity requirements of the network depend on the intended use. Fundamentally when it forms part of the primary reporting path to the CIE, the standards relating to communication of fire alarm signals should be met.

In the UK, BS 5839-1:2025 clause 11.2.2 b) stipulates that a single communication fault should not disable protection within an area of more than 2000m². Due to the large area coverage of a single ASD detector, it is generally the case that each ASD covers a separate zone (see Section 8.1). Therefore, it is essential that any fault on the ASD communication network should not impair the communication from more than one ASD detector. Such communication faults may result from the loss of a detector, display or other device, or from a short, partial short or open circuit on any one link in the network. Careful consideration should be given to the latter and confirmation sought from the manufacturer on the ability of their network to continue communicating the primary alarm information in the event of a single fault.

In addition, BS 5839-1:2025 11.2.2 c) stipulates that two simultaneous communication faults should not disable protection within an area greater than 10,000m². Special consideration must therefore be given to ASD communication networks, which cover areas greater than 10,000m² and redundant reporting paths should be provided to meet this requirement.

Similar requirements prevail in other European territories and reference should be made to the appropriate standards.

However, where the communication over the said network is only for information additional to the primary alarm and fault signals the integrity requirements of the network may be relaxed.

8.5 Fault Monitoring

The ASD should provide fault monitoring for airflow, detector removal/isolation, power supply fault, battery disconnection fault etc. Any fault should be signalled to, and indicated on the CIE or any other monitoring systems on which the action plan depends. Particular specifications or national standards may also require local fault indication within the protected area.

Where the ASD is connected to a CIE the signal cabling should be monitored to the relevant national standards i.e. for open and short circuit fault conditions.

8.6 Maintenance

Maintenance requirements should be considered during system design. In particular, the recommended maintenance intervals and techniques should be defined. If performance parameters (such as air flow and transport time) are used to confirm system performance during maintenance, appropriate deviation limits should be defined and recorded in the maintenance documentation. Typical examples might be:

- Airflow reading during maintenance should be confirmed as ±20% of the values measured at commissioning.

Measurements of transport time from the furthest hole (or dedicated maintenance test point) during maintenance should be confirmed to be within ±15% or ±3 seconds, whichever is the greater, of the same measurement taken at commissioning.

8.7 Power Supplies

Within Europe, the power for the ASD should be supplied by a power supply unit (PSU) complying with EN 54-4. In other territories, appropriate standards should be used.

The PSU should be installed in accordance with local wiring regulations. In the UK, it should be installed to meet the requirements BS 5839-1 and BS 7671.

The PSU may be integral to, or separate from, the ASD. Where the PSU is separate from the ASD, consideration must be given to the fault tolerance of the wiring, particularly where the PSU provides power to more than one ASD. In this latter case a single fault should not disable protection of an area in excess of that allowed by the prevailing standards. In the case of BS 5839-1:2025 a single fault (open or short circuit) should not disable protection within an area greater than 2000m².

PSU faults may be transmitted direct to the CIE (or other relevant monitoring system) or, the PSU fault may be transmitted via the ASD, where this functionality is supported.

The PSU should be capable of supplying the maximum load for the ASD system when in both quiescent and alarm conditions whether the PSU is in normal (e.g. mains present) or standby (e.g. battery only) mode. Where the ASD is installed as an essential element of the fire alarm system, the standby periods should be the same as the fire alarm system. In the UK, BS 5839-1:2025 clause 24.3 should be considered.

8.8 Fire Suppression/Extinguishing Systems

It is possible to use ASD to provide part or all of the smoke detection in areas where automatic extinguishing may be released to suppress or extinguish fires. Usually this includes coincidence detection to avoid false operation and unnecessary extinguishant release. A variety of coincidence arrangements is possible using ASD systems (see Section 8.8.1). Some national codes and product standards exist and specify how extinguishing release is to be arranged in general, but these rarely take into consideration with the use of an ASD system as one or more of the extinguishing input triggers. Some examples of these national codes are:

- BS 7273-1, 3 & 5 Electrical actuation of; gaseous total flooding extinguishing systems, pre-action watermist and sprinkler system, and watermist systems - are relevant in the UK
- FIA have published "Guidance for Coincidence Connection of Detectors for Triggering Extinguishing Systems" which focusses on the recommendations of BS 7273-1
- VdS 2496: "Guidelines for the Triggering of Fire Extinguishing Systems - Planning and Installation"
- VdS 2095: "Automatic Fire Detection and Fire Alarm Systems, Planning and Installation"
- EN 12094, EN 12259, EN 12845 extinguishing series.

Direct triggering of an extinguishing system (without a suppression release panel) is not recommended because an ASD alone does not provide the monitoring and integrity required for such applications.

There are many advantages to incorporating ASD into automatic extinguishing systems and the following points should be considered:

a. The high sensitivity alarm thresholds available on Class A and Class B detectors could provide early warning capability to avoid unwanted suppression release, typically through the use of a primary sampling arrangement (see Section 9.3.1). However, such high-sensitivity signals should not be used for *both* inputs to a coincidence arrangement.

b. Where early indication of a possible suppression release is desirable, the high sensitivity alarm thresholds available on Class A and Class B detectors may be used as one input to a coincident extinguishing system, with the second input provided by a separate, normal sensitivity, detector such as a Class C ASD or a point-type smoke detector, providing room/void (secondary) detection.

c. The normal sensitivity alarm thresholds available on Class C ASDs are fully compatible with extinguishing systems. They may be used as one or both inputs to a coincident system (see Section 8.8.1). However, when using Class C detectors to provide room/secondary detection (see Section 9.3.2) consideration should be given to the cumulative effect and it is recommended that a single zone is limited to a maximum of 10 "normal sensitivity" Class C holes.

d. A lower sensitivity alarm output may be used as an input to the coincidence arrangement, which takes account of smoke entering more than one hole. For example, where it is anticipated that the extinguishing system should operate when there is an appreciable density of smoke at two locations (i.e. sufficient to operate two point-type smoke detectors), it would be appropriate to use an ASD with its alarm threshold set to twice that needed to achieve Class C in recognition of the cumulative effect.

e. Using multiple alarm thresholds based on the signal from a single ASD sensing element is not considered to provide coincident detection. However, it may be relevant in specific applications where the consequences of unnecessary suppression release are minimal.

8.8.1 Coincidence Detection with ASD

Coincidence detection combines the output from two separate devices to verify a fire alarm. The technique is most often applied to automatic fire extinguishing systems where unwanted discharges are expensive and may take time to recharge, leaving the area/risk unprotected while the system is reinstated, but it is also used in other applications where unwanted alarms have unacceptable consequences.

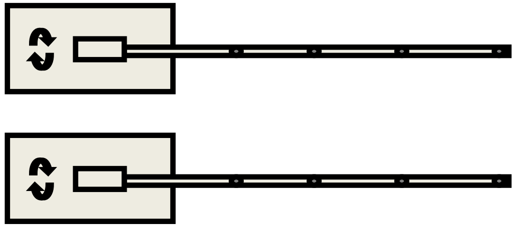
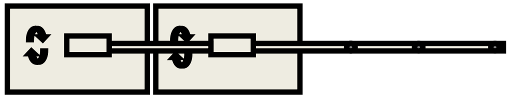
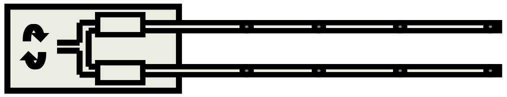
> Historical note:
> Point-type smoke detectors were less reliable and detection systems were structured such that a system output would require activation of 2 detectors: coincidence. This method was refined to overcome the limitations of different detector technologies (e.g. optical-type detectors giving good response to large particle electrical fires and ionisation-type detectors giving good response to small particle paper type fires) by requiring a mixture of detector types on each "circuit". Conversely, in some cases, coincidence was required from two separate and specific technologies to provide confirmation that a fire is in progress. (e.g. ionisation on one circuit and optical on the other).

It is important not to confuse coincidence with redundancy. Redundancy is achieved by a system design in which critical components are duplicated so that, if one fails, there is a backup and the system will continue to function as intended. When multiple detectors are used to achieve coincidence, this does not necessarily provide for redundancy, as both systems must operate to provide the coincident signal.

ASD systems may be used in coincidence configurations and can, where necessary, provide redundancy.

To help clarify the possible arrangements of ASD in a coincidence detection system, four common arrangements, which may provide appropriate redundancy, are illustrated in Table 4.

Table 4 – Redundancy and Coincidence Solutions using ASD

Description	Figure	Comments	Consideration	Disadvantages	Example
Scheme A Two ASD systems protect the same area with independent aspirator, detectors, and pipe networks.		All system components are duplicated with independent detector, fan, and sampling pipe systems. Coincidence or redundancy (not both)	Coincidence achieved from at least two sampling locations.	More equipment required: expensive.	Critical Category Risks, such as Internet Hosting Centres or Nuclear/Biological Control Rooms.
Scheme B Two ASDs protect the same area with independent aspirator, detectors, and a shared pipe network.		ASDs are duplicated: redundancy (excluding shared pipework). Coincidence from independent detectors.	Smoke at a single location could trigger suppression.	Shared sampling pipe network.	High Category Risks such as Main IT Facilities or Telecommunications Areas.
Scheme C A single ASD with two detectors protects against the risk with a shared pipe network and shared aspirator.		Detector modules are duplicated; redundancy is achieved.	Smoke at a single location could trigger suppression.	Shared pipework and aspirator fan.	Medium Category Risks, such as Call Centres.
Scheme D A single ASD with two detectors protects against the risk with separate pipe networks.		Coincidence from independent sampling pipe networks and detector modules.	Fan is not redundant.	Shared aspirator fan.	Medium Category Risks such as Call Centres.

9 DESIGN TOOLS

The design of the sampling device is critical to the performance of the ASD system.

ASD systems draw samples through multiple sampling holes. The sensitivity of each hole is dependent on the amount of air entering each hole relative to the total flow through the detector (and of course its sensitivity). Generally, the objective is to have an equal amount of air entering each hole so that the system is "balanced". However, practical considerations such as the range of drill diameters available mean that some compromises must be made.

It is essential that the manufacturer of the ASD system provides a design methodology to ensure that the design of the system meets the performance requirements.

This is achieved through the application of design rules, tables and/or software supplied by the ASD manufacturer.

On no account should the design tool or methodology from one manufacturer be used to design the sampling arrangement and/or predict the system performance of an ASD system supplied by another manufacturer because the individual characteristics of each system are NOT identical.

In essence, the design tools may be *prescriptive* – giving design solutions (e.g. hole sizes) based on pre-determined performance goals, or may be *descriptive* – predicting the performance of the system (e.g. transport time, hole sensitivity, etc.) based on a given design arrangement. Generally, they have an element of both but as with all design tools, it is important that the designer is fully trained and competent to use the tools and understands the results presented.

Irrespective of the technique used to calculate the system design, the design tools will require a number of input parameters to be specified. These parameters will provide predictions of the performance/capability of the ASD system that can be measured to verify the installed system. (see Section 14)

Details of the design input parameters and output predictions are specific to individual design tools but may include the following.

Design Input parameters

- Area to be covered
- Sampling point positions
- Pipe configuration
- Pipe sizes
- Temperature
- Atmospheric/Differential Pressures
- Airflows
- Sensitivity selection
- Transport Time objectives

Design Output predictions

- Transport Time
- Sampling Hole Relative Sensitivity
- Sampling Hole sizes

- Pipe sizes
- Airflows/Balance
- Suction Pressure

Some of the inputs/outputs may be reversed depending upon the design tool used.

Generally, the better the information that is entered into the design tool, the better will be the prediction that the design tool will provide.

Note: Design tools are not formally assessed under EN 54-20:2006, but they are used to determine the "worst case" sampling arrangement subjected to fire tests. VdS have published guidelines (VdS 6036) containing requirements and test methods for ASD with Design Software for Sampling Devices which MAY influence future revisions of EN 54-20.

One of the major benefits of ASD systems is the ability to tailor the sampling pipe design to the specific requirements of the application. However, there is a trade-off which needs to be appreciated/understood. This is best illustrated by outlining the two fundamental approaches to pipework design, often referred to as closed-end pipe and open-end pipe:

9.1 Closed-End Pipe

In closed-ended pipework a balanced system is achieved through sampling points of various sizes; in this case, the furthest sampling points are sized in relation to the remaining points (i.e. they are larger to compensate for the lower suction towards the end of the pipe furthest from the detector).

9.2 Vented-End Cap

Vented-end pipe networks reduce transport time by arranging for the last hole (usually in the end cap) to be larger than the rest, accepting the compromise that this may result in a particularly sensitive last hole.

This arrangement allows single-size holes to be used for the remaining holes while maintaining acceptable balance.

Note: *When ASD systems were first introduced, open-ended pipe systems (no end cap) were installed. This practice is not currently recommended by any of the major ASD manufacturers because the air would be drawn from the open end rather than the sampling points. Such systems are not recommended.*

9.3 Pipe Design Consideration

9.3.1 Primary Detection Sampling Systems

These are arranged to monitor for smoke carried by air movement inherent in the protected space using pipework and air sampling points mounted directly in the return airflow. This type of system is usually regarded as supplementary to other forms of detection due to its limited response capability once the air movement ceases.

In such a system, when monitoring a single point of supply or extract, the system sensitivity may be directly related as equal to the sensitivity of the central detector due to the cumulative effect. In the case of a system monitoring more than one point of supply/extract, then the system sensitivity will only be determined in discussions with the manufacturer or their representative.

9.3.2 Secondary Detection Sampling Systems

These are arranged such that the air sampling points are sited and spaced as if they are point-type smoke detectors. They can be positioned to satisfy BS 5839-1 or BS 6266 requirements, when the calculated relative sensitivity per air sampling hole equates to a point-type smoke detector (see Section 9.3.5).

9.3.3 Maximum Permissible Transport Time

The time taken for a system to transport a sample from a protected area should not exceed 120 seconds (2 minutes).

Transport times in excess of this should be the subject of a variation - see Section 7. Shorter maximum transport times may be required by particular systems for compliance with their EN 54-20 product approval. Shorter transport times are often desirable in certain applications and should be specified as part of the risk assessment. For example, Class A ASD systems are generally designed with transport times of less than 60 seconds, where early warning is the objective.

Maximum transport time can be directly affected by the layout of the sample pipe, see Figure 1.

The 4-pipe designs (C & D in Figure 1) will generally provide the shortest transport time because the distance from the end of the pipe is shorter. Note that the three pipe designs B, C and D in Figure 1 could be provided by a multiple inlet ASD (as shown) or by branching from a single pipe entry but, in general, branching of a pipe network may compromise the flow monitoring capability of the system – see Section 9.3.6.

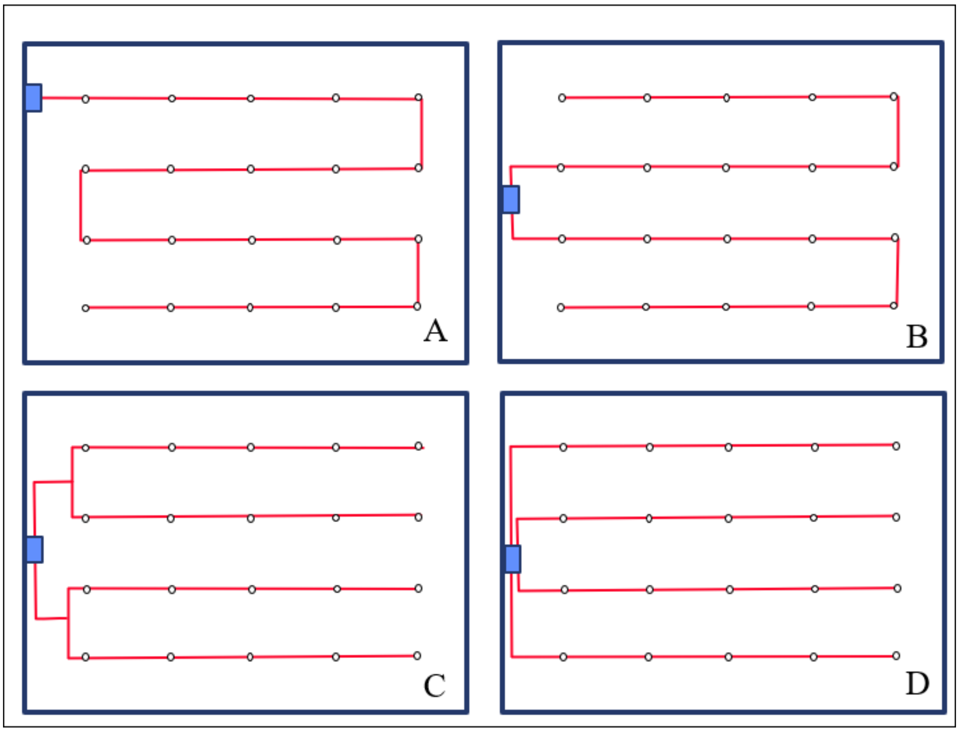


Figure 1 – Example pipe layouts to illustrate the effect on transport time

9.3.4 Balance

Balance is generally expressed as a percentage. For an exact definition refer to the manufacturers, as there is no universal definition. However, if all the sampling points have the same amount of air entering each sample hole (an unrealistic ideal), then this is described as a system with 100% balance.

9.3.5 Relative Sensitivity

The relative sensitivity of each air sampling hole can be calculated from the fractional proportion of air entering each hole compared to the total flow through the detector. For example, with a 0.1 %obscuration/m detection device, if 10% of the air is entering through a hole then the relative sensitivity of that hole is 1 %obscuration/m.

In practice, it may be useful to assume that all sampling points have the same amount of air entering each sample (i.e. 100% balance) whereby the relative sensitivity of each hole can be estimated as a simple function of the detector sensitivity and the number of sample points.

For example, a 0.1 %obscuration/m high sensitivity detection device connected to pipework containing 40 balanced air sampling points can be regarded as a 4 %obscuration/m system which can be considered as a Class C sensitivity system.

9.3.6 Airflow Monitoring

Good practice pipe design should consider airflow monitoring and aim to minimise the area (number of holes) that could become unprotected through hole blockages or pipe breakage without triggering the airflow monitoring function of the ASD.

Note: EN 54-20 only requires that an airflow fault be indicated when there is a 20% (or more) change in volumetric flow through the detector).

9.3.7 Recommendations

The design methodology for the ASD system should be understood and in full accordance with the manufacturer's instruction and approval requirements.

Open-ended pipe systems (with no end cap whatsoever) are not recommended.

The maximum transport time should not exceed 120 seconds (2 minutes).

The relative sensitivity of each sampling point should be better than 5 %obscuration/m unless otherwise stated in the manufacturer's documentation or design tool.

The predicted performance of a sampling network should be compared with the measured performance on-site in order to confirm that the pipework is installed as intended.

10 APPLICATIONS

This section is intended to describe some of the challenges associated with specific applications of ASD. It highlights some of the common pitfalls and suggests possible methods to avoid or overcome them.

The applications listed below are common examples of usage for ASD. This list is not exhaustive and there are many other applications where an ASD can be usefully deployed.

10.1 Normal Environments

ASD systems are increasingly being used in "normal" environments on account of the benefits afforded by: concealed sampling holes, centralised maintenance and/or the cumulative effect.

10.1.1 Number of Sampling Points Per Area

Where an ASD is used to protect a number of separate areas/rooms, it is good practice to provide at least two sampling holes for each area/room, wherever possible. This is to reduce the possibility of a decrease in sensitivity due to a partially or fully blocked sampling hole. The use of two sampling holes per area/room will ensure that the benefits of the cumulative effect are present to provide more reliable detection.

10.1.2 Areas Protected – Limited by Investigation Time

While addressable point-type smoke detection can indicate the location of the individual area/room, an ASD (used to protect a number of separate areas/rooms) may not be able to provide such information (see Section 10.1.3). However, when investigating an alarm, the extra time provided by a Class A or Class B ASD system may compensate for the lack of addressability in that configuration. Furthermore, a Class C alarm is likely to be readily apparent upon investigation, particularly where the number of areas/rooms is not excessive and each is readily accessible (e.g. <10 rooms with unlocked or 'windowed' doors). However, the important factor when determining the number of separate areas/rooms that can be covered is the time it takes to reach them and inspect them. Search distances are specified in some codes for non-addressable systems, but the following recommendations are also provided in terms of search times.

It should be possible to investigate all individual areas covered by a Class C ASD within 1 minute of arriving at the zone and by travelling less than 60m.

Where the ASD system is arranged to provide a Class B pre-alarm signal, and it is possible to investigate all individual areas covered by an ASD within 2 minutes of arriving at the zone and by travelling less than 60m.

Where the ASD system is arranged to provide a Class A pre-alarm signal, and it is possible to investigate all individual areas covered by an ASD within 5 minutes of arriving at the zone and by travelling less than 60m.

Note: The 60m travel distance limits recommended above match BS 5839-1:2025 clause 12

10.1.3 Areas Protected – Multi-Chanel ASD

Some multi-channel ASD systems can identify the channel (or pipe) into which smoke is drawn and so provide a more precise indication of the likely location of the fire within the zone. Where such capability is available, the recommendations given in 10.1.2 apply to each individual sub-zone that can be identified.

10.2 Electronic Equipment Areas (EEA)

Fire Detection in Electronic Equipment Areas is continually evolving to keep track of data centre developments and good design practice is covered in several documents. BS 6266:2011 has a wealth of guidance, but also reference should be made to the FIA Guidance Document – Fire Detection in High Airflow Environments.

Within this type of environment, there are a number of issues to be considered in designing the ASD system. These being:

- High airflow
- Lack of smoke energy
- Resultant low smoke temperature
- Dilution caused by airflow velocities
- Addition of clean air by ventilation systems
- Increased use of containment aisles

Due to these issues, it is considered best practice to protect areas using both primary and secondary detection principles to provide early warning and protection when the AHU is not operational. Detection is therefore required at ceiling level, and at the return grilles of the AHUs. Detection in ceiling and floor voids should also be provided where necessary or where required by the risk assessment.

Note that BS 6266:2011 clause 8.3.2.2 suggests that the sole use of primary detection may be considered when the AHU will remain operational for 24 hours in the event of a power failure. However, careful consideration should be given to the risks associated with not having secondary detection as there may be times during commissioning and maintenance when the AHU is not operational.

Dependent upon the area being covered, it is often necessary to use separate ASD systems to monitor the specific areas as identified in the preceding paragraph. However, in small applications, it may be possible to use a single Class A detector to provide primary and secondary cover depending on its capabilities (refer to the manufacturer's data).

Secondary detection spacing, at ceiling levels and within voids, will require the sampling points to be spaced in accordance with Section 8.3.3.2 (which reflects the guidance from A.2 of BS 6266:2011).

Primary detection of air return grilles or pressure relief vents can be used to overcome the effects of high airflows, which often prevent the smoke particles from being detected at ceiling level. The maximum number of air return grilles that can be monitored by a single ASD is generally limited to four, depending on the air grille size, airflow and the specific ASD being used. Refer to the manufacturer's recommendations when designing Primary Detection for such areas.

A sampling pipe is required to be installed across the grille with the sample points positioned typically at an angle of 30-60° off centre, into the airflow to avoid the pressure build-up on the face of the pipe. Maximum spacing recommendations are given in Section 8.3.3.1. The use of a union socket is recommended to allow the selection of the final orientation during the commissioning of the system and to allow for maintenance access to the grilles of the AHU.

Increasingly, the concept of containment aisles is applied to improve energy efficiency. These aisles are either designed as Cold or Hot containment aisles.

Cold Containment Aisles (CCA) are where a corridor is created between equipment racks, so the chilled air is allowed to pass horizontally through the racks. This air then returns to the AHU return air vent through the main body of the data hall. See Figure 2.

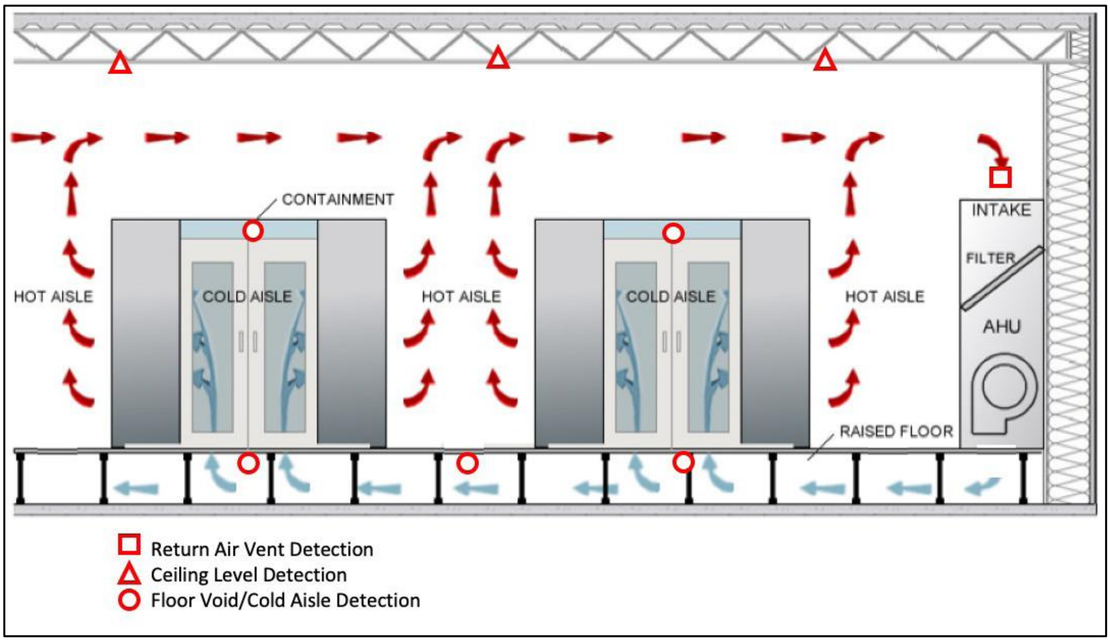


Figure 2 – Cold Containment Aisle (CCA) illustration

In Hot Containment Aisles (HCA), which are more common, the cold air is fed into the main body of the data hall, again to flow horizontally through equipment racks into the Hot Aisle, where the air is then ducted through a chimney arrangement to the ceiling void acting as a return air plenum to the AHU Return Air Vents. See Figure 3.

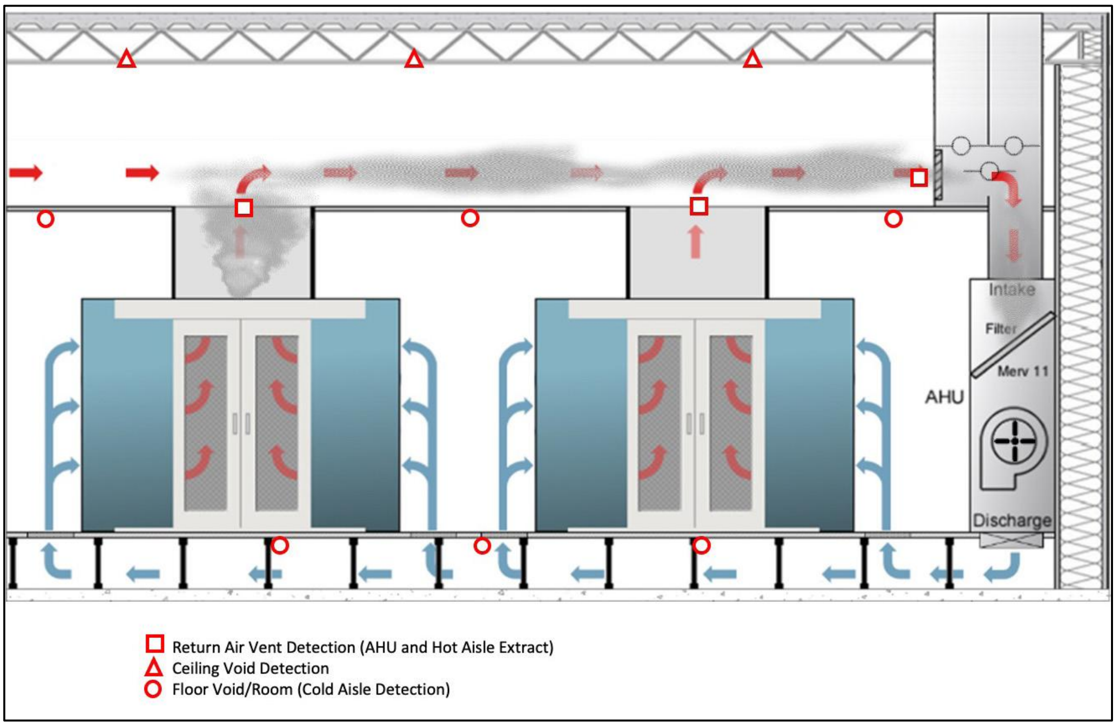


Figure 3 – Hot Containment Aisle (HCA) illustration

In both cases of CCA and HCA arrangements, there are still AHU return vents that should be covered for primary detection.

The additional benefit of the HCA extraction chimney is that additional Primary Detection can be applied to this location. This allows the large area of a data hall to be broken down into smaller areas allowing for a better targeted response to a fire signal.

Another airflow consideration in data halls that can have an impact on effective use of ASD systems is fresh air make-up or “free cooling”. This is where external air is used to help cool the data hall and is commonly applied in areas where external air temperatures are low.

When this fresh air is fed directly to the data hall, smoke particulates can cause an unwanted alarm on the data hall ASD. This issue can be mitigated by the use of reference detection whereby another ASD unit is used to monitor the incoming air and this will temporarily adjust the sensitivity of the ASD in the protected space (see Section 12.1.4).

Although free cooling is common, its effect on the data hall is not always as described above because the incoming air is often heavily filtered before it enters the data hall. As such, the designer must have a full understanding of the airflow and filtration being applied.

As suggested in BS 6266:2011 clause 13, detection in areas with ancillary facilities providing the services that support EEA areas needs to be considered. Generally, these are protected to the same level as the areas they serve. Of particular note is the growing demand for Battery Energy Storage Systems (BESS). Batteries have been used for many years as part of the UPS system, providing power in the event of a mains power loss before a generator can be brought online.

BESS installations have always been a fire risk. However, with the increased use of Lithium-Ion batteries, this risk is much greater and specific protection/detection systems are needed to monitor them. However, there is still a need for ASD detection systems as the batteries are managed by a high density of electronic equipment that requires fire detection.

BESS will be found inside data halls or, more commonly, due to the understanding of the risks associated with Li-Ion batteries, in storage enclosures outside of the main building.

10.3 Warehousing

Within this type of environment, there are a number of issues to be considered in designing the ASD system. These being:

- High ceilings
- Stratification
- Compartmentalisation caused by racking/shelving
- High fire load
- Maintenance access
- External/internal pollutants

For open warehousing, the recommendations given in Section 8.3 for spacing and height limits should be followed, with special consideration being given to the compartmentalisation that is determined by the racking/shelving.

Special attention should also be given to specific areas such as forklift truck recharging areas, control systems, loading/docking areas and electrical distribution equipment.

It is not possible to provide prescriptive guidance on the most appropriate detection arrangement in every warehouse, particularly those containing substantial amounts of racking.

The quantity, density and positioning of the sampling points will depend on the level of risk and the nature of the goods/area to be protected. The cumulative effect makes ASD systems particularly effective in detecting diffused smoke at high levels, and this, coupled with the ability to locate the detector for convenient maintenance, makes it a natural choice for warehouses. In addition, the deployment of ASD for in-rack detection is a common solution to counter the propagation time needed for smoke to rise to the ceiling and thereby achieve earlier detection (compared to the ceiling mounted systems) thus, enabling earlier intervention. While a high density of strategically positioned sampling points in the rack will provide the best level of protection, any design must be based on a risk assessment that considers all factors.

For the purposes of this Code of Practice, five example detection schemes are described (see Section 10.3.1) to illustrate various levels of protection to match the risks presented by typical warehouse scenarios. It is not an exact science so a "graduated" approach, ranging from "code compliant", "minimum spec", ceiling mounted ASD through to comprehensive in-rack detection, is used. The five example schemes are NOT intended to be prescriptive but, together with assistance provided by the warehouse design template presented in Section 10.3.2, they provide a basis to select and describe an appropriate scheme to apply.

10.3.1 Five Example Schemes for Protecting Warehouses Incorporating Racking

The five schemes represent particular factors or inputs to improve the probability of detecting a fire early. Whether that is early enough to facilitate *safe* early intervention to minimise risk to property needs careful consideration, but appropriate use of multistage alarms (see Section 8.4.2.2) should facilitate timely evacuation of the premises.

10.3.1.1 Scheme 1 - Ceiling detection only – normal coverage:

Represents an ASD system at the ceiling only with coverage per sampling point in line with the recommendations of BS 5839-1:2025 (and Table 3 of this CoP). Pipework may run in the same direction as the aisles (as shown in the left-hand illustration in Figure 4) or perpendicular to them (per the right-hand illustration). The choice often depends on practical considerations such as the direction of roof purlins, the most suitable location for the ASD, and the aspect ratio of the floor area. However, attention to minimising transport times is essential (see Section 9.3.3).

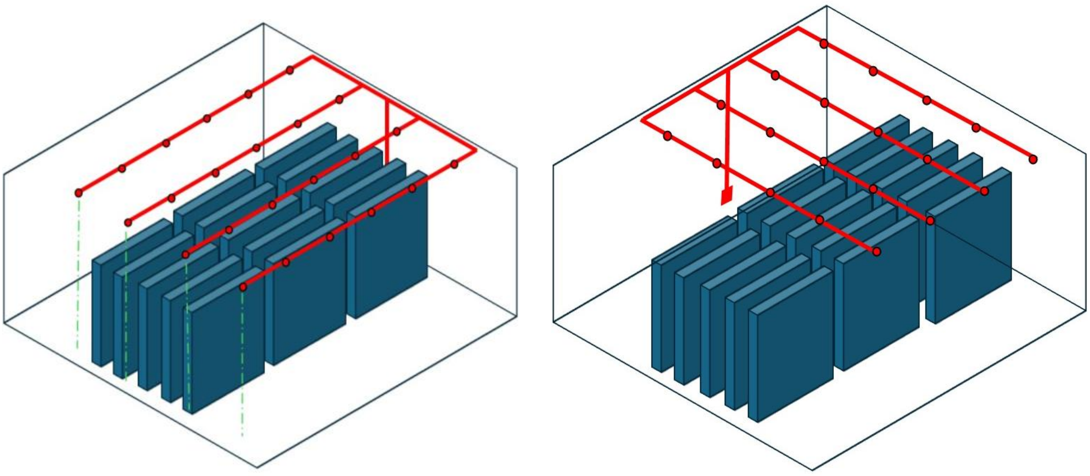


Figure 4 – Warehouse Scheme 1 - Ceiling detection only

10.3.1.2 Scheme 2 - Ceiling detection only – strategically positioned relative to the racking:

Represents ASD at the ceiling only with sampling point coverage related to the racking aisles and storage rack layout. Pipework may run above and *along* the aisles (as depicted in the left-hand illustration in Figure 5) or *across* the aisles (per the right-hand illustration). The choice will depend on practical considerations (see examples in Scheme 1 above). However, it should be appreciated that the left-hand scheme will direct personnel to one of four aisles while the right-hand scheme will provide no useful information other than, perhaps, how far along the aisle the incident is.

Note: While attempts have been made to install a matrix (running pipe in both directions) in an attempt to identify the location of an incident this has not proved particularly successful due to timing differences and the tendency for smoke to spread somewhat chaotically!

Smoke modelling has indicated that there is no significant performance advantage (such as improved response time) in the choice. However, where the ASD is able to identify which pipe is the source, then running pipe along the aisles clearly has the advantage of identifying the aisle of concern. Moreover, the advantage of the left-hand scheme is all the more acute when the racking reaches close to the ceiling (e.g. within 1m), as smoke will tend to spread *along* rather than *across* the aisles, so the cumulative effect will be more pronounced. However, the left-hand scheme will almost certainly require more pipework than the right-hand scheme.

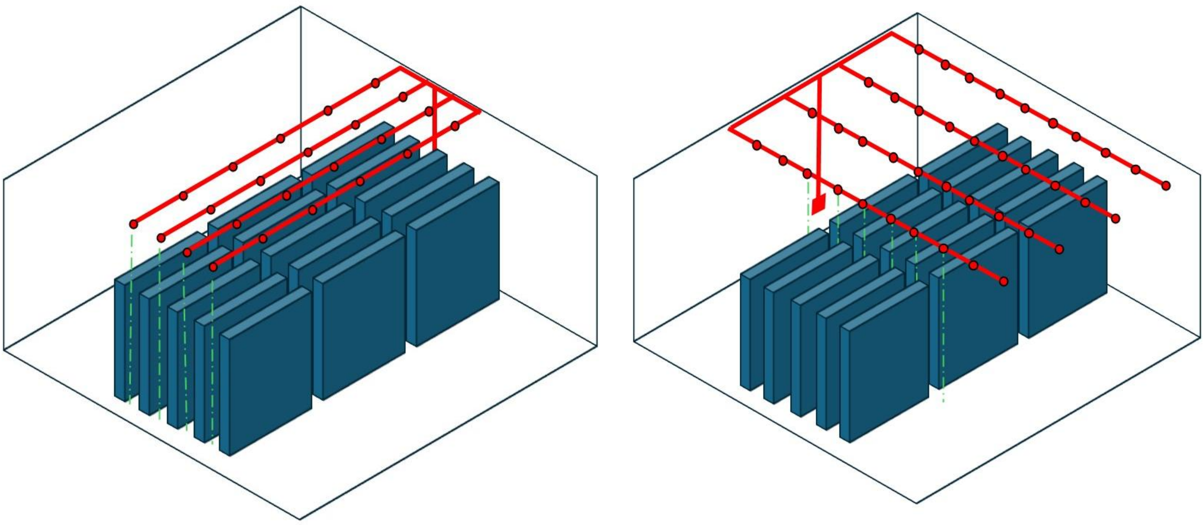


Figure 5 – Warehouse Scheme 2 - Ceiling detection strategically positioned relative to the racking

10.3.1.3 Scheme 3 – Ceiling plus top of rack detection:

Represents in-rack detection at the top of the rack in addition to the sampling holes at the ceiling (see Figure 6). This scheme is only really advantageous if the top of the rack finishes significantly short of the ceiling (e.g. rack height < 80% of ceiling height) or if the ceiling detection is according to "normal" coverage and not positioned relative to the racks (see schemes 1 & 2).

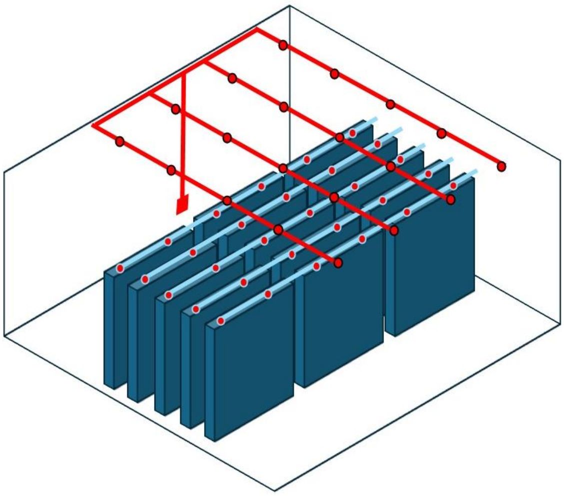


Figure 6 – Warehouse Scheme 3 - Ceiling detection plus top of rack detection

10.3.1.4 Scheme 4 – Ceiling plus Multi level in-rack detection:

Represents multi-level in-rack detection in addition to the sampling holes at the ceiling. The physical characteristics of the racking will largely dictate the routing of the pipes and spacing of sampling holes. Usually, the pipes run horizontally with holes spaced to provide good coverage of the whole rack.

The layout in the left-hand illustration in Figure 7 shows one additional level using horizontal pipe runs with the hole spacing matching, but offset relative to, the top-of-rack detection (Scheme 3).

The layout in the right-hand illustration in Figure 7 depicts a design with more detection levels with the relative position of holes offset between layers.

The higher the ceiling and the racking, the more important it is to have in-rack detection. Guidance on the spacing of sampling holes can be found in Section 10.3.4.

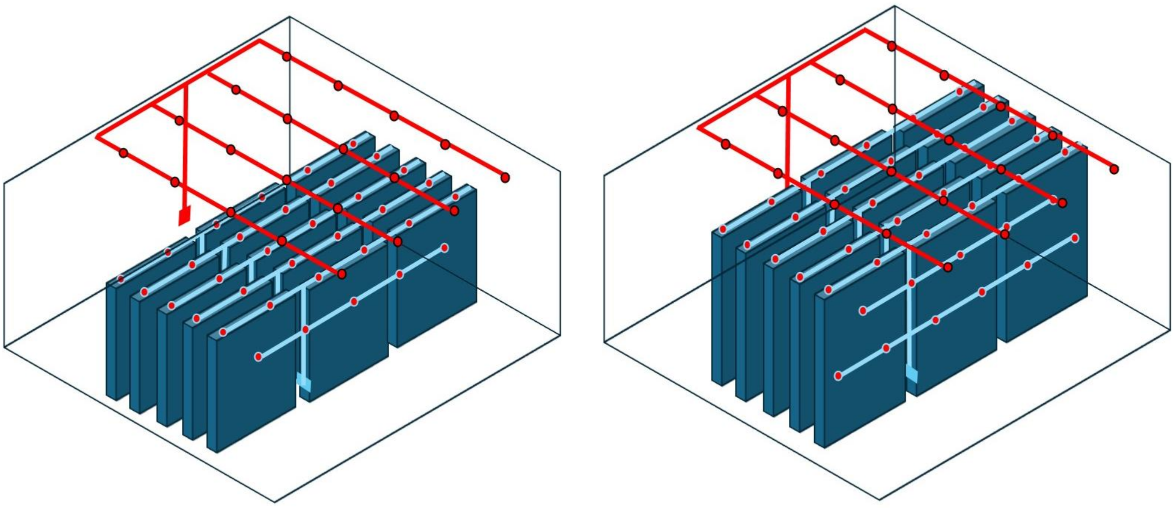


Figure 7 – Warehouse Scheme 4 - Ceiling detection plus multi-level in-rack detection

10.3.1.5 Scheme 5 – Ceiling plus localised multilevel in-rack detection

Represents a scheme whereby pipe runs are arranged vertically which, with a multi-channel type of detector, can help to identify the location of a fire event along the aisle when each vertical pipe (or pair of vertical pipes) can be identified as the source of smoke. The arrangement also has the advantage of minimising transport times as the pipe runs are shorter. However, there may be practical challenges with locating detectors within the aisle and any advantages that may be gained by offsetting the holes between the horizontal planes will be difficult without complex pipe runs.

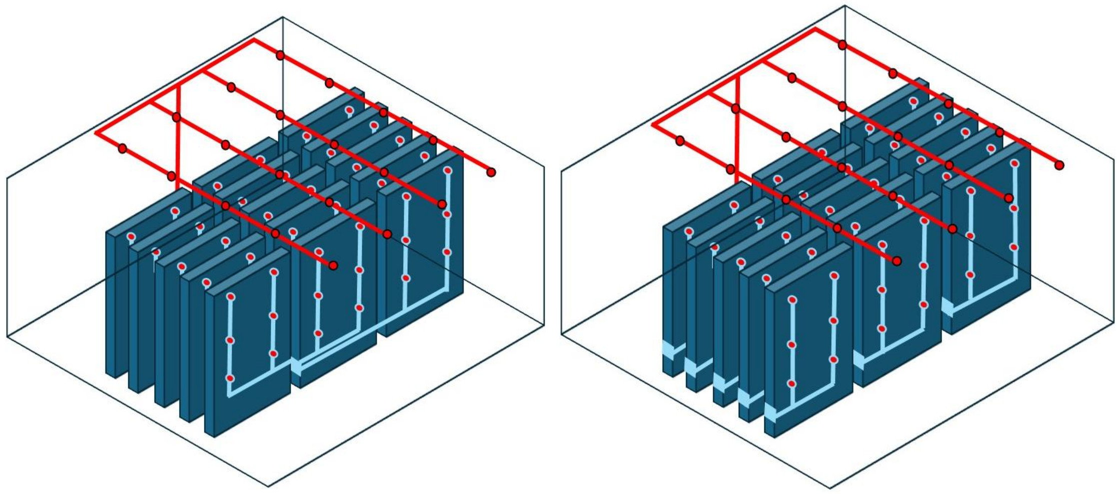


Figure 8 – Warehouse Scheme 5 - Ceiling detection plus localised multi-level in-rack detection

Beyond Scheme 5 it may be necessary to increase the density and/or sensitivity of detection to mitigate specific risks. For example, applying primary detection to mitigate airflow challenges in cold store applications or where mixing fans are used for heat distribution.

10.3.2 Warehouse Design Template

The design template provided in Table 5 below is a tool to indicate, rather than prescribe, the appropriate ASD solution for a warehouse. The template leads the designer/specifier to consider several questions (6 risks and 3 mitigations) and score them on a scale of 1 to 5. The result, simply the total sum of the 9 scores, is compared with the 5 schemes presented in Section 10.3.1 to indicate which might be most appropriate.

Further guidance (~key) on the 9 considerations included in Table 5 is provided on the following page Furthermore, an excel version of the table is available from the FIA using the following link:

https://www.fia.uk.com/static/3d814c56-ceed-481f-8e2008f969a2c354/ASD-CoP-Warehouse-ASD-Design-Considerations-Spreadsheet.xlsx

A screenshot of this spreadsheet, with a completed example (and including the key) is provided in Table 6.

WAREHOUSE ASD DESIGN CONSIDERATIONS

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The following greyscale table is provided to allow the designer/specifier to consider several questions regarding the overall aspirating detection system design within a warehousing facility. The emphasis and conclusions of the various questions guide the designer/specifier to a selection of five different detection schemes. Scheme 1 to Scheme 5 contain increasing amounts of aspirating system detection points to protect the warehouse facility more comprehensively.

One of the five boxes underneath each of the highlighted questions may be used to confirm the degree of risk/consideration for the particular warehouse facility. By way of weighting the results of all the questions should suggest one of the five schemes detailed below the questions.

Against each of the considerations below enter figures on a scale of 1 to 5 to determine the suggested scheme.

- While integers are expected to be used, this is not mandatory if greater precision is required.
- Numbers greater than 5 can be used if a weighting against specific risks is required.

Scale	Consideration	Scale	Score	Guidance
Low (1)	Criticality of the warehouse to the business	High (5)	0	Increasing criticality of facility 1 to 5
Low (1)	Consequence of the loss	High (5)	0	Increasing consequence of loss 1 to 5
Low (1)	Ceiling Height	High (5)	0	1: h ≤ 10; 2: 10 < h ≤ 15; 3: 15 < h ≤ 20; 4: 20 < h ≤ 25; 5: 25 < h h = height in metres
Low (1)	Flammability, fire load and risk of fire spread	High (5)	0	Increasing risk 1 to 5
Low (1)	Probability of ignition	High (5)	0	Increasing probability a fire will start 1 to 5
Low (1)	Detection challenges (airflows, obstacles, temperature gradient)	High (5)	0	Increasing difficulty to detect fire 1 to 5
High (1)	Occupancy	Low (5)	0	Higher occupancy offers ability to provide early warning 1 to 5
High (1)	Response capabilities	Low (5)	0	Ability to respond and fight an incipient fire Full on-site fire fighting = 1; No ability to respond = 5
High (1)	Provision of automatic suppression (sprinklers)	Low (5)	0	Full sprinkler coverage = 1; No sprinklers = 5

9	10 to 18	19 to 27	28 to 36	37+
Scheme 1	Scheme 2	Scheme 3	Scheme 4	Scheme 5
Ceiling only normal coverage (see table 3)	Ceiling only strategically positioned relative to the racking	Ceiling + top of rack detection	Ceiling + multi-level in rack detection	Ceiling + localised multi-level in rack
0				
OVERALL SCORE				

Overall score is given simply by summing inputs.

The suggested scheme based on responses is highlighted in yellow.

The bar graph below adds detail to aid the decision - for example if close to boundary perhaps could consider next scheme.

Table 5 – Design Template for Graduated Approach to Warehouse Design

KEY to Table 5

Criticality of the warehouse represents the importance of the warehouse facility to the business. For example, if this is a single warehouse supplying numerous outlets, then this is more critical to this business than one which may have multiple warehouses (perhaps regional), which could allow the continuation of supply to the outlets if one warehouse is damaged or lost through fire.

Consequences of loss represent the effect of the loss of some or all of the warehouse facility through fire. How many stock and operational processes are still available to continue to supply products, and how long could it take for the restoration of normal supplies? How will the business be able to operate following the fire event? Can the business operate following the fire event?

Ceiling height can influence how a fire may develop and spread through a warehouse, and therefore the resultant amount of stock that could be affected by a fire event. As building height increases, the density and quantity of racking and stored stock generally increase, therefore, an increased fire detection provision may be more appropriate.

Flammability, Fire Load and Risk of Fire Spread represent the potential growth of a fire event based on what may be stored in the facility. Increased detection should be considered if the stored stock is flammable, creates a large fire load and permits ease of the fire event to spread quickly. Alternatively, if little fire risk is represented by the stored stock, potentially less detection may be required. However, the design should still meet minimum standards.

The probability of ignition represents the likelihood of a fire event happening within the facility. Are there potential ignition sources such as elec./mech. plant, forklift truck or charging areas, are Lithium-Ion batteries used/charged/stored. Is 'hot working' allowed? Is there a potential for arson from staff or non-staff? The higher the probability of a fire event, would represent the requirement for additional detection.

Some facilities may present **Detection Challenges**. These could include natural and forced airflow changes and airflow movements, temporary or permanent structural or operational obstacles, significant temperature variations, or temperature extremes such as sub-zero cold storage facilities. Detection systems should consider the significance of these factors and be adjusted accordingly.

Occupancy represents the availability of staff within the facility (at all times), able to act quickly in response to a developing fire event. Staff, with access to all areas of the warehouse, could prevent a small fire event from becoming a larger one. In automated warehouses, there could be very few staff within the facility, making any human intervention unlikely, and thereby increasing the demand for additional automatic detection.

Response capability represents the timeline for a response to a fire event. This can be a facility response by staff to attend a developing fire event, a building fire protection system such as sprinklers, or local fire brigade availability and response. Increased detection may be required if the above are not considered adequate.

WAREHOUSE ASD DESIGN CONSIDERATIONS

The following greyscale table is provided to allow the designer/specifier to consider several questions regarding the overall aspirating detection system design within a warehousing facility. The emphasis and conclusions of the various questions guide the designer/specifier to a selection of five different detection schemes. Scheme 1 to Scheme 5 contain increasing amounts of aspirating system detection points to protect the warehouse facility more comprehensively.

One of the five boxes underneath each of the highlighted questions may be used to confirm the degree of risk/consideration for the particular warehouse facility. By way of weighting the results of all the questions should suggest one of the five schemes detailed below the questions.

Against each of the considerations below enter figures on a scale of 1 to 5 to determine the suggested scheme.

- While integers are expected to be used, this is not mandatory if greater precision is required.
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Low (1)	Criticality of the warehouse to the business	High (5)	0	Increasing criticality of facility 1 to 5
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High (1)	Occupancy	*Low (5)*	0	Higher occupancy offers ability to provide early warning 1 to 5
High (1)	Response capabilities	*Low (5)*	0	Ability to respond and fight an incipient fire Full on-site fire fighting = 1; No ability to respond = 5
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9	10 to 18	19 to 27	28 to 36	37+
Scheme 1 Ceiling only normal coverage (see table 3)	**Scheme 2** Ceiling only strategically positioned relative to the racking	**Scheme 3** Ceiling + top of rack detection	**Scheme 4** Ceiling + multi-level in rack detection	**Scheme 5** Ceiling + localised multi-level in rack
0				
OVERALL SCORE				

Overall score is given simply by summing inputs. The suggested scheme based on responses is highlighted in yellow. The bar graph below adds detail to aid the decision - for example if close to boundary perhaps could consider next scheme.

Table 6 – Design Template for Graduated Approach to Warehouse Design

10.3.3 Ceiling Detection

A 'code-compliant' design may be achieved using a Class C ASD system mounted on the ceiling as an alternative to point-type smoke detectors, thereby providing advantages both in terms of installation and maintenance, and in improved sensitivity to diluted smoke on account of the cumulative effect.

However, in recognition of the large fire loads and high values associated with storage it is often advantageous to provide enhanced protection at the ceiling, particularly in areas where items are stored above 5m. In such circumstances, a ceiling-mounted Class B ASD system should be considered with sampling holes spaced according to national guidelines (e.g. max 7.5m from any location on the ceiling according to BS 5839-1).

Ceiling-mounted sampling points should be positioned above the aisles wherever possible, particularly where the rack height is >90% of the ceiling height.

Note: *BS 5839-1 recommends that where racks reach within 300 mm of the ceiling, the storage racks should be treated as walls that extend to the ceiling and as such detection should be provided in every aisle.*

Note: *In some cases, it may be practical to run pipes across the aisles with spacing >10m and with sampling holes spacing <10m positioned above the aisles (see Figure 9). In other cases (particularly retrofit projects) it may be more practical to run pipe along the aisles (see Figure 10). The former is likely to require shorter pipe runs and can cover every aisle while the latter, which may be more convenient to install, will either require more pipe OR may only provide sampling above every other aisle which may not be optimal. Furthermore, many warehouse layouts have long aisles, and it may be more practical in terms of transport time and the provision of a floor height maintenance test point to run pipe across the aisles. The decision depends on the particular characteristic of the warehouse to be protected.*

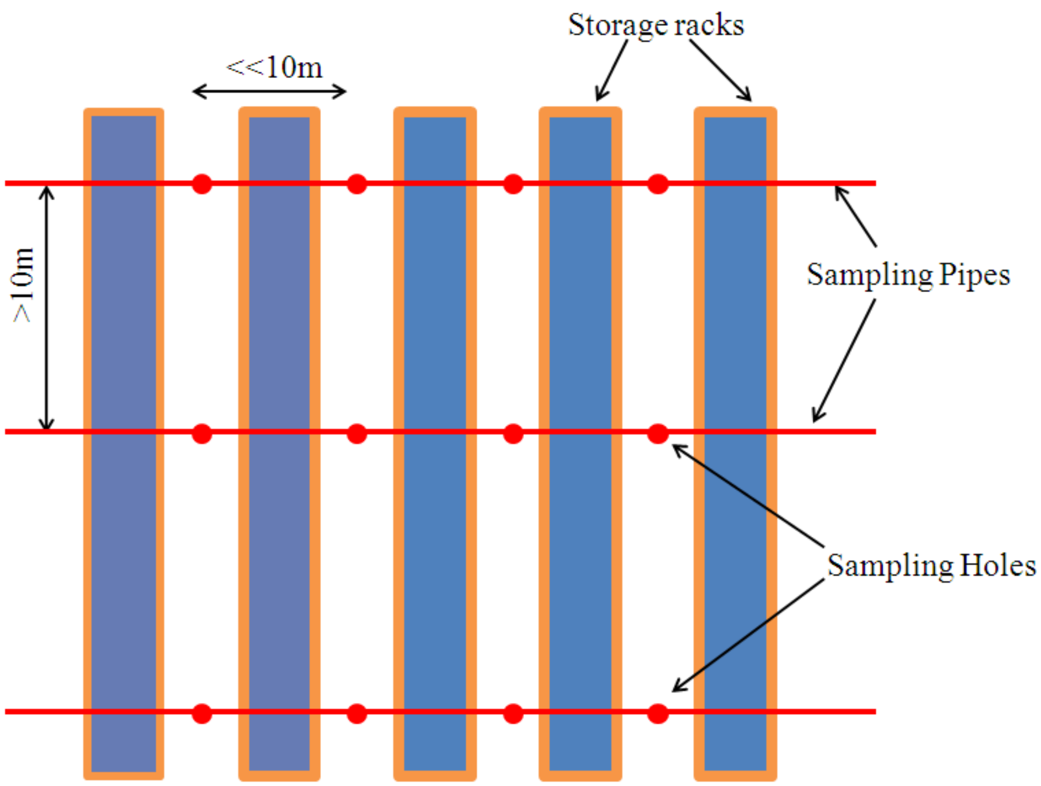


Figure 9 – Warehouse ceiling pipes running *across* the racks

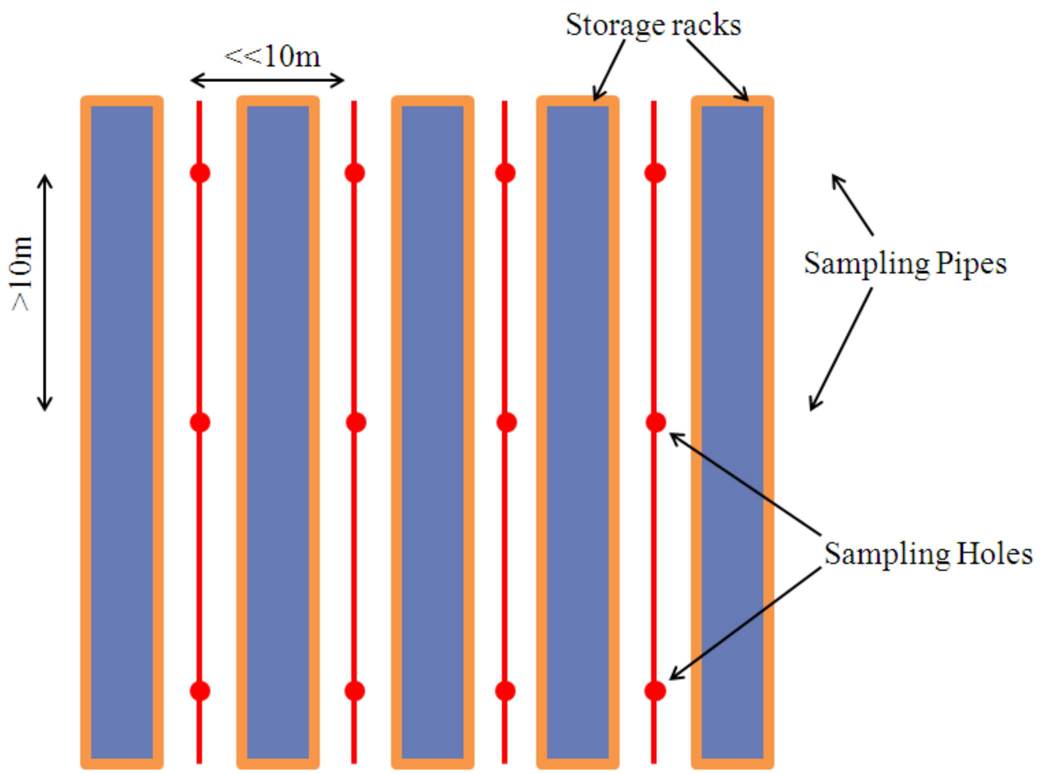


Figure 10 - Warehouse ceiling pipes running *along* the racks

10.3.4 In-rack Detection

When using in-rack detection, the quantity, density and positioning of the sampling points in the rack will depend on the level of risk and the goods/area to be protected.

The following points provide recommendations for the minimum spacing of in-rack detection which are applicable in whole, or in part, to solutions depicted by schemes 3, 4 or 5 in 10.3.1.

1. When protecting warehouses with high racking or shelving, sampling points should be provided within the rack commensurate with the fire load created by the stored items and the height of the rack. A higher density of sampling holes in the horizontal plane is recommended to reduce the possibility of smoke passing between sampling holes.

   A maximum horizontal spacing of 6m is recommended.

2. Where rack heights extend above 8m, in-rack sampling should be provided. The top level of in-rack sampling should be within the top 25% of the rack height and no less than 10m from the ceiling. Additional levels of in-rack sampling should be provided to ensure a maximum vertical spacing of 8m. Thus, racks where rack heights exceed ~10.5m are likely to require two levels of detection and racks over ~21m are likely to have 3 or more levels of sampling.

3. Where multiple levels of sampling are provided, each level should be offset from the one below to minimise the possibility of smoke rising vertically and passing between multiple layers of sampling points.

   Note: W*here practical considerations suggest that a vertical pipe solution is preferable this recommendation may be omitted provided that the horizontal spacing (see point 1) is not excessive (e.g. <6m)*

4. The positioning of pipework and sampling holes within the rack will depend on the details of the racking and items to be stored. In general, there are two options.

   A) Position the pipework and sampling holes within the space between back-to-back shelving.

   B) Position the sampling holes at the shelving edge, adjacent to the aisles

   Aisle-side sampling may provide faster detection of ignition sources in the aisles as it is closer to the likely ignition source (e.g. vehicles in the aisles) compared to detection in the central “chimney” (if present in the space between back-to-back shelving). However, modelling has indicated that the response time advantage is not substantial. Furthermore, while aisle-side sampling may be easier to install and test, it is more exposed to the risk of mechanical damage. The decision needs to be made on a case by case basis in the knowledge of the rack design, the fire risk of the materials stored and the operational activities. However, in general it is more typical to install detection in the chimney,

   Note, *when using aisle-side sampling it is not generally necessary to provide it on both sides of the aisle unless the aisle is very wide (e.g. >3m). However, where multi-level sampling is provided, consideration should be given to offset the levels across the aisles.*

   These recommendations are illustrated in Figure 11.

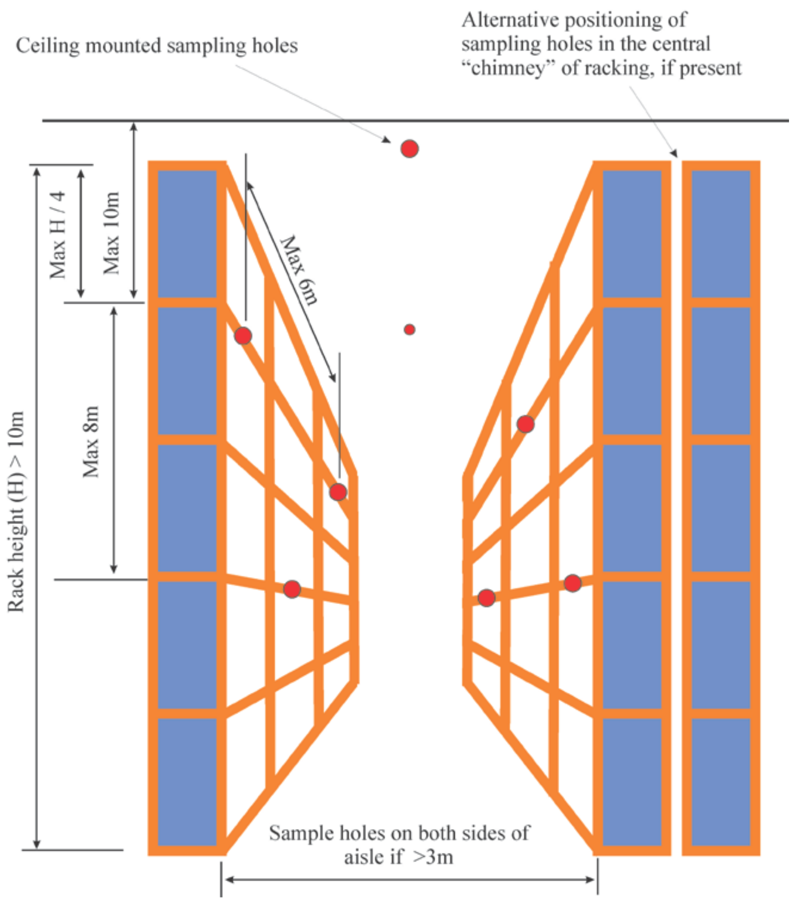


Figure 11 – Illustration of sampling hole locations for in-rack detection

10.4 In-Cabinet Detection

Cabinets often contain equipment which is critical to the operation of a business, and hence, consideration should be given to providing localised smoke detection to provide the earliest possible response. Higher sensitivity sampling should be considered for particularly critical cabinets or where the airflows are high.

Cabinets generally fall into 3 types, which additionally may or may not be compartmentalised:

- Sealed - Where cabinets are sealed, internal sampling is required. Dependent upon the sealing integrity, it may be necessary to provide a breather air inlet or exhaust return sampling arrangement. If the cabinet is compartmentalised, it is recommended that a sampling point is provided for each compartment.
- Naturally ventilated - Cabinets that are ventilated without forced air movement rely on natural air movement, a combination of internal and external sampling may be required.
- Forced ventilated - Cooling air is generally supplied through the floor or sides. All extract (grilles) should be protected.

A portable sampling detector may be useful when searching and identifying the cabinet that is the source of an alarm, particularly where the ASD system is Class A.

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

10.4.1 Sample Hole Location & Recommendations

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

a. 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 be provided where the ventilation exits the cabinet. In a naturally vented cabinet, this will be the upper vent.
b. Multiple sample points should be provided where the cabinet has more than one outlet vent or very large outlet vents.
c. Multiple sampling points should be provided in cabinets with internal compartments which impede the movement of smoke internally with at least one hole in each compartment.
d. Multiple sampling points should be provided where the cabinet is large (e.g. greater than 1200x600mm footprint).
e. Forced cooling air is likely to introduce dilution effects, and consideration should be given to using higher sensitivity detection (Class A or B).
f. It may be beneficial to install external smoke collection covers/hoods to outlet vents to avoid installation of pipework on or inside the protected cabinet and thereby channel/direct smoke towards the sampling points.
g. Where cabinets are fitted with in-cabinet suppression systems, the detection system should provide an alarm signal for each cabinet (or for each group of cabinets if the suppression system discharges into multiple cabinets simultaneously).
h. Where the cabinet or enclosure is sealed, environmentally protected or has a specified IP rating, the detection arrangement should maintain the same level of sealing. Particular attention should be given to any penetrations of the cabinet walls. It may also be necessary to provide a breather air inlet or to return the ASD exhaust to the cabinet. Consideration should also be given to installing the ASD within the cabinet to avoid any possible degradation of the cabinet's sealing/integrity.
i. ASD units should be installed in close proximity to the cabinets wherever possible to avoid transport time delays associated with long pipe runs

These recommendations are very general and where the cabinets are particularly critical or where there are high air flows then the number of sampling holes in each cabinet should be increased.

10.4.2 Number of Cabinets Protected

Consideration needs to be given to the number of cabinets monitored by a single ASD system, with respect to the search and identification of the generated smoke particles. The recommendations of Section 10.1.2 may be used for determining the number of cabinets protected by a single ASD or the following recommendations may be considered:

- For cabinets protected by a Class C system – max 5 cabinets
- For cabinets protected by a Class B system – max 8 cabinets
- For cabinets protected by a Class A system – max 15 cabinets

These recommendations are very general and where the cabinets are particularly critical or where there are high air flows then the maximum numbers protected by a single ASD should be reduced.

10.5 Heritage Buildings

When designing ASD systems for heritage buildings it is necessary to consider the following:

- Aesthetics
- High ceilings
- Stratification

ASD can be utilised within heritage buildings to provide discreet air sampling that is not visible to normal occupants.

The design and décor of the room will often determine the positioning of the air-sampling pipe network. Concealing the sampling pipe within the fabric of the building can provide discreet smoke detection. Small-bore pipes can be connected to the main pipe network to provide discreet detection at the required location (i.e. blending in with paintings, forming part of ceiling sculptures, merged into cornices or incorporated into chandeliers). It is not unusual to install two sampling points near opposite corners rather than in the centre of the room.

Installation codes often specify a minimum distance to a wall or other obstruction (e.g. BS 5839-1:2025 clause 21.2.8 recommends a minimum distance of 500mm). While the active sampling characteristic of ASD might support a minor variation from these recommendations, it would be prudent to perform a smoke performance test (see Appendix A) for any significant variation from this recommendation.

In large volume applications, such as cathedrals, it is recommended that the ASD systems are installed at high levels and at intermediate levels to overcome stratification (refer to Sections 8.3.2 and 8.3.4).

The ASD should be installed in accordance with national standards, with special consideration given to the recording of any variations necessary for the practical positioning of the sampling holes.

10.6 Harsh and Hazardous Environments

ASD systems can provide reliable smoke detection in environments where other forms of detection are unsuitable.

Harsh environments can be identified as areas where the sampled air is generally outside the normal working conditions of the detector and therefore requires additional precautions. Typical areas are cold stores, freezers, food preparation areas that require frequent wash down, high temperatures from ovens or machinery and conveyors/escalators which can be dirty or dusty. Each situation will require different installation considerations.

10.6.1 Cold Areas

Cold storage and process areas fall into three categories,

- Blast freezers that have high air movement and very low temperatures (often as low as -30°C)
- Freezer stores that have less air movement and chill storage (typically -18°C to -25°C)
- Process areas normally at 3°C to 5ºC.

All these environments require an assessment of the following considerations.

10.6.1.1 Temperature of The Air Sample

If the sampled air temperature is below the manufacturer's specification, the air sample may require warming before it enters the ASD. There are three techniques generally employed. Firstly, to have sufficient pipe outside the cold area, whereby the normal ambient temperature will raise the temperature of the air sample within the pipe to an acceptable level. Secondly to heat a section of the pipe with trace heating tape and thirdly to pass the air sample through an enclosure that contains a heater.

Note: Even if the temperature of the sample entering the detector is within the manufacturers' specification consideration should be given to external condensation forming on the cold equipment during periods of high humidity.

10.6.1.2 Moisture

The risk of moisture entering the ASD in a cold store is low because condensation normally forms on the outside of the cold pipes as they exit the cold store and not inside, however where there is any risk of condensation forming inside the pipes the recommendations of Section 10.6.2 should be followed.

10.6.1.3 Freezing of the Sampling Points

In general, freezers are dry because all moisture is frozen, but the following should be considered.

- Sampling points should not be positioned near to doors or directly in front of the freezer units.
- When doors are opened, humidity in the warm air entering the freezer freezes.
- Another source of moisture is from the freezer units when in a defrost cycle.
- Sampling points should not be positioned directly in front of the freezer units.
- Where there are particular problems with the icing up of individual sampling points local heating can be employed to prevent it or other techniques such as regular backflushing of the pipe with dry air may be appropriate.

10.6.1.4 Installation

The pipes can be installed in, or above the area to be monitored. In either case it is imperative that whilst pipe is being installed into an existing cold area that all open ends of the pipes penetrating through the ceiling / insulation are temporarily sealed until the final connections are made. This is to stop moisture in the air condensing inside a pipe, then running down to the sampling point and freezing.

Where there is a requirement for the ASD exhaust to be returned to the cold store then consideration should be given to the possibility of icing at the re-entry point.

Consideration should be given to the type, layout and fixing of the sampling pipe used as pipe will expand and contract when subjected to changes in temperature. In addition, the pipe material must be suitable for use at low temperatures.

10.6.2 Wet Areas

Where water can enter sampling points, such as wash down areas, the normal precaution is to mount the ASD so that the sample pipes enter from below and a water trap is incorporated into the pipe. This can range from simple U-bend to a proprietary water trap. A drainpipe with an automatic or manual drain valve can be fitted to the U-bend. For a water trap to be effective, it is important that it is installed at the lowest point in the pipework. Multiple traps may be needed where there are several low points in the pipe runs.

10.6.3 High Temperature Areas

If the sampled air temperature is above the manufacturer's specification, the air sample will need to be cooled. Cooling the sample is likely to produce condensation in the sample pipe unless the humidity is very low and so the installation techniques described in Section 10.6.2 should be used. Cooling of the air sample is normally done by routing the sample pipe through an area of lower temperature (such as the ambient environment where the ASD is mounted) prior to reaching the ASD. This length of pipe will be dependent on the flow rate, pipe material used, and amount of cooling required. Refer to the manufacturer for guidance.

10.6.4 Dirty and Dusty Areas

Most ASD systems incorporate filtration or methods to manage the impact of dust, within the ASD unit. In very dirty or dusty environments, additional measures may need to be taken, such as:

- additional filtration or the use of a cyclone to prevent contamination of the ASD.
- an ASD system or technology that has been specifically designed for harsh applications.
- an air purging system to keep sampling points and pipe clear.

Note: An air purging system could be a manual or automated process and may involve a positive blowing-out of the pipe network with compressed air or the use of a vacuum cleaner. In all cases such systems should be suitable for the application and installed in accordance with manufacturer's guidelines.

Where additional filtration is installed, the filters should be regularly checked and replaced/cleaned according to a maintenance regime appropriate to the specific environment. Regular smoke testing is recommended to ensure that the filter does not compromise system performance.

10.6.5 Potentially Explosive Environments

ASD systems protecting potentially explosive environments must be approved to the relevant standard for explosion-proof systems and be suitable for the hazardous zone into which they are applied. In the European Union, this is covered under the ATEX Directive and compliant products will be CE marked.

Note: In the UK, the UKCA mark and UKEX are applicable (see SI:2019:696) but for this document we refer to ATEX only.

Warning: This is a specialist topic and appropriate expertise in the protection of a hazardous environment MUST be consulted. The following guidelines are for information only and should not be considered to be definitive. General guidance and information is provided in the FIA Guide on equipment for use in explosive atmospheres (ATEX).

A typical ASD approved system for Zone 1 will be mounted in an ATEX-certified enclosure with integral flame arrestors and the complete assembly tested to the relevant standard. The air sample is drawn into the enclosure through the inlet flame arrestor and the exhaust air passes out through another flame arrestor before returning into the hazardous area.

Subject to risk assessment, it may be acceptable to use a non-certified ATEX ASD to protect a Zone 2 hazardous area, as illustrated in Figure 12, since Zone 2 is defined as 'not likely to occur in normal operation and/or only expected to be for a short period'. However, the risk assessment should take account of the following points:

- The non-certified ATEX ASD must be located in the safe area, but consideration should be given to the fact that potentially hazardous air is constantly drawn from, and returned to, the potentially hazardous area.
- The ASD exhaust must be piped back into the risk to ensure that potentially explosive air is returned to the hazardous area. It also helps to alleviate issued caused by pressure differences between the safe and the hazardous area.
- Flame arrestors (approved for use with the ASD in configuration calculations) must be used at the

transition from the safe to hazardous areas for both sampling and exhaust pipes. Their purpose should be clearly understood; whether they protect the safe area from incidents in the hazardous area, vice versa, or (most likely) both.

- Steel sampling pipe should be used to facilitate equipotential earthing and avoid the possibility of static buildup which, though unlikely, can occur with plastic pipes.
- **MOST IMPORTANTLY, the likelihood of ignition and consequences of ignition occurring when potentially explosive air is present within the ASD must be considered, as this could impact on the safe area.**

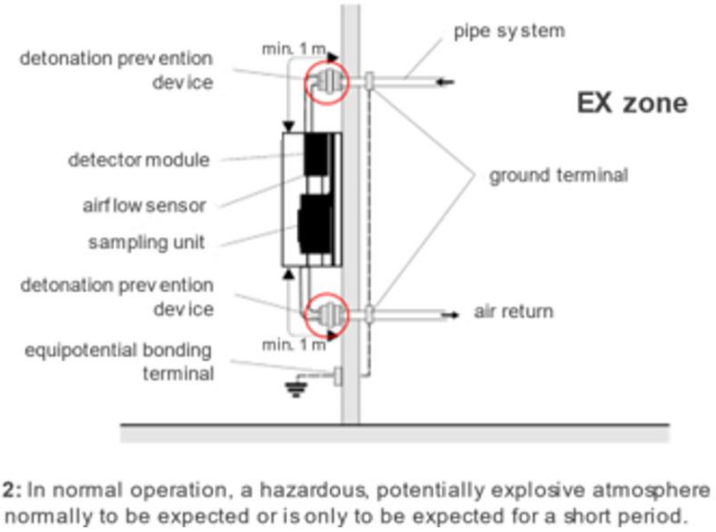


Figure 12 – Illustration of an ASD using flame arrestors to sample from a Zone 2 hazardous area

The area coverage of an ATEX certified ASD may be less than with a standard ASD system.

10.7 Inaccessible or Restricted Environments

ASD systems can provide reliable smoke detection in environments where access is restricted, because the detector can be located remotely from the sampling pipework. Provision can be made for regular maintenance testing of the ASD system from an accessible and unrestricted location.

Access is typically restricted because an area presents a challenge to personnel responsible for installation or maintenance of the fire detection system.

Particular examples include:

- Lift shafts and other vertical shafts (also see Section 10.8)
- Floor and ceiling voids
- Cable tunnels
- Prison cells
- Locked or secure areas
- High voltage risks
- Industrial or chemical risks

- Warehousing (see Section 10.3)

Of particular relevance in the UK is that BS 5839-1:2025 clause 21 makes it clear that the ongoing maintenance of an inaccessible detector should be considered at the design stage. Additionally, the Construction (Design and Management) Regulations make it clear that safe ongoing maintenance is critical.

Thus, such areas are often best covered by an ASD system providing remote fire detection.

Provision should be made for performing safe and repeatable tests and maintenance that avoids the need to work in inaccessible or restricted spaces, as well as ensuring that the integrity of the pipework can be verified. For example, an accessible maintenance test point or an additional device which facilitates transport time tests without accessing the space should be provided. (see Section 15 for further advice).

Consideration should also be given to penetrations that may affect the structural integrity/fire compartmentalisation (see Section 13.3.1).

10.8 Lifts

Lift (elevator) shafts present many challenges, both in terms of the fire risks they introduce, and the difficulties associated with providing reliable and accessible fire detection.

The shafts may act as vertical channels (chimneys) for the spread of heat, smoke and toxic gases to other floors of the building. Moreover, transient pressures inside the shaft caused by the motion of the lift car in the shaft may encourage smoke to infiltrate the shaft and spread to other floors of the building. In the worst case, they may entrap passengers in the event of a fire.

While such risks are partly mitigated by (passive/structural) protection measures beyond the scope of this guidance, detection within the lift shaft is a requirement. ASD offers a practical solution, providing both multi-level detection and accessibility for maintenance and national codes are increasingly recognising these benefits.

Fire detection standards in some countries recognise the advantages of using ASD and mandate protection of (lift) shafts with ASD where there are maintenance and health and safety issues (e.g. Eire I.S. 3218:2024). Other national standards (e.g. Netherlands NEN 2535) recommend using multilevel detection to provide early warning and mitigate any risks associated with stratification.

In the UK, BS 5839-1:2025 does not specifically recommend ASD for lift shafts but notes that:

- Multi-level detection might be appropriate in very high shafts.
  (Specifically, BS 5839-1:2025 table 3 recommends that point-type smoke detectors should not be installed on ceilings above 10.5m and notes (in clause 21.8.3) that shafts exceeding 25m would be better protected by having detection at several levels and/or higher sensitivity).
- Each lift shaft should be treated as a separate fire detection zone. (see BS 5839-1:2025)

In view of the accessibility benefits offered by ASD (see Section 10.8.1), together with the advantages and the relatively low cost of installing vertical sampling (see Section 10.8.2), ASD is becoming a common choice for lift shaft detection. Accordingly, the following sections provide guidance on best practise and key considerations when installing ASD in lift shafts.

10.8.1 Accessibility

It has been common practice to install a point-type smoke detector at the top of lift shafts. However, this practice often leads to some practical challenges relating to ongoing servicing which can ultimately lead to omission of (or very infrequent) testing.

Typically, these practical challenges would include the following:

- The shaft itself must be taken out of service, which is often done out of hours to avoid inconvenience to the building occupants.
- The risk assessment and method statement typically identify that the technician must be accompanied by the lift service provider to make the lift(s) safe for the required works.
- All operatives doing this servicing work should be harness trained and must be aware of relevant safe electrical working and confined space working practices.

ASDs can overcome these challenges as the ASD can be mounted in an accessible area local to the lift shaft. The sampling pipe is installed from the ASD into the lift shaft with sampling holes located within.

The pipe installation should include a dedicated sample pipe maintenance test point in an accessible area (ideally close to the ASD).

The exhaust port of the ASD should be returned to the lift shaft. This will allow any pressure differentials between the lift shaft and the location of the ASD to be equalised.

10.8.2 Multi-level Detection

There are several challenges with only providing detection at the top of a lift shaft, which can be mitigated by the use of multilevel detection (vertical sampling) including;

1. Stratification: large fires are required to provide sufficient heat energy to move smoke to the highest point in a lift shaft, and faster detection is afforded by sampling at lower levels
2. Obstruction, particularly when the lift cabin is stationary: smoke may need to pass the lift cabin in order to reach detection at the highest point
3. Ventilation: some lift shafts are provided with forced ventilation (firefighting lifts for example). Vertical sampling provides detection in the airflow irrespective of flow direction. However, the best detection in such cases might be achieved by primary detection (sampling extract/return air, see Section 9.3.1) if the location of the ventilation grilles is known. Ventilation may also be provided to cool the lift equipment and/or to provide safe conditions if people are trapped. The details of such arrangements are often unavailable, but the provision of multi-level sampling inevitably improves the likelihood of detecting a fire early.

In accordance with the ceiling height limitations (see Table 3), lift shafts up to 10.5m in height can be adequately protected by ASD detection at the top of the shaft. However, in view of the factors described above, it is recommended that lift shafts higher than 10.5m are protected with a minimum of two sampling holes at the top of the shaft. Furthermore, consideration should be given to including vertical sampling, with holes located at alternate floors (following the recommended 3-8m spacing for vertical sampling holes – see Section 8.3.4) particularly where the lift shaft height exceeds 18m.

10.9 Duct Detection

As stated in Section 5.2.5, there are two principal applications for sampling smoke from a duct using an ASD system:

- either as a Duct Smoke Detector (see Section 3.9) to activate means to prevent smoke spread through a building
- or to provide early warning of a fire condition in an area or piece of equipment from which air is extracted.

Note: A Code of Practice for Duct Smoke Detectors is published by the FIA

Within these applications there are several issues to be considered when designing a duct detection system using ASD. The primary considerations are:

- Pressure equalisation
- Maintenance accessibility
- Monitoring upstream or downstream of filters (generally on the upstream side)
- Suitability of the sampling probes for the application
- Relative siting of the equipment (duct probes and/or the ASD unit)
- Sensitivity setting/class

These are covered in more details below.

As ducts can have different pressures, it is recommended that a single ASD only monitors a single duct.

Monitoring of smoke is achieved by installing a sample pipe/probe within the duct. To balance the pressure across the ASD the exhaust air should be returned to the duct downstream of the monitoring sample probe. The arrangement of the sampling probe and the exhaust can have a significant effect on the pressure balance across the ASD – particularly where flow rates in the duct are high. Thus, manufacturer's recommendations should be followed to minimise the risk that flow change in the duct will affect flow through the ASD system and results in unnecessary fault indications.

In general, sampling probe(s) will require the sampling points within the duct to be positioned at an angle of 30-60° off centre, into the airflow, unless directed otherwise by the ASD manufacturer. It is typically recommended that each sampling point should have a maximum area coverage of $0.4m^2$ of the cross-sectional area (to be consistent with the recommendations for sampling across an air return vent – see Section 8.3.3.1 b)).

The use of a socket union is recommended to allow the adjustment of the final orientation during the commissioning of the system, and the final orientation of the probe should be marked to ensure it is not changed during maintenance (see the FIA Guidance for Duct Detectors clause 11.5.3 for further info). Where possible the sampling probe(s) should be installed in the centre of the airflow and away from bends, dampers, filters etc.

It is also recommended that the sampling probe(s) be installed close to inspection hatches for maintenance purposes. Due to the use of High Efficiency Particle Arrestor (HEPA) filters within HVAC systems it is recommended that monitoring be carried out before the filter, as smoke particles may also be removed by the filter.

To provide the ASD with a maintenance facility, it is recommended that the sample probe span the width of the duct and protrude beyond the opposite side to an accessible maintenance test point. This will allow test smoke to be introduced at this point for commissioning and maintenance purposes.

Note: that maintenance testing may require the duct flow to be reduced or terminated as significant negative pressures in the duct may hinder the operation of the maintenance test point.

It important to ensure that the material used for the sampling probes is suitable for the environments experienced in the duct. For example, when extracting from a hot oven the use of standard ABS pipe may be inappropriate. The probe(s) should have sufficient strength/stiffness to span the duct as it can be challenging to provide supports within the duct.

Further guidance on the siting and application of Duct Smoke detectors is available in the FIA guide for Duct Smoke Detectors (clause 11.5). In general, the ASD should be as close to the probe(s) as possible, but both should be accessible for maintenance.

With regard to sensitivity, due to the dilution of the smoke particles from the protected area, as a result of high airflows, it is recommended that only Class A & B ASDs are suitable for early warning applications, whereas for DSD applications (prevention of smoke spread) a Class C ASD may be suitable depending on the approval to EN 54-27.

Note: *The European product standard for DSDs (EN 54-27:2015) defines ASD as a "type 5" DSD and requires that they are approved in accordance with EN 54-20*.

11 PRODUCT STANDARDS & MARKING

The EN 54 series of European Standards covers fire detection and fire alarm products. Part 20 specifies the requirements for ASD systems. This is a harmonised standard and has been mandated under the Construction Products Regulations (CPR) 305/2011 and 2024/3110. As such, it is a legal requirement in EU countries that an ASD system installed for fire protection in buildings must be approved by an authorised third party (called a “Notified Body”). The product must be supported by a Declaration of Performance (DoP) outlining the performance of the detector. The DoP must itself be supported by an EU Certificate of Constancy of Performance (CoCoP) issued by a Notified Body. The approved product must carry a CE mark underscored by the number of the Notified Body, the reference number of the DoP, and the year the CE mark was first applied. It must be clearly marked as complying with EN 54-20 and indicate the relevant sensitivity class(es) applicable. Furthermore, the product must be supported by sufficient technical information to “enable correct installation, sensitivity setting and operation” and “the necessary means to determine the classification of any used configuration”.

Following the UK’s withdrawal from the EU in January 2020, the UK government introduced a new UKCA mark intended to replace the EU CE mark on products placed on the market in the UK. However, the UK legislation issued at the time also allowed for the continued use of the CE mark for construction products. Initially, this was a time-limited arrangement, but as of September 2024, the time limit was cancelled.

As of the time of publication of this document, CE marking is acceptable to place products on the marketplace in the UK indefinitely. Any change to this recognition of CE marking will be subject to a minimum 2 year transition process. See https://www.gov.uk/guidance/construction-products-regulation-in-great-britain

IF the manufacture opts to provide UKCA marking then the requirements broadly follow that for CE marking whereby ASD systems must be assessed to EN 54-20 by a UK Approved Body and a UK CoCoP must be issued. In such cases, the manufacturer must issue specific UK Declarations of Conformity (UK-DoC) and UK Declarations of performance (UK-DoP) referring to UK legislation and standards. Similar to the CE mark, the UKCA mark affixed to the product must be accompanied by the UK Approved Body Number, the year the mark was applied and the UK-DoP reference.

Note: *Prior to the publication of EN 54-20:2006, ASD systems were tested and approved against standards published by the Comité Européen des Assurances (CEA) - specifically to CEA 4022 and it’s earlier incarnations (CEA GEI 1-077 and CEA GEI 1-048).*

12 LIMITATION OF FALSE ALARMS

False alarms may be categorised into “unwanted alarms”, caused by fire-like phenomena in the protected environment, and “equipment false alarms” caused by faults in the detection equipment or system. BS 5839-1:2025 clause 30 identifies two further categories: “malicious false alarms” arising from malicious actions and “false alarms with good intent” arising from intentional but misguided operation of a call point. In relation to ASD systems, only “unwanted alarms” and “equipment false alarms” are considered.

12.1 Unwanted Alarms

ASD systems can operate at levels of sensitivity much higher than point-type smoke detectors and, as a result, it is sometimes stated that they are more prone to false alarms. However, unwanted alarms are uncommon in ASD systems. In fact, there is evidence of instances where the alarm has been raised by an ASD system and, on inspection of that area, no obvious signs of a fire have been identified; a false alarm has been reported but subsequently a fire has developed. In these instances, the detector has responded correctly to the early stage of a developing fire, but the warning has been misinterpreted. This is more likely to occur in high-sensitivity (Class A) applications. Appropriate training is therefore essential, particularly where pre-alarm or condition warnings forms part of the intended response plan.

There is much that can be done during the design (Section 8) and installation (Section 13) of such systems to minimise the risk of unwanted alarms. In some applications, there may be potential for the reduction of false alarms using coincidence detection (Section 8.8.1).

In addition, ASDs incorporate features to minimise the likelihood of false alarms. Careful consideration should be given to the relevance and value of these features to any particular application, and the following notes are intended to provide an overview of some of the techniques employed.

12.1.1 Alarm Thresholds

Almost all ASD systems allow for adjustment and refinement of the alarm thresholds (and/or detector sensitivities) to ensure that they are appropriate to the environment and level of protection required. In addition, many ASD systems incorporate software that may:

- continually alter the threshold/sensitivity to reduce the likelihood of false alarms by considering the dynamics of the normal background readings
- modify the alarm decision according to the dynamics of the signal leading up to the alarm condition (such as the rate of rise) or the use of multiple sensor inputs
- average the measured signal to smooth out normal transients
- operate for a set period to “learn” an environment and automatically set appropriate thresholds/sensitivity at the end of the learning period.

Note: It is important to ensure that any such adjustments to the sensitivity do not result in a variance from the intended sensitivity class.

12.1.2 Fault Logs

Many ASD systems incorporate historic logs, which provide accurate data to support the investigation of any unusual or unwanted alarm conditions. Such on-board historic logs vary in size and complexity. Therefore, consideration should be given to the amount and quantity of historic data that would be suitable for a particular application. Where there are phenomena present that may lead to “unwanted alarms” a more comprehensive logging facility may be desirable.

12.1.3 Multiple Alarm Thresholds

Multiple alarm thresholds are available on the majority of ASD systems. Trained personnel are able to respond to warnings and take appropriate action. Clearly, where the warning is related to a fire condition, it can be tackled before it escalates. However, where the alarm is identified as being unwanted, for example, caused by activity in an area (e.g. soldering or minor building works), then the activity can be curtailed before disruptive evacuation procedures are initiated.

12.1.4 Referencing

Referencing is a technique used to reduce false alarms caused by the introduction of pollution or smoke from the external environment. Essentially, the smoke obscuration of the incoming air is measured, and this signal is used to offset the measurements from active detectors within the protected area. Manufacturers' instructions should be followed to ensure that reference detectors are correctly configured.

Note: it is normally the case that the amount of reference offset is limited but where this is not the case consideration should be given to provide a warning signal (from the reference detector) to inform when external influences are detected.

12.1.5 Alarm Delays

The majority of ASD systems support configurable alarm delays whereby the alarm threshold must be exceeded for a preset period before the alarm or condition warning is signalled. This is a very effective technique for minimising unwanted alarms caused by short transient events.

12.1.6 Day/Night or Temporary Setting

Many ASD systems provide alternative sensitivity settings that can be applied according to the occupancy or time of day. This allows for less sensitive detection during the periods when the area is occupied. Such features can also be applied to mitigate known unwanted alarm sources which occur during specific periods or operations (e.g. for a period after the oven door is opened)

12.1.7 Software Algorithms

Many ASD systems incorporate software algorithms which discriminate between false alarm signals and those deriving from a real fire. For example, software algorithms may cancel out the effect of spikes in the signal caused by dust particles.

12.1.8 Multi-Sensor

The use of multiple sensors in an ASD has the potential to reduce false alarms and to alter the speed detection. A multi-sensor device incorporates two or more sensors. The signals from these sensors are then used individually or in combination using proprietary algorithms, to make an alarm decision.

Whilst unwanted fire alarms are not generally a problem with ASDs given their typical applications, multi-sensor devices can offer the potential to improve the reliability of a fire alarm signal and so reduce the risk of nuisance alarms.

Suitable sensors which could be combined for use in a Multi-sensor ASD could include:

- **Single Angle Optical Sensors:**
  In general, optical sensors use the scattering of light from smoke particles to detect the presence of a fire.
- **Multi-angle/frequency Optical Sensors:**
  These sensors use the response from multiple scatter angles or from the use of dual/multiple light frequencies to distinguish between smoke and other phenomena (which look like smoke).

  Although they can be used in combination with other sensors, multi-angle optical sensors could be considered as multi-sensor devices on their own.
- **Cloud chamber:**
  A cloud chamber also looks for the presence of particles of combustion but uses a different technique to sense their presence.
- **Gas detection:**
  Typically, an electrochemical cell is used to detect the presence of gases such as CO that are produced by combustion and, used in combination with an optical sensor or a cloud chamber, can enhance decision making.

Note that heat sensors, while commonly employed in point-type multi-sensor detectors, are not appropriate for ASD systems, as the distance from the sampling point to the sensor will allow the sample to cool, and so the response will be unreliable.

Where a multi-sensor ASD is provided with different modes of operation it is important to confirm that the mode selected is approved to EN 54-20 and that the appropriate design recommendation/constraints are met.

12.1.9 Filtering

Many ASD systems use physical filters to remove larger dust particles from the air sample before it is analysed. These may be incorporated into the ASD equipment or installed in the pipework upstream of the detector. Such filters can reduce the risk of unwanted alarms caused by dust/dirt and can minimise contamination of the detector in particularly harsh environments.

Note: Any additional component in the sampling pipework should not invalidate the design specification. For example, ensure the Transport Time limit is not exceeded.

12.2 Equipment Alarms

False alarms by equipment faults can be minimised by the choice of good quality equipment that satisfies the relevant equipment standards that has third party certification, and has been regularly serviced and maintained in accordance with Section 15 and manufacturer's recommendations.

13 INSTALLATION

As a minimum, the following considerations should be given to ASD installations:

- **Siting of equipment,** including the detector, control equipment, power supplies, repeat or remote displays and any other device associated with the ASD system
- **Electrical installation** to include power, loop and associated interface wiring
- **Mechanical installation** to include installation of pipe, necessary mounting/fixing assemblies and any other associated works
- **Inspection, testing, commissioning** including performance tests of the installed systems

Before installing the equipment ensure that the manufacturer's instructions are observed.

13.1 Siting of Equipment

Wherever possible, equipment (including power supplies and interfaces) should be installed at a location that is easily accessible and gives consideration to future maintenance and servicing. In particular, ensure that sufficient space is provided to all points of access such as covers, connectors and cable entries.

For the detectors, the maintenance requirements for any filters and the removal of sampling pipes should be considered.

Where possible, the detector should be installed in the same fire compartment as the protected space. In cases where this is not possible, the consequences for fire compartmentation should be considered (see Section 13.3).

Whenever the detector is installed outside the protected space, consideration should be given to arranging for an air return of the exhaust air back into the protected area to avoid the effects of any significant pressure difference.

For all installations, ensure that the exhaust port is not impeded.

Where the detector has indicators or a display that is required to be visible it should be sited accordingly.

Local environmental conditions and risks should be taken into account. For example, avoidance of inadvertent mechanical damage, moisture, extreme temperature, etc.

Consideration should be given to ensuring the last sample hole (or a maintenance test point) is accessible for testing purposes.

13.2 Electrical Installation

Generally, ASD electrical cabling should be completed in accordance with National Standards. In the UK it should comply with BS 5839 Part 1:2025 clause 25. A risk assessment should determine whether enhanced or standard cabling is needed:

- From a local power supply to the ASD.
- From the ASD to the house fire system/CIE.
- To any remote or repeat ASD displays.

13.3 Mechanical Installation

13.3.1 Pipework

Installation of the pipework and the selection of pipe material should take into account the following external influences:

- Undue stress
- Mechanical impact
- UV radiation
- Temperature extremes
- Flammability and toxicity/reaction in case of fire

All pipework should be clearly labelled to indicate its purpose in a fire protection system.

Installations in red ABS pipe are considered normal. However, alternatives are permitted as some applications require piping to be installed either; to select a colour that matches the building aesthetics and/or to select a material to comply with any restrictions relating to material usage in the application. For example, it is not uncommon for metallic pipe to be used where enhanced mechanical resistance, heat resistance, limited combustibility, non-flammability or low smoke or fume characteristics are required.

Minimum mechanical resistance for ASD pipe is specified in EN 54-20:2006 clause 5.7 by reference to specific mechanical tests in EN 61386-1. However, it does not require the ASD pipe to be marked in accordance with this standard for electrical conduit and the requirements relating to colour are known to conflict with the normal practice of using red pipe for ASD systems.

Concerning limited combustibility, in the UK, BS 9999:2017 clause 34.1.6 identifies that materials of limited combustibility should be used in a number of situations including “escape stairs in certain single stair buildings” and in “ceiling voids where the undivided cavity exceeds 40m in extent”.

With regard to flammability, in the UK, BS 7671:2018+A4:2026, clause 422.2.1 requires that cables, conduits, trunking & ducting which are installed in protected escape routes should be non-flame propagating. This is generally considered to be necessary because cables also carry an inherent risk of overheating. While this risk of ignition is not inherent to ASD pipes, consideration should be given to using non-flame propagating ASD pipes in protected escape routes – particularly where they are routed close (e.g. <500mm) to possible ignition sources such as luminaires or where the fire load resulting from multiple ASD pipes is considered to be excessive.

Suitable and sufficient fixing supports must be used and designed for each application, and pipe material. They should be agreed with all appropriate parties concerned before installation commences. Guidance should be taken from building codes, the ASD manufacturer and/or pipe manufacturer.

Typical fixings include:

- Closed clips for surface mounting
- Fast fix clips and tie wraps onto suitable beams, joists or other structural steelwork
- Double tie wrap onto false floor stanchions

Note: *In the UK, BS 5839-1:2025 clause 35.3 recommends that methods of cable support should be non-combustible and notes that non-metallic clips are unlikely to be suitable for supporting cables. This is related to minimising the risk of entanglement and is not relevant for plastic ASD pipes which do not present the same risk of entanglement.*

Expansion joints or strategically positioned bends in the pipe run, in combination with non-clamping clips which allow for movement/expansion along the pipe run, should be considered. This is particularly important where long, straight, uninterrupted pipe runs might be installed or where there are large temperature variations. If expansion is constrained, it can lead to snaking of long pipe runs, detachment from clips or, worst case, pipe breakage when the pipe contracts.

Metal pipe installations should be earthed in accordance with national standards.

Consideration should be given to the fire compartmentalisation of the building fabric. Wherever possible, the ASD system should not pass pipe between fire compartments. However, since the penetrations required for an aspirating sampling pipe are typically deemed to be small (e.g. <40mm as detailed in BS 9999:2017 clause 32.5.14 & table 31), they do not usually require special measures (e.g. intumescent seals) to maintain the integrity of a fire compartment. In all cases appropriate fire stopping should be used around the pipe to keep the penetration into the fire compartment as small as possible. However, where there are multiple pipe penetrations in close proximity, it is good practice to use intumescent seals in addition to the provisions recommended in BS 9999:2017.

Note: While intumescent seals will block the sampling pipe when activated, it happens when the fire is fully developed, and fire spread is the main concern, taking precedence over detection since the detector should already be in alarm.

13.3.2 Sampling Points

Sampling points can either be drilled directly into the main sampling pipe or be positioned several metres from the main sampling pipe using extended sampling pipes or capillary pipes.

13.3.2.1 Extended Sampling Pipe

If a sampling point is distant from the main pipe run, it may be connected into the main pipe run via an extended sampling pipe. It may also be described as a “drop-down sampling point” or a “stand up sampling point”, depending on the orientation. See Figure 13.

Note: ASD manufacturers may refer to Branches, Tees and Spurs which generally connect several sampling holes into the main pipe run. Care should be taken when modelling such fittings to follow the manufacturer’s terminology/instructions.

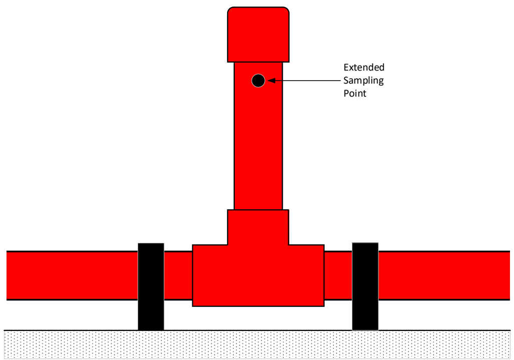


Figure 13 – Example of an extended sampling pipe

13.3.2.2 Capillary Pipe

If a concealed pipe installation is required, capillary air sampling can provide a solution. In many cases, the main sampling pipe is installed in the ceiling void/building structure, and a capillary pipe is taken from the main pipe to the sampling point. The sampling points are then at the end of this capillary pipe.

The sampling point may be flush-mounted or protrude into the space to be protected (see Figure 14). In some cases, it is appropriate to have a concealed sampling point.

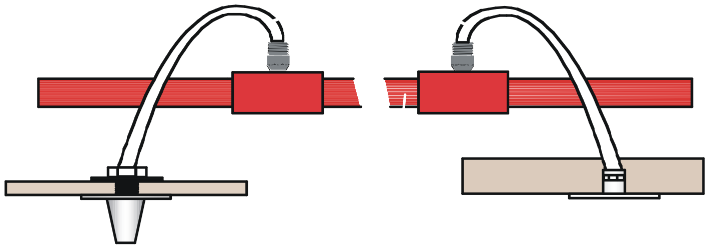


Figure 14 – Examples of capillary sample point mounting

Note: *The flush-mounted sampling point is often used for thicker ceilings as they are fixed from the front.*

Capillary sampling may be used to position sampling points in specific locations - e.g. in the outlet flow from enclosed equipment or near specific hot spots on a machine, thereby negating the need to run the main sampling pipe through complicated routes.

Particular attention should be paid to the mechanical integrity and routing of the capillary pipes and fittings to minimise the risk of inadvertent disconnection or damage.

The maximum capillary length should be established by the system manufacturer.

13.3.2.3 Sampling Points

These may be realised either by drilling custom sizes or drilling common sizes and using reducing ports, sheets or clips. In either case care should be taken to make sure the sampling point has the correct hole-size and that any swarf from the drilling process is removed from the sampling pipe.

Ensure that it is clear which party is responsible for drilling the sampling holes!

Labelling Requirements

The following parts of an ASD should be clearly labelled;

- Sampling Pipe
- Sampling Points
- ASD Units

- Power Supplies and battery enclosures (if separate)
- Remote or repeat displays

The labelling should clearly identify the purpose and, where appropriate, the zone/location of the equipment.

Where discreet installations are required, labelling will be detrimental to the desired visual effect. In this situation, it is essential to supplement the ASD with a plan of the protected area showing sampling points and/or sampling pipe locations to avoid sample holes being overlooked during maintenance or inadvertently filled in!

13.4 Inspection

It is necessary to inspect the completed installation to check for quality of workmanship, correct use of materials and that the installation fully complies with the correct National Standard that the intended ASD systems have been installed to.

During inspection, it might be necessary to clean the pipe system internally to remove unwanted/excessive swarf, debris and dust which could affect the ASD system performance. This may be done by either a positive blowing-out of the pipe network with compressed air to expel particulate through the (temporarily open) pipe end or by the use of a vacuum cleaner. Guidance should be sought from the manufacturer.

14 COMMISSIONING AND HANDOVER

14.1 Commissioning Testing

Commissioning tests should be carried out depending on the ASD system application and only when the area is in its normal, intended running state. Appropriate commissioning tests should also be performed after modifications and/or additions to the ASD system.

14.2 Commissioning

There are several stages during the commissioning process, which should be carried out, recorded and checked as necessary:

- **Inspection of Installation**
  Verify conformity to design, definition of system (see Section 5) including mechanical & electrical installation.
- **Power up/Configuration**
  Required checks and configuration.
- **Commissioning Tests**
  To include mechanical, functional and performance testing.
- **Signalling**
  To verify the connections between ASD and other connected systems (e.g. CIE, BMS).
- **System Handover**
  Including relevant documentation and technical drawings.

14.2.1 Inspection of Installation

It is necessary to inspect the installation to confirm that it has been designed and installed correctly for the application and conforms to the design documentation. In particular;

- When using ASD for high and enhanced sensitivity (Class A/B), ensure that the installation conforms to the design specification (e.g. it may be necessary to measure the air velocities in the protected area to ensure that the design spacing is appropriate. (see Section 8).

- When using ASD as a primary sampling system, ensure the pipe and sampling points are installed correctly onto the Air Handling Unit (AHU) within the airflow. If monitoring more than one AHU, it is important to ensure different running speeds do not cause an unbalanced airflow in the pipe, which may affect ASD performance.

- When using ASD to replace point-type smoke detectors (Class C) – ensure the installation (particularly sampling point spacing) conforms to the relevant standard (e.g. BS 5839-1:2025) and the ASD sensitivity/alarm thresholds are correctly set to ensure that the sensitivity of each hole meets the minimum performance requirements for individual sampling points. This may require reference to the approval compliance notes for the particular ASD system and should also take into account any potential automatic adjustments of the sensitivity/threshold settings, which may occur after commissioning.

- When using ASD for other Installations (Cabinet, duct work or other specialist protection), confirm that the ASD system is in accordance with the design.

A thorough inspection of the mechanical and electrical installation should also be carried out to include;

- Pipe network including correct supports.

- In-line filters (where required) are correctly installed.
- Clear identification of sampling points.
- No obstructions to sampling points/remote capillaries.
- All internal & external electrical wiring has been installed correctly.
- Power supplies are correctly sized and provide the correct emergency battery standby period.
- Correct hole positions and sizes.

Before the ASD is powered up, it is very important to check that the installer has cleared the pipe of any foreign articles e.g. swarf, dust etc that will impede or stop the ASD performance. (see Section 13.4)

14.2.2 Power up/Configuration

It is very important that the ASD manufacturer's technical documentation is followed during system set-up. If there is any doubt, refer to the manufacturer for clarification.

The system should be powered up in accordance with the manufacturer's instructions. Before carrying out any functional and performance tests, the ASD equipment should be configured for:

- Fire signal alarm thresholds and detector sensitivity settings to give the required sampling point sensitivity.
- Alarm and Fault delay periods.
- Airflow parameters.
- Any other defined parameters.

14.2.3 Commissioning Tests

Before these tests are carried out, ensure that the room or area being protected is in its operational state, particularly in terms of airflows and cleanliness. For example, any air handling units should be running, all floor and ceiling tiles should be installed, and any equipment producing a heat load should be in its normal operational mode.

For ASD systems that are designed to conform to prescribed standards, commissioning tests should include, but are not limited to:

- Maximum smoke transport time from the last sampling hole in the system.
- Fault detection, including blockage & rupture of the pipe.
- Tests to confirm that sampling points are functioning.

For ASD systems that are designed to conform to a particular performance requirement, additional tests should be carried out to confirm that this performance is met.

14.2.3.1 Transport Time Measurement

Maximum transport time is measured by introducing a small quantity of smoke or aerosol into the furthest sample hole and measuring the time between first introducing the smoke and observing a "reaction" at the detector. Depending on the ASD device used, the "reaction" could be a first response of a bar graph or a similar indication of the detector's initial response. However, it may also be the first indication of an alarm. Where an alarm indication is used, it should not include any alarm delays, which should, where possible, be temporarily set to zero for the closest measurement of the maximum transport time.

Where there are multiple branches or pipes, it is essential that the last sampling hole in each branch is tested individually, and its transport time recorded to confirm the full integrity of the pipework and that all sampling holes are within the transport time limits.

The maximum transport time (from the last sampling hole) should be less than the maximum time specified within the design documentation (Appendix I2) and should be less than the limits specified in Section 9.3.3.

Where transport time predictions are provided with the design of the installation, they may be compared with the measured transport time to verify that the installation is in accordance with the design. Such comparisons should take account of the expected accuracy of the predictions and the measurement, generally +/-10% unless otherwise stated.

All measurements should be recorded for later reference during maintenance visits. Where possible, measured transport time should be compared to the predicted design transport time.

Note: *the transport time from a maintenance test point (which is closed during normal operation) should also be recorded for comparison during future maintenance visits. The transport time from the maintenance test point may exceed the maximum transport time if the transport time from the furthest sampling hole is confirmed to be less than the maximum specified limit.*

14.2.3.2 Fault Detection

To ensure continuous integrity of the pipework, it is recommended that each pipe entering the ASD unit is first blocked and then ruptured (i.e. opened) to ensure that low and high flow faults are reported.

It may be required that blockage of sampling holes is identified, (for example, due to high probability of malicious tampering), and appropriate tests should confirm this.

It is recommended that, where possible, flow readings are recorded during commissioning for comparison during future maintenance visits.

Note: *A 20% reduction in volumetric flow (EN 54-20) is considered an appropriate fault condition. It is generally the case that sampling holes do not block individually but become contaminated at similar rates. In this case, regular maintenance, including inspection/cleaning of sampling holes and monitoring for changes in pipe flow rate between visits, is sufficient to ensure the integrity of the ASD system.*

Any faults with the power supply should be detected and signalled appropriately. As a minimum, it is recommended that first the battery and then the mains supply are disconnected to verify that a PSU fault is reported.

All ASD systems monitor for internal faults, and many include a fault test feature to simulate an internal failure. Where this feature is provided it should be used to verify that internal faults are reported. Alternatively, disconnection of an internal lead may be used to simulate internal failure after consultation with the manufacturer.

14.2.3.3 Functional Tests

Commissioning must include sufficient testing to verify that sampling holes are fully functional. The functional tests described in Section 15.2.2 provide guidance on how this should be done. However, careful inspection/validation of the sampling holes to confirm that they are correctly drilled and comparison of measured transport times to predicted transport times is often considered sufficient validation – particularly where performance tests are also specified.

The actual current drawn from the power supply should be measured and recorded to ensure that the designed standby period can be achieved.

14.2.3.4 Performance Tests

Where performance tests are required (see Section 5.3), they should be conducted in accordance with the design requirements. In many cases, a smoke performance test from this Code of Practice will be specified.

All necessary permissions to perform the tests should be established and recorded. It is recommended that videos of tests are shown to those granting permission so that the scale of smoke and heat is properly appreciated. This is particularly relevant for the larger tests.

Note: attention is drawn to the hazard warnings in the Foreword.

Results from the test, particularly details of the test positions, should be recorded so that they can be repeated during maintenance when necessary.

Ancillary connections should be confirmed. These may include remote monitoring services or BMS links not otherwise included in the "cause and effect" verification.

14.2.4 Signalling

All signalling between the ASD system and the house fire alarm system/CIE should be verified in accordance with the design. In particular, the signalling and response to each alarm level and fault condition should be checked and verified.

Where an ASD system provides local disablement or isolation, it should be verified that this condition is signalled to the house fire alarm/CIE.

Any "cause and effect" requirements – particularly in relation to the integration with automatic suppression systems should be verified.

14.2.5 System Handover

During the commissioning all results should be recorded. These records, along with all configuration data, should be submitted as part of the commissioning certificate.

All relevant drawings should be submitted, including the pipe layout, hole sizes, sampling point positions and detector locations. These should be deemed part of the system handover.

All the collated documentation, along with a signed certificate, should be issued to the customer.

15 MAINTENANCE

As with all fire systems, ASDs require regular maintenance to ensure their continued performance and reduce the potential for false alarms. In many cases, maintenance may be a legal requirement and while ASDs may be considered low maintenance, they are not "no maintenance".

The frequency and method of maintenance should be clearly documented and kept with the fire safety logbook for each installation, and determined by a risk assessment that should include consideration of at least the following;

- Equipment installed in dirty conditions will need to be checked more thoroughly and at more frequent intervals than that in clean and dry situations.
- The class of the system.
- Value or extent of the risk.
- Detector technology employed.
- Manufacturer's recommendations.
- Practicalities of performing safe and compliant maintenance/testing of sampling points removing the need to work at height or in confined spaces to reduce risk.

15.1 Frequency of Maintenance

Maintenance should be carried out at least annually. More frequent maintenance is needed if the ASD system is installed in dirty/dusty environments, or if the risk assessment dictates. The routine to be adopted in individual premises may vary depending on the use of the premises.

15.2 Recommendations for Routine Inspection and Functional Testing

ASD manufacturers' instructions for maintenance and functional testing should be followed and carried out by a trained competent person.

In general, the maintenance of an ASD system involves inspection/test of all elements of the system and an overall functional test to ensure its continued performance and should be in accordance with the manufacturers recommendation and appropriate national standards (e.g. BS 5839-1).

15.2.1 Routine Inspection

All fault and alarm output functions of the ASD, including any interfaces which may form part of the system, should be tested where practicable.

It is important to ensure that operation during testing does not result in an unwanted signal being sent from the ASD to another system.

Where ASD systems contain power supplies and battery back-ups, these should be checked.

Any components fitted to the system with a defined operating life as defined by the manufacturer, should be examined, and replaced if necessary (e.g. filters, batteries).

It should be checked that there have been no unauthorised changes to the system configuration (e.g. sensitivity). If changes are required or have taken place, then these must be documented.

Any systems reliant on additional additives or consumables, should be topped up in accordance with the manufacturer's recommendations.

A visual inspection should be made to check whether structural, building or occupancy changes have affected the design requirements for the pipework and sampling points.

A visual inspection should be made of all sampling points, pipework, fittings, cables and equipment for secure fixing, appropriate labelling, absence of damage and freedom from obstructions.

All systems must be functionally tested in a safe manner.

15.2.2 Functional tests

The objective of the functional test of a system is to ensure that the ASD and its associated pipework are still operational. This is ideally achieved by introducing smoke into each sampling point in turn and verifying a response at the detector. However, where access is restricted or other conditions prevent this, other verification techniques should be employed such as:

- Verifying transport time from the furthest hole or a maintenance test point using a safe and repeatable technique, comparing with the original and all previously recorded results to identify deviations.
- Confirming that the flow monitoring is capable of detecting the loss of a single sampling point, or collection of sampling points that are deemed to be acceptable for the risks involved.
- Inspection of flow readings and comparing with the original and all previously recorded results to identify deviations that would indicate a loss of detection performance.
- Measurement of the pressure at each sampling point and comparing with the original and previously recorded results to identify deviations that would indicate a loss of detection performance.

The technique used is dependent on the particular features of the ASD technology, the risk and the specific application and should be considered at the design stage (see Section 8.6). Such techniques may also be supported by visual inspection of sampling points where possible, but it should be verified that adequate detection performance is maintained. Details of the techniques used must be recorded and agreed with all parties, taking the following points into account.

1. Simulation smoke aerosol cans may leave residue if used to test ASD systems, and/or particle lifetime maybe insufficient. Their acceptability needs to be verified by the ASD manufacturer.
2. The functional test carried out should not involve more than one sampling point at a time. Too large a test source is likely to affect more than one sampling point and invalidate the test results.
3. Differences in response times can indicate pipework and/or detection problems and/or changes to the pressure differentials between the protected areas. Response time differences should be investigated.
4. If the original commissioning time is not known, or the acceptable deviation from it is not understood, then all sample holes or groups of sample holes must be tested individually in accordance with the requirements of BS 5839-1. Where access to individual holes is restricted, it may be necessary to clean the system and re-test in accordance with Section 14.2.3.
5. Where the ASD is specifically installed to provide early warning, regular repetition of the original commissioning performance smoke tests (see Section 14.2.3.4) may be necessary to ensure that the original performance capability has not been compromised.
6. Many of these systems are installed in sensitive areas where permission is necessary for even the smallest amount of smoke or test aerosol to be released. Where permission cannot be granted for a smoke test, other methods, such as measuring the suction pressure at each sampling point, may be used to assess the system performance.

16 USER RESPONSIBILITIES

Clause 47.1 of BS 5839-1:2025 clearly identifies the need for the user of a fire detection and fire alarm system to appoint a person responsible for supervising "all matters pertaining to the fire detection and fire alarm system". It is especially important that a responsible person is appointed to supervise an ASD system, whether it is a "stand-alone" system or an integral part of the overall building fire detection and fire alarm system.

As well as carrying out the general duties laid out in clause 47 of BS 5839-1:2025, the responsible person should be trained in identifying potential environmental influences and situations which might affect the satisfactory performance of an ASD system, and the actions which can be taken to overcome those problems. Problems may arise from:

- Changes to the use of the premises,
- Changes to the layout of the premises,
- Introduction of new processes or changes to existing processes,
- Changes to the internal environment, such as the installation of new air-conditioning,
- Changes to the external environment, such as an increased level of background diesel fumes or increased levels of exhaust from another factory in close proximity.

APPENDIX A – ASD SYSTEM PERFORMANCE TESTS - OVERVIEW

The table below 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 application.

This table should be used as a guide to select the most appropriate performance test to be carried out during commissioning and maintenance of a specific ASD system.

Table A1 – Matrix of performance tests according to the desired response

Type	Application	Response Class A	Response Class B	Response Class C
Primary	Clean room, Telco or computer facility (ceiling <3m)	2m PVC wire (E.2)	1m PVC wire (E.1)	7-9g pellet (B.1)
	Other (inc open areas and high ceilings)	1m PVC wire (E.1)	7-9g pellet (B.1)	13-18g pellet (B.2)
Secondary	Low ceilings (<3m)	2m PVC wire (E.2)	1m PVC wire (E.1) Paper Chimney (C.1)	7-9g pellet (B.1) Paper Chimney (C.1) Poly' mat (G) Pot' Lactose (H)
	Normal ceilings (up to 20m unless otherwise stated)	7-9g pellet (B.1) Paper Bin (C.2@30%)	13-18g pellets (B.2) Paper Bin (C.2@50%)	2x13-18g pellets (B.3) Paper Bin (C.2) Poly' mat (G) Pot' Lactose (H)
	High ceilings (>20m)	N/A	2x13-18g pellets (B.3) Paper Bin (C.2@50%)	Paper Bin (C.2) Pot' Lactose (H)
Localised	Ideally devise custom test to reflect risk – otherwise use…	2m PVC wire (E.2)	1m PVC wire (E.1)	7-9g pellet (B.1) Poly' mat (G) Pot' Lactose (H)
In-Cabinet	Vented/cooled	2x12ohm for 80sec (F.3)	2m PVC wire (E.2)	1m PVC wire (E.1)
	Unvented >3m^3	12 ohm for 70sec (F.2)	2x12ohm for 80sec (F.3)	2m PVC wire (E.2)
	Unvented <3m^3	12ohm for 8 sec (F.1)	12 ohm for 70sec (F.2)	2x12ohm for 80sec (F.3)
Duct	For smoke generated in the Duct	2m PVC wire (E.2)	1m PVC wire (E.1)	7-9g pellet (B.1)
	For smoke generated in the room, devise custom test to reflect volume and usage of space protected.	1m PVC wire (E.1)	7-9g pellet (B.1)	13-18g pellet (B.2)

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 chimney test (Annex C.1) or the paper bin test (Annex C.2) may be used.*

Note 3 – *Reduced quantities of fuel may be used for the paper bin test as indicated by "@"*

APPENDIX B – SMOKE PELLET PERFORMANCE TEST

B.1 System Performance Test Using a Single 7-9g Smoke Pellet

B.1.1 Apparatus

B.1.1.1 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.1.1.2 Metal plate, at least 200 mm square.

B.1.1.3 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.1.1.4 Calibrated stop clock or stopwatch, capable of measuring in 1 s intervals.

B.1.1.5 One smoke pellet of weight 7 g to 9 g

B.1.2 Procedure

B.1.2.1 Place the metal platen upon the burner and place the pellet(s) centrally on the platen.

B.1.2.2 Place the chimney centrally around the pellet.

B.1.2.3 Ignite the burner and start the timer when the pellet starts producing smoke.

B.1.2.4 Operate the burner for the appropriate length of time as indicated by Table B.1.

B.1.2.5 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.*

B.1.3 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 (of the ASD) 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.

Table B1 – Burner operating times for smoke pellet tests

Burner Operation Times :

Height (m)	Temperature Differential (°C)				
	<3°C	3 to 6°C	6 to 9°C	9 to 12°C	12 to 15°C
3 -5	3s	6s	9s	12s	17s
5-10	7s	13s	20s	27s	34s
10-15	10s	20s	30s	40s	51s
15-20	13s	27s	40s	54s	67s

Note 1 *No heat input is required for applications with a height of less than 3 metres when conducting these tests.*

Note 2 *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.*

Note 3 *The times in the above table are based upon 5.8KW burner, a smaller burner can be used i.e. 1.2KW but the times may need to be extended to reach the same end of test criteria.*

B.2 System Performance Test Using a Single 13-18g Smoke Pellet

The test is identical to that specified in section B.1 but a smoke pellet with a weight of 13-18g is used at section B.1.5

B.3 System Performance Test Using Two 13-18g Smoke Pellets

The test is identical to that specified in section B.1 but two smoke pellets with an individual weight of 13-18g are used at section B.1.5

APPENDIX C – PAPER BURN PERFORMANCE TEST

C.1 System Performance Test Using Paper in a Chimney

The Paper Chimney test is used for performance-based testing of ASD systems based on Cloud Chamber technology. This test is used where thermal lift may be expected and is only suitable for ceiling heights up to 3m.

C.1.1 Apparatus

C.1.1.1 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.1.1.2 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.1.1.3 Calibrated stop clock or stopwatch, capable of measuring in 1 s intervals.

C.1.1.4 A4 sheet of white paper (80 g/m2).

C.1.2 Procedure

C.1.2.1 Roll the sheet of A4 paper lengthways and place it inside the chimney so that the paper contacts the sides of the chimney.

C.1.2.2 Place the chimney centrally on the burner so that the flames (when lit) surround the chimney.

C.1.2.3 Fit the mesh cap to the chimney.

C.1.2.4 Ignite the burner and start the timer when the paper starts producing smoke.

C.1.2.5 When a further 180 s has elapsed, extinguish the burner.

Note: *Thermal lift will occur during the whole test.*

C.1.3 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 (of the ASD) 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.

C.2 System Performance Test Using Paper in an Incinerator

This paper incinerator test is used for performance-based testing of ASD systems installed to protect spaces with high ceiling (not less than 8m) as this test provides thermal lift due to the heat created by the burning material.

The test produces white smoke.

C.2.1 Apparatus

C.2.1.1 Tabloid sized newspaper pages (typically 580mm x 370mm)

C.2.1.2 Steel Incinerator Bin approximately 90litres in volume with 'stand-off' feet, and a number of low-level ventilation holes. The Incinerator Bin should be fitted with a chimney lid with a coarse wire mesh (typically 10mm grid) to contain any embers.

C.2.1.3 Long Taper

C.2.1.4 Lighter/Matches

C.2.1.5 Stopwatch

C.2.1.6 Suitable Fire Extinguisher

C.2.2 Test Procedure

C.2.2.1 The Incinerator Bin should be positioned at the test location with suitable precautions taken to ensure that heat generated does not damage the flooring.

C.2.2.2 The newspaper sheets should be loosely rolled and/or crumpled and placed lightly so that they are well oxygenated and burn fully in the incinerator. The number of newspaper sheets required is based on the following formula:

> 1 sheet per meter of height + 10 sheets for ceiling heights up to 20m (Class C) (reduce fuel to 30% for Class A or 50% for Class B responses – see Table A1)
>
> 1½ sheets per meter for ceiling heights above 20m (Class C) (reduce fuel to 50% for Class B responses – see Table A1)

Note: the above formula is suitable for ambient conditions of 5°C to 25°C. Temperatures outside these conditions may require additional sheets to accommodate the effects of excessive cooling (colder areas) or thermal stratification (warmer areas).

C.2.2.3 The newspaper should be carefully lit through one of the low-level ventilation holes with the chimney lid in place using the Long Taper.

C.2.3 Pass/Fail Criteria

The system is deemed to have passed the test if the detection system registers a response within 300 s of ignition.

The response should be a full fire condition (of the ASD) 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.

APPENDIX D – OVERHEATED ENAMEL WIRE PERFORMANCE TEST

Overheated wire tests are used for performance-based testing of ASD systems based on Cloud Chamber technology; this test is used where no thermal lift may 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 stopwatch, capable of measuring in 1 s intervals.

D.1.5 Enamel coated wire, 18 AWG. 2m long

D.2 Procedure

D.2.1 Strip the two ends of the wire to the conductor, connect them 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.

APPENDIX E – OVERHEATED PVC/LSF WIRE PERFORMANCE TESTS

E.1 System Performance Test Using Electrically Overloaded PVC-coated Wire (1m)

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) of 5 parts per million ($5x10^{-6}$) in a 15-minute 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. 2m) of the smoke source, personnel should wear appropriate protective equipment such as an E1 respirator confirming to EN 140 and goggles without ventilation conforming to EN 166.

E.1.1 Apparatus

E.1.1.1 Wire, either:

- 1 m 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 mm2; or
- 2 m length of single strand low smoke and fume (LSF) ethernet 24 AWG cable.

E.1.1.2 Transformer, 240 V to 6 V, capable of supplying at least 15 A.

E.1.1.3 Insulating board, of non-combustible material, of minimum size 600×600 mm.

E.1.1.4 Stop clock or stopwatch, capable of measuring in 1 s intervals.

E.1.1.5 Arrangement to shield the overheating cable from the cooling effects of high airflows, where present.

E.1.2 Procedure

E.1.2.1 Connect the wire to the 6 V output terminals of the transformer.

E.1.2.2 Ensure that the wire is laid on the insulating board so that there are no kinks or crossovers.

E.1.2.3 Connect 240 V mains electricity supply to the primary terminals of the transformer for a period of 60s.

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

E.1.3 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.

E.2 System Performance Testing Using Electrically Overloaded PVC Coated Wire (2m)

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 test described in E.1, hydrogen chloride vapour is unlikely to be produced due to the relatively low temperatures reached. This test may also be undertaken in under-floor spaces or ceiling voids.

E.2.1 Apparatus

E.2.1.1 Wire, either:

- 2m 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 mm2; or
- 2.5m length of single strand low smoke and fume (LSF) ethernet 24 AWG cable.

E.2.1.2 Transformer, 240 V to 6 V, capable of supplying at least 15 A.

E.2.1.3 Insulating board, of non-combustible material, of minimum size 600×600 mm.

E.2.1.4 Stop clock or stopwatch, capable of measuring in 1s intervals.

E.2.1.5 Arrangement to shield the overheating cable from the cooling effects of high airflows, where present.

E.2.2 Procedure

E.2.2.1 Connect the wire to the 6 V output terminals of the transformer.

E.2.2.2 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 180s.

Note: *After this period, the insulation is expected to be scorched but largely intact.*

E.2.3 Pass/Fail Criteria

The system is deemed to have passed the test if the detection system registers a response within 120s 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 (2x1m)

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 the short-term exposure limit (see HSE publication EH40) of 5 parts per million ($5x10^{-6}$) in a 15-minute 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. 2m) of the smoke source, personnel should wear appropriate protective equipment such as an E1 respirator conforming to EN 140 and goggles without ventilation conforming to EN 166.

E.3.1 Apparatus

E.3.1.1 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 mm2.

E.3.1.2 Transformer, 240 V to 6 V, capable of supplying at least 15 A.

E.3.1.3 Insulating board, of non-combustible material, of minimum size 600×600 mm.

E.3.1.4 Stop clock or stopwatch, capable of measuring in 1s intervals.

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

E.3.2 Procedure

E.3.2.1 Connect the wires in parallel to the 6 V output terminals of the transformer.

E.3.2.2 Ensure that the wires are laid on the insulating board so that there are no kinks or crossovers

E.3.2.3 Connect 240 V mains electricity supply to the primary terminals of the transformer for a period of 60s.

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

E.3.3 Pass/Fail Criteria

The system is deemed to have passed the test if the detection system registers a response within 120s 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.

APPENDIX F - OVERHEATED RESISTOR PERFORMANCE TESTS

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.

As a general guide, Test F2 produces about 3 times more smoke than F1 and F3 produces about 3 times more smoke than F2.

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. 2m) of the smoke source then it is recommended that personnel wear appropriate protective equipment such as an E1 respirator confirming to EN 140 and goggles without ventilation conforming to EN 166.

F.1 Apparatus

F.1.1 Resistors, 12 Ohm, 0.25W carbon film (one for tests F1 and F2; two for test F3).

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

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

F.1.4 Shielding tube, consisting of a pipe (approximately 90mm diameter & approximately 100mm long) with eight 4mm holes around the base and a cap perforated with 12 twelve 8mm holes.

F.1.5 Stop clock or stopwatch, capable of measuring in 1 second intervals

F.2 Procedure

F.2.1 Connect the resistor(s) to the ceramic terminal blocks. Use one resistor for tests F1 and F2 and two resistors in parallel for test F3.

F2.2 Ensure the resistors are not touching anything other than the connections to the terminal blocks.

F2.3 Place the shielding over the resistors to shield them from airflows within the cabinet.

F.2.4 Energise the resistor(s) as follows

a) test F1: energise one resistor for a period of 8 seconds
b) test F2: energise one resistor for a period of 70 seconds
c) test F3: energise both resistors for a period of 80 seconds

F.3 Pass/Fail Criteria

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

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

APPENDIX G – POLYURETHANE MAT PERFORMANCE TEST

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

G.1 Apparatus

G.1.1 Polyurethane mat(s) of non-fire-retardant expanded polyurethane foam (500mm x 500mm x 20mm) meeting the requirements for TF4 in EN 54-7:2001[2]

Note: *The French R7 Rules (2014) and NEN 2535 (2017) have similar recommendations regarding the number of mats to use to trigger point-type detection (typically ~ 5 mats for 10m ceiling height). See Table G1. However, experience indicates that, under normal circumstances, fewer mats are needed to trigger an ASD system due to the advantages of cumulative sampling.*

Height of the space (in m)	***Number of mats suggested***
≤ 2,5	*2 x 1/2*
2,5 to 4	*2*
4 to 6	*3*
6 to 9	*4*
9 to 12	*5*
12 to 15	*6*
15 to 18	*7*
18 to 21	*8*
> 21	*9*

Table G1 – Number of polyurethane mats suggested in NEN 2535 Table B.1

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

G.1.4 Stop clock or stopwatch, capable of measuring in 1-second intervals

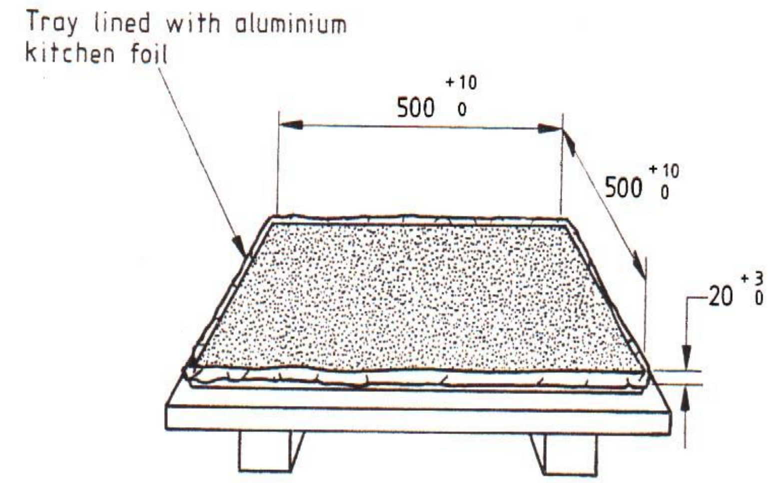
G.2 Procedure

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.

[2] For information on the availability of suitable foam contact your aspirating system supplier



G.3 Pass/Fail Criteria

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

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

APPENDIX H – POTASSIUM CHLORATE & LACTOSE PERFORMANCE TEST

This test is used for the performance testing of Response Class 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. This test generates temperatures of 1,000°C within seconds and does not simulate a developing fire.

Warning The chemicals should be kept separate until the point of use.

Note: *Attention is drawn to the Control of Substances Hazardous to Health Regulations 2002 in respect of chemicals in storage and transport. Attention is also drawn to the Control of Substances Hazardous to Health Regulations (Northern Ireland) 2003.*

H.1 Apparatus

H.1.1 Potassium Chlorate

H.1.2 Lactose powder

H.1.3 Steel container

H.1.4 Insulating board or wood battens

H.1.5 Calibrated timer

H.1.6 Long taper

H.1.7 Matches/lighter

H.1.8 Calibrated 15g measuring spoons

H.2 Procedure

H.2.1 Thoroughly mix 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 (m)	Qty Lactose	Qty Potassium Chlorate
<5m	30g	20g
5m < 10m	45g	30g
10m < 20m	90g	60g
20m < 30m	135g	90g

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.2.2 Place the steel container on a 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.2.3 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.

H.3 Pass/Fail Criteria

The system is deemed to have passed the test if the detection system registers a response within 180 seconds 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 or pre-alarm.

APPENDIX I – EXAMPLE FORMS

I.1 ASD Planning & Overview Form

Project Name / Reference	
Client	
Site	
Contact	

Area / Location Reference				
Drawing Reference				
Application	Computer Room		Electrical Room	
	In Cabinet		Duct	
	Ceiling Void		Floor Void	
	Warehouse		Atrium	
	Heritage		Cold Store	
	Wash down		Production	
	Retail			
Environmental conditions	Temperature		Humidity	
	Dirty/dusty			

Performance Requirement

Prescriptive Standard	BS 5839 Pt 1	L1		L2		L3		L4		L5		P1		P2	
	BS 6266 (risk)	A		B		C		D		E					

Or Performance-based design	A:Very early warning		B:Enhanced Sensitivity		C:Normal sensitivity	
Performance test to use						
Battery backup time required	24 Hours		72 Hours		Other	

Design Information

Dimensions of protected area	Room	L		W		H	
	Ceiling Void	L		W		H	
	Floor Void	L		W		H	

Sampling Method	Primary		Secondary		In cabinet		Localised		Duct	

Air Movement / AHU,s / Duct	Number of air return grilles				
	Dimensions of grilles		X		=
	Dimensions of duct		X		=
Differential pressure					

Multiple height sampling / vertical spacing (in metres)	Ceiling only		Intermediate levels					

Pipe/sampling Requirements

Pipe	Material		Colour		Diameter	
	Surface run			Concealed		
Sampling Points	In pipe		Capillary		Drop pipe	
Pipe supports						
Maintenance access requirements						

Equipment Locations

ASD units	
Display(s)	
Power supply (PSU)	
Maintenance access requirements	
Other special requirements	

Interface requirements to CIE/BMS

Alarm level Description	**1**		**2**		**3**		**4**	
Alarm interface								
Fault(s)								
Isolate								
Reset								

Actions in event of alarms

Alarm level 1	
Alarm level 2	
Alarm level 3	
Alarm level 4	
Fault	
Isolate	

Sketch

Comments………

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Name (in Block letters)……………………………………………… Position………………………………………………

Signature…………………………………………………Date………………………………………

For and behalf of………………………………………………………………………………………

I.2 ASD Design Form

Project Name / Reference	
Client	
Site	
Contact	

Area / Location Reference	
Drawing Reference	
Planning form reference	

Performance Requirement

Prescriptive Standard	BS 5839 Pt 1	L1		L2		L3		L4		L5		P1		P2	
	BS 6266 (risk)	A		B		C		D		E					
Or Performance-based design		A:Very early warning		B:Enhanced Sensitivity		C:Normal sensitivity									
Performance test to use															

Battery backup time	24 Hours		72 Hours		Other	
Battery/Charger Calculations	Battery		Charger			
Expected current consumption						

Pipe configuration	Number of branches		Number of sampling points					
In-line features (e.g. filter / water trap / temperature conditioning)								
Pipe/Sampling point calculation reference								
Maximum transport time	120 sec		90sec		60 sec		Other	
Predicted transport time(s)								

ASD unit settings

Sensitivity		%obscuration/m							
Smoke alarm thresholds		1st		2nd		3rd		4th	
	Day								
	Night								
Time Delays		1st		2nd		3rd		4th	
Airflow fault thresholds		Low				High			
Relay Outputs	Alarm	Latching				Non latching			
	Fault	Latching				Non latching			
Filtration requirements									

Cabling

Supply from PSU/Charger	
ASD to display	
ASD to CIE/BMS	
ASD network cabling	

Maintenance Requirements

Frequency of maintenance	
Routine Functional Tests	
Performance parameters	

Sketch

I certify that the above system complies to the best of my knowledge with the required design standard, except with variations, if any, as stated above.

Name (in Block letters)……………………………………Position…………………………………

Signature……………………………………………………Date……………………

For and behalf of…………………………………………………………………

I.3 ASD Installation Form

Project Name / Reference	
Client	
Site	
Contact	

Area / Location Reference	
Drawing Reference	
Design form reference	
Pipe/Sampling point calculation reference	

Equipment Locations:

ASD(s)	
Display(s)	
Power supply (PSU)	

Pipe	Material		Colour		Diameter	
	Surface run		Concealed			
	Identified as ASD pipe by labels		Pre-printed			
Sampling Points	In pipe		Capillary		Drop pipe	
	Drilled / sized in accordance with design calculations					
	Sampling point labels installed					

Cabling:

Supply from PSU/Charger	Cable specification					
	Surface		Concealed		Conduit	
	Insulation tested*		Earth continuity tested*			
ASD to display	Cable specification					
	Surface		Concealed		Conduit	
	Insulation tested*		Earth continuity tested*			
ASD to CIE/BMS	Cable specification					
	Surface		Concealed		Conduit	
	Insulation tested*		Earth continuity tested*			
ASD network cabling	Cable specification					
	Surface		Concealed		Conduit	
	Insulation tested*		Earth continuity tested*			
	Cable specification					
	Surface		Concealed		Conduit	
	Insulation tested*		Earth continuity tested*			

* separate test sheets to be available from responsible electrician

"As Fitted" drawings	Unless supplied by others, the "as fitted" drawings have been supplied to the person responsible for commissioning the system.	

I certify that the installation complies to the best of my knowledge with the design and conforms to the requirements of BS 7671 and BS 5839-1, except with variations, if any, as stated above.

Name (in Block letters)………………………………….Position……………………………..

Signature………………………………………………..Date…………………………………..

For and behalf of……………………………………………………………………………….

I.4 ASD Commissioning Form

Project Name / Reference	
Client	
Site	
Contact	

Area / Location Reference	
Drawing Reference	
Design form reference	
Pipe/Sampling point calculation reference	
Installation form reference	

Inspection

Type of System	Primary	Air handling		Duct sampling	
	Secondary	Number of sampling points			
	In Cabinet	Number of cabinets			
Environmental conditions		Temperature			
		Humidity			
		Other			
As fitted installation drawings		Are as fitted drawings available			
ASD		Is ASD installed in accordance with the design			
Display		Is display installed in accordance with the design			
Power supply (PSU)		Is PSU installed in accordance with the design			
Pipe		Is pipe installed and labelled in accordance with the design			
Variations					

Power up/configuration

Sensitivity		%obscuration/m							
Smoke alarm thresholds		1st		2nd		3rd		4th	
	Day								
	Night								
Time Delays		1st		2nd		3rd		4th	
Airflow fault thresholds		Low				High			
Relay Outputs	Alarm	Latching				Non latching			

	Fault	Latching		Non latching	

Commissioning tests

Transport time(s)	Predicted time				
	Actual time				
Alarm outputs verified					
Fault outputs verified					
Reset (if events are latched)					
Isolate function verified					
Battery/mains disconnect verified					
Current consumption verified					
Hole/pipe blockage fault verified					
Pipe fracture fault verified					
Airflow readings (when required)					
Pressure readings (when required)					

System Performance Verification

Performance requirement (from initial project planning/design)

Either…

Prescriptive Standard	BS 5839 Pt 1	L1		L2		L3		L4		L5		P1		P2	
	BS 6266 (risk)	A		B		C		D		E					

Or…

Performance based design	A:Very early warning		B:Enhanced Sensitivity		C:Normal sensitivity	
Performance test used						
Results (including sketch of locations and response times):						

Comments…….

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I certify that the above system complies to the best of my knowledge with the design specification and performance requirements, except with variations, if any, as stated above.

Name (in Block letters) …………………………………………… Position……………………………………………

Signature…………………………………………………Date………………….

For and behalf of…………………………………………………………………

I.5 ASD Maintenance Form

Project Name / Reference	
Client	
Site	
Contact	

Area / Location Reference	
Drawing Reference	
Design form reference	
Pipe/Sampling point calculation reference	
Commissioning form reference	

Inspection

Check design & commissioning.	Have there been any design changes since system was last inspected/commissioned.	
Check the configuration	Have there been changes to the setting/sensitivity of the detector since the system was inspected/commissioned	
Environment and use	Have there been any changes in the environment or area usage since the system was inspected/commissioned.	
Filters & other serviceable items	Checked and replaced as necessary	

Maintenance Requirements

Frequency of maintenance	
Routine Functional Test	
Performance parameters	

Tests

Transport time(s)	@ Commissioning				
	Current times				
Limits for TT variation (see 8.6)	within limits?				
Alarm outputs verified					
Fault outputs verified					
Reset (if events are latched)					
Isolate function verified					
Battery/mains disconnect verified					
Current consumption verified					

Hole/pipe blockage fault verified	
Pipe fracture fault verified	
Airflow / Pressure readings (when required)	
Performance test results (when required)	

Comments……

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I certify that the above system has been maintained and verified to be fully functional.

Name (in Block letters) ……………………………………………… Position………………………………………………

Signature…………………………………………………Date……………………..

For and behalf of……………………………………………………………………

Published September 2026. Design, Installation, Commissioning & Maintenance of Aspirating Smoke Detector (ASD) Systems Code of Practice

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