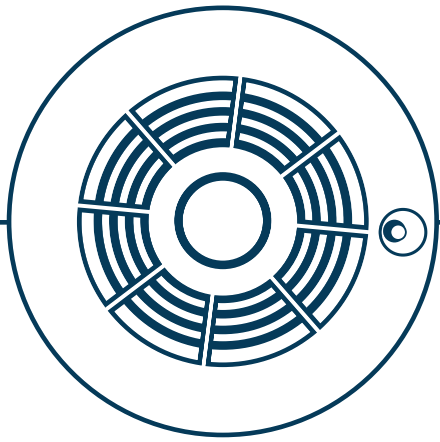
Guidance Note

Fire Industry Association



Design, Installation, Commissioning and Maintenance of Aspirating Smoke Detector (ASD) Systems

Design, Installation, Commissioning and Maintenance of Aspirating Smoke Detector (ASD) Systems

1. SCOPE 3

2. NORMATIVE REFERENCES BS 5839-1: 2008 3

3. TERMS, DEFINITIONS AND ABBREVIATIONS 4

4. INTRODUCTION TO ASPIRATING SMOKE DETECTORS 6

5. DEFINITION OF ASD SYSTEMS 7

6. EXCHANGE OF INFORMATION, PLANNING AND RESPONSIBILITIES 12

7 VARIATIONS OF RECOMMENDATIONS 13

8 DESIGN CONSIDERATIONS 14

9. DESIGN TOOLS 24

10. APPLICATIONS 27

13 INSTALLATION 39

14 COMMISSIONING AND HANDOVER 42

15. MAINTENANCE 45

16 USER RESPONSIBILITIES 47

APPENDIX A – ASD SYSTEM PERFORMANCE TESTS 48

APPENDIX B – SMOKE PELLET PERFORMANCE TEST 49

APPENDIX C – PAPER BURN PERFORMANCE TEST 50

APPENDIX D – OVERHEATED ENAMEL WIRE PERFORMANCE TEST 53

APPENDIX E – OVERHEATED PVC/LSF WIRE PERFORMANCE TESTS 54

APPENDIX F – OVERHEATED RESISTOR PERFORMANCE TESTS 57

APPENDIX G – POLYURETHANE MAT PERFORMANCE TEST 58

APPENDIX H – POTASSIUM CHLORATE AND LACTOSE PERFORMANCE TEST 60

APPENDIX I – EXAMPLE FORMS 62

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.

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 (eg pipe hole sizes or pipe diameters), which must be specified in-conjunction with the specific manufacturer's design tools.

2. NORMATIVE REFERENCES BS 5839-1: 2008

Fire detection and fire alarm systems for buildings – Part 1: Code of Practice for system design, installation, commissioning and maintenance

BS 6266: 2011	Code of Practice for fire protection for electronic equipment installations
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: 2010-05	VdS-Richtlinien für automatische Brandmeldeanlagen – Planung und Eunbau
ADPAD R7 (Jul06)	Règle d'installation. Détection automatique d'incendie
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 54-7:2001/A2: 2006	Fire detection and fire alarm systems – Part 7. Smoke detectors – Point detectors using scattered light, transmitted light or ionisation
prEN 54-27	Fire detection and fire alarm systems – Part 27. Duct smoke detectors (Draft)
The FIA CoP DSD	The FIA Code of Practice for Design, Installation, Commissioning and Maintenance of Duct Smoke Detector (DSD) Systems

3. TERMS, DEFINITIONS AND ABBREVIATIONS

For the purpose of this document, the terms and definitions in BS EN ISO 13943 and the following apply.

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 EN 54-20 for ASD which specifically includes the sampling device.

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 (eg fan or pump).

Note: Each smoke sensing element may contain more than one sensor exposed to the same smoke sample.

3.3 Balancing orifice

In pipework systems, the system pipework may be balanced by an end of pipe orifice of a calculated size which is, in general, less than the bore of the sampling pipe.

3.4 Balanced system

An ASD in which there is an equal air flow and thus equal detection sensitivity at each sampling point.

3.5 Capillary pipe

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

3.6 CIE – control and indicating equipment

Equipment in accordance with EN 54-2.

3.7 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.

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.

3.8 Conditioning

The exposure of a specimen to environmental conditions in order to determine the effect of such conditions on the specimen.

3.9 Condition warning (pre-alarm warning)

The status of an ASD reflecting a change of signal at the control equipment which is greater than the ambient non-fire state, and not exceeding the normal fire state.

3.10 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.

3.11 EDP – Electronic data processing

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.

3.12 Extended sampling pipe

A length of pipe with a diameter equal to or less than the main pipe; with a minimum diameter and length limited by the manufacturer's recommendations.

3.13 Extended sampling point

A single sampling point which is extended from the main pipe by an extended sampling pipe or capillary pipe.

3.14 Main pipe

A length of pipe which, together with sampling holes makes up the most common form of sampling device.

3.15 Maintenance test point

A test point, provided beyond the last sampling point, to test the integrity of the pipework. Such a test point is closed in normal operation and is not subject to the maximum transport time.

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 Primary sampling system

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

3.18 PSU – power supply unit

Equipment in accordance with EN 54-4.

3.19 Referencing

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

3.20 Response time

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

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

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

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

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

4. INTRODUCTION TO ASPIRATING SMOKE DETECTORS

The use of ASDs has significantly increased since their introduction, their incorporation into BS 5839 Part 1; BS 6266; NFPA 72; NFPA 76; and the publication of the 1996 BFPSA Code of Practice for Category 1 Aspirating Systems. ASDs now provide the solution to a wide range of fire detection problems.

The ASD system is often an integral part of the overall fire detection and alarm system particularly when used as an alternative to point or beam type smoke detectors. When this is the case, the ASD system designer must still maintain compliance to National Standards, especially for fault monitoring, zoning, battery standby etc.

There are many reasons and motivators for using ASDs, as summarised in 4.2. 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 Reason for using ASDs
The principal reasons for applying ASDs are:

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

4.2 Common motivators

There are many motivations for deploying an ASD system. The following list is intended to assist in the classification and therefore specification of ASD systems.

4.2.1 Extreme environments

Harsh environments (eg extreme temperature, 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 and 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 (eg in racking and storage systems).

4.2.6 Anti-vandal systems

Vandalism may be an issue so therefore discreet detection is required.

4.2.7 Hazardous environments

The risk is hazardous, eg explosive, chemical, radioactive environments etc.

5. DEFINITION OF ASD SYSTEMS

As described in the 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 (eg 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 Appendix A.

Several typical examples ASD definitions are given in 5.4.

5.1 Sensitivity classes

For the purposes of definition there are considered to be three sensitivity classes which relate directly to those specific in EN 54-20:2006.

Note: The sensitivity class relates to the 'ASD system' (see section 3.2) and includes any dilution due to '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 detection systems meeting the requirements of EN 54-7.

For the nominal bands of sensitivity for these classes see Table 2 (page 11).

5.2 ASD Sampling types/methods

For the purposes of definition, there are considered to be 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/accumulate. Most typically, this is at the air intake grilles of air handling units (AHUs) or pressure relief vents (PRV), but sampling may be arranged wherever any 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 are 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, but it should be noted that these are maximum spacing requirements which are normally bettered when using ASD as a result of performance based design. Some example Standards are shown in Table 1 (page 9).

Sampling hole positioning in accordance with established standards for point detectors

Country	Standard for normal environments	Standard to high risk environments
United Kingdom	BS 5839-1	BS 6266
Germany	VdS 2095	VdS 2095 (appendices)
France	R7 Rules	-
USA	NFPA 72	NFPA 76

Table 1 – example standards for sampling hole positioning.

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 detector), is equivalent to (or exceeds) the minimum performance requirements of a point 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 into more than one sampling point, then 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 assure the performance of the ASD system as being equivalent to a point 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 of such localised systems can only be determined during the full design considerations by the specialist/manufacturer. However, 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.

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 is 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 10.3) 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:

- Duct smoke detection (DSD) provided to trigger a control system to prevent smoke being transferred through a building.
- Duct sampling applications, where the detection of smoke in a duct is used 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, 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 air-flow 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 (eg detention cells) duct sampling may be at a similar smoke sensitivity to replace point smoke detectors, ie ~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. The manufacturer's recommendations should be sought to determine the optimum position in the duct for the intake and exhaust pipes and the maximum duct airspeeds (See 10.7 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 smoke detection zone under BS 5839-1: 2010 Section 2:13.

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 is only one situation 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), with sampling hole spacing that falls within the full requirements of the relevant prescriptive code (eg BS 5839-1: 2008). This situation is highlighted in the table on page 11. In all other situations, it is recommended that a suitable performance test is specified and carried out during commissioning to verify the system. Refer to Section 14.

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 or beam technologies according to EN-54 Part 7 or 12	Smoke visible and sufficient to be detected by point 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 appropriate
Secondary Detection: positioning sampling holes according to the codes for point 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 appropriate
In-cabinet Sampling: Localised sampling:	Appropriate for low risk	Appropriate for high risk	Not appropriate
Duct Sampling:	Appropriate for high risk	Appropriate for low risk	Not appropriate
Other Motivators (see Section 4.2) • Extreme environments • Exceptional ceiling height • Aesthetics • Anti-vandal systems • Restricted/difficult access • Heat barriers • Risk of mechanical damage • Hazardous environment			

Table 2 – sensitivity classes vs detection requirements.

Using this table, it is possible to define all ASD systems.

Key – shaded block indicates where prescriptive design may be used.

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 detector providing primary sampling within high airflow area to BS 6266 spacing.
- Class A detector providing primary sampling for VERY EARLY WARNING to meet Test E.2.
- Class B detector providing localised sampling of equipment X to BS 6266 spacing.
- Class C detector 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 of the stages shall 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 these consultations, documents should be prepared; these may include but are not limited to:

- Details of the installation proposed, including 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 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 false 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. Therefore, it is essential that 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 be additionally consulted on behalf of the user or occupier may include the following:

- The manufacturer of the ASD system.
- The supplier of any third party equipment supplier 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/air movement within one occupancy, may adversely affect the operation of any ASD system installed elsewhere in the building. It is important that consultations should take place with those interested parties early in the planning stage of any ASD system and during the whole life of the system.

7 VARIATIONS OF RECOMMENDATIONS

7.1 General

This document is a Code of Practice and therefore 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, albeit not compliant, with one or more recommendations of the Code of Practice.

It does not however, imply that the designer or installer has 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 need to be clearly identified in all relevant system documentation.

8 DESIGN CONSIDERATIONS

When designing ASD systems there are two main aspects that require consideration: the design of the ASD system itself (including the sampling device) and the operation/function of 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 must be followed (eg BS 5839-1:2008, section 13). 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 clause 8.2.3.1).

When a condition warning is given by the ASD system, 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, a single aspirating detector should cover an area not exceeding a maximum area of a detection zone (nominally $2000m^2$ BS 5839-1). This does not preclude the aspirating detector from covering multiple detection zones within a single evacuation area.

Failure of any single aspirator/fan or other critical component within an ASD system, should not remove protection from an area greater than $2000m^2$.

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 of the abilities of these systems to detect combustion aerosols at an early stage, prior to there being 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 from large areas within a building, and may therefore not be confined to the definition of a detection zone as specified in BS 5839. 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 conventional ionisation and optical scatter 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 sited 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 a number of 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 or design software, which are used to ensure suitable design of the pipework systems.

8.2.3.1 Multi-channel detectors

Some ASD systems are able to 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 continually (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. Additionally, that after the signalling of the first alarm, no pipe/channel is left unsampled for a period greater than three minutes.
3. That all areas protected are sub-zones within a single detection zone.

8.3 Sampling point spacing and positioning

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

8.3.1 Horizontal spacing in normal environments

For prescriptive based designs (see 5.3), the requirements for national or international Standards should be followed. Specifically, the spacing of the sampling points should follow the recommendations for the spacing and positioning of 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. (Eg 7.5m radius of coverage for each sampling point in BS 5839-1: 2010 section 22.)

For performance based design, 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.

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

8.3.2 Ceilings height limits

Most national Standards prescribe maximum ceiling heights for standard point detectors. Increasingly, maximum ceiling heights for other detection techniques (including ASD) are provided.

The maximum ceiling heights for ASD according to BS 5839-1:2008 and other European Codes are very conservative and there is considerable evidence that satisfactory systems can be (and have been) 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 (page 17) and the following list are provided. These recommendations may be used as a basis for a variation from national codes on a project by project basis. In all situations where a variation exists the risk should be assessed and performance tests should be considered to verify the system response.

Reference

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

Detector type	Generally applicable maximum ceiling height		10 % of ceiling height no greater than	
	General Limits	P + Rapid Attendance[1]	General Limits	P + Rapid Attendance1
Any ASD system approved to EN 54-20	10.5m	15m	12.5m	18m
ASD system with: at least 5 Class C holes or at least 2 Class B holes	15m	21m	18m	26m
ASD system with: at least 15 Class C holes or at least 5 Class B holes	25m	40m	28m	43m
ASD system with: at least 15 Class B holes	40m	40m	43m	43m

Table 3 – Recommended ceiling height limits for ASD.

Reference: 1: The higher limits are for Category 'P' systems (for property protection) with five minute fire service attendance.

The following recommendations are provided in addition to the limits specified in Table 4.

a. The ASD holes should be located close to the ceiling (typically within 600mm) and spaced in accordance with maximum areas specified in national codes (eg 7.5m radius in BS 5839-1:2002).

b. An enhanced response can be achieved by using an ASD with increased Class. For example, a Class A detector with at least five 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 (eg 5m as opposed to 10m) will provide enhanced detection in spaces up to 25m.

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

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

f. The recommendations given assume that there is no stratification and that smoke rises to the ceiling unimpeded by thermal gradients. If 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 8.3.4).

g. Any air flows (eg as a result of air conditioning) should be considered and taken into account by the provision of primary sampling where necessary (see 8.3.3).

In applications where the risk of stratification is minimal, the likelihood of cross flow from ventilation is very small and 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 of 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, where sampling points cover AHU return grilles. For primary sampling, the following design points must take into consideration:

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

b. It is recommended that each sample point shall have a maximum area coverage of $0.4m^2$ of the air grille.

Note: typically, three or more sampling holes are used to cover a single air intake.

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

d. It is generally the case that airflows into the grille follow the louvers (where fitted) the pipe should be positioned in the main air-stream.

e. Sampling holes are typically positioned at an angle of $30\text{-}60^o$ off centre, into the airflow.

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

g. Internal mounting of the pipe is sometimes desirable, but requires special consideration due to the internal operation of the air-handling unit (internal dampers and louvers) and the increased negative pressures relative to the pressured inform of the air return grille.

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 (EDP areas) and Section 10.7 (Duct detection).

8.3.3.2 Secondary detection hole spacing in EDP/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 Part2:2009 Annex E specify closer spacing of point detectors mounted on ceiling or in voids. These spacing rules are generally intended for point detectors and may be used where the ASD is being installed to meet the prescriptive design goals, because each sampling hole has equivalent sensitivity to a standard point 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 recommendations state:

Detectors within the electronic equipment installation should be spaced such that the effective area coverage of each point or sampling hole is $25m^2$ 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) $5m^2$ if airflows >1 m/s and ≤4 m/s are present in >25% of the space;

2) $10m^2$ if airflows >4 m/s are present in >25% of the space.

b. Increase by $10m^2$ if the air-conditioning is to be shut off by early warning detection at the air return vents.

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

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

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

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

g. For floor and ceiling voids (up to 1.5m high), adjust as follows according to the level of ventilation present.

1) Reduce by 5m² 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 (ie airflow = 0):

i) Increase by 5m² for voids with a smooth ceiling.

ii) Reduce by 5m² when the void has very shallow beams (eg <5% of the void height).

iii) Reduce by 10m² when the void has shallow beams (eg 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. It is recommended that for comprehensive 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). Vertical pipes should be carefully considered for the extent of coverage in the horizontal plane.

It is possible to install vertical air sampling systems, with sampling points arranged at regular intervals within vertical shafts and ducts, 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 ASD systems 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 and alarm system.

8.4.1 Standalone systems

Where the ASD does not report into a CIE then it is considered 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 shut down of process plant. In such cases, the recommendations for integrated systems (page 20) 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 its is reset from the CIE or reset locally at the ASD system.

ASD systems can provide a number of 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, and should draw attention to the need to investigate the condition in accordance with the action plan (see 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, when 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:

- First stage; 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 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 located 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).

Such networks may also be used to transmit the primary fire signals to the CIE, for example, by providing relays local to the CIE. 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. 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.

In the UK, BS 5839-1: 2008 clause 12.2.2 c) stipulates that a single communication fault should not result is a loss of more than 2000m. Due to the large area coverage of a single ASD detector, it is generally the case that each covers a separate zone. 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: 2008 12.2.2 d) stipulates that two simultaneous communication faults should not result in the loss of coverage of an area greater than 10,000m. Special consideration must therefore be given to ASD communication networks which cover areas greater than 10,000m 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.

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, ie for open and short circuit fault conditions.

8.6 Maintenance

Maintenance requirements should be considered during system design. In particular, the recommended maintenance period 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. 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 international 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.

The PSU may be integral 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 in excess of that allowed by the prevailing Standards. In the case of BS 5839-1: 2008, a single fault (open or short circuit) should not disable protection within an area greater than 2000m.

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 alarm load for the ASD system when in either normal or standby conditions. Where the ASD is installed as an essential element of the fire alarm system, the standby periods should the same as the fire alarm system.

8.8 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. Some national Codes and product Standards exist and specify how extinguishing release is to be arranged in general. However, these rarely take into consideration the use of an ASD system, as one or more of the extinguishing input triggers. However, a wide variety of coincidence arrangements are possible using ASD systems (see 8.8.1).

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

a. The high sensitivity alarms thresholds available on Class A and Class B systems, often provide early warning capability to avoid unwanted suppression release. However, they are not normally used for both inputs to a coincidence arrangement.

b. The high sensitivity alarm thresholds available on Class A and Class B systems may be used as one input to a co-incident extinguishing system (with the second input provided by a normal sensitivity ASD or point detection system) where early indication of a possible suppression release is desirable.

c. The normal sensitivity alarm thresholds available on Class C systems are fully compatible with extinguishing systems and may be used as one or both inputs to a co-incident system (see section 8.8.1).

d. When using a Class C ASD system, 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.

e. A low 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 (ie sufficient to operate two point 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.

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

8.8.1 Coincidence detection with ASD

Coincidence detection is used as a system of verification. The technique is most often applied to automatic fire fighting systems, where unwanted discharges are expensive and leave a risk unprotected while the system is reinstated; it is also used in other applications where unwanted alarms have unacceptable consequences.

Historically, point smoke detectors were less reliable and detection systems were structured such that a system output would require activation of two detectors: coincidence. This method was refined to overcome the limitations of different detector technologies (eg 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 is required from two separate and specific technologies to provide confirmation that a fire is in progress (eg ionisation on one circuit and optical on the other).

With the introduction of addressable systems, the concept of two 'circuits' is often reflected by the grouping of detectors into zones and requiring coincidence from two zones before triggering an extinguishing system. Alternatively, an addressable system can be configured to trigger the extinguishing when any two detectors signal alarm.

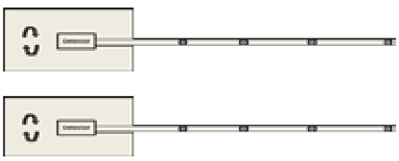
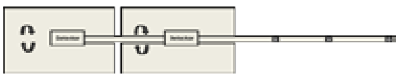
Increasingly, coincidence from any two detectors is being used in larger buildings as a useful technique for reducing unwanted alarms.

Sometimes supplementary detection is required to provide redundant detection to ensure that loss of one detector does not remove protection from the risk. It is important to differentiate the two requirements (coincidence and redundancy) to ensure selection of the most appropriate methodology.

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

To help clarify the possible arrangements of ASD in a co-incidence detection system the following common arrangements are presented:

Table 4 – Redundancy and coincidence solutions using ASD.

Description	Figure	Advantages	Disadvantages	Example
Scheme A Two ASD systems protect the same area with independent aspirator, detector and pipe networks		All system components are duplicated: redundancy. Coincidence from independent detector and sampling pipe systems	More equipment required: expensive	Critical Category Risks such as Internet Hosting Centres or Nuclear/Biological Control Rooms
Scheme B Two ASD's protect the same area with independent aspirator, detectors and a shared pipe network		ASD are duplicated: redundancy (excluding shared pipe work). Coincidence from independent detectors.	Shared sampling pipe network	High Category Risks such as Main IT Facilities or Telecommunications Areas
Scheme C A single ASD with two detectors protects the risk with a shared pipe network and shared aspirator		Detector modules are duplicated: redundancy	Shared pipe work and aspirator fan	Medium Category Risks such as Call Centres
Scheme D A single ASD with two detectors protects the risk with separate pipe networks		Coincidence from independent sampling pipe networks and detector modules	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/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 (eg hole sizes) based on pre-determined performance goals or may be descriptive – predicting the performance of the system (eg 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 commissioning 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.

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 (ie 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 considerations

9.3.1 Primary detection sampling systems

These are arranged to monitor for smoke carried by air movement using pipework and air sampling points mounted directly in the 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.

When monitoring a single point of supply or extract in such a system, its 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 his 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 and BS 6266 requirements, when the calculated relative sensitivity per air sampling hole equates to a point detector. See relative sensitivity (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 (two minutes). Transport times in excess of this must 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 to figure 3. The 4-branch design (figure 3) will provide the shortest transport time.

Figure 1: Single branch system.

Figure 2: Two branch system.

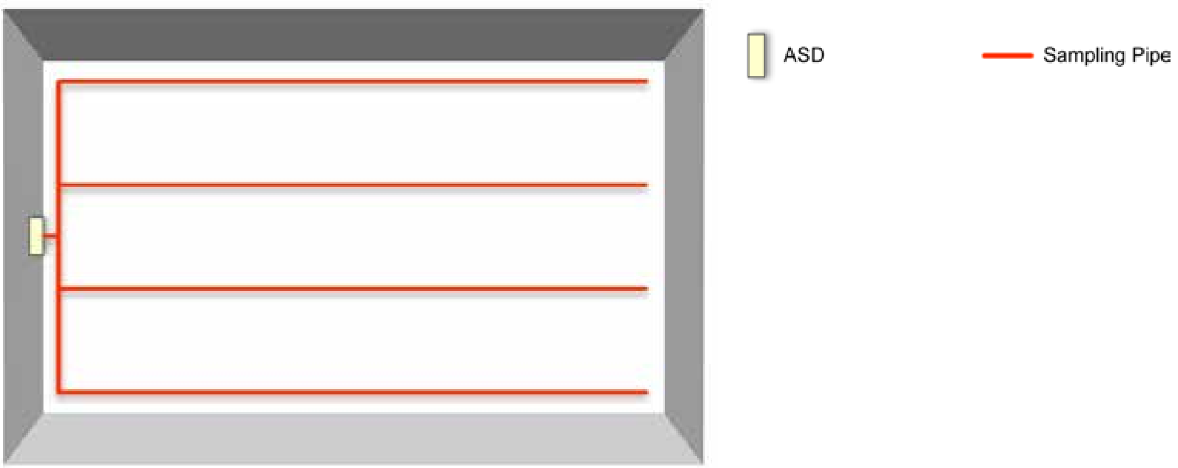


Figure 3: Four branch system.

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 sample points have the same amount of air entering each sample hole then this is invariably described as a system with 100% balance.

9.3.5 Relative sensitivity
The relative sensitivity of each air sampling hole (assuming that all sampling points have been calculated for an equivalent sensitivity ie 100% balance) can be calculated as a simple function of the detector sensitivity and the number of sample points.

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

Unless otherwise stated in a manufacturer's approval documentation, a figure of better than 5%/m sensitivity per hole may be applied for a Class C system.

9.4 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 (two minutes).

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

Where possible, 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 of concealed sampling holes, centralised maintenance and/or the cumulative effect.

10.1.1 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 While addressable point 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 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. Furthermore, a Class C alarm is likely to be readily apparent on investigation, particularly where the number of areas/rooms is not excessive and each is readily accessible (eg <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.

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

10.1.2.2 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 two minutes of arriving at the Zone, and by travelling less than 60m.

10.1.2.3 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 five minutes of arriving at the Zone, and by travelling less than 60m.

Note: The 60m travel distance limit above match clause 13.2.3 of BS 5839-1:2008 for non- addressable automatic fire detectors.

10.1.3 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 applies to each individual sub-zone that can be identified.

10.2 Electronic data processing (EDP) areas

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.

Due to these issues it is necessary to protect areas using primary and secondary detection principles. Detection is therefore required at ceiling level, floor void and return grilles of AHU. Ceiling (roof) voids should also be taken into consideration where necessary.

Dependent upon the area being covered, it may be necessary to use separate ASD systems to monitor the specific areas as identified in the preceding paragraph. However, in applications smaller than 150m. It may be possible to use a single Class A detector to cover the area as identified above (refer to manufacturer for design implications).

Secondary detection spacing, at ceiling levels and within voids, will require the sampling points to be spaced in accordance with clause 8.3.3.2.

Primary detection of air return grilles 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.

Sampling pipe is required to be installed across the grille with the sample points positioned at a typical angle of 30-60o off-centre, into the airflow. Maximum spacing recommendations are given in clause 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 allow maintenance access to the grilles of the AHU.

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 re-charging areas, control systems, loading/docking areas and electrical distribution equipment.

10.3.1 Ceiling detection

A 'code compliant' design may be achieved using a Class C ASD system mounted on the ceiling as an alternative to point detectors, thereby providing advantages both in terms of installation and maintenance, and in improved performance 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 head height. Hence, it is recommended that in any area with storage above head height, a ceiling mounted Class B ASD system should be installed, with sampling holes spaced according to national guidelines (eg 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 300mm 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 4). In other cases, (particularly retrofit projects) it may be more practical to run pipe along the aisles (see figure 5). 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.

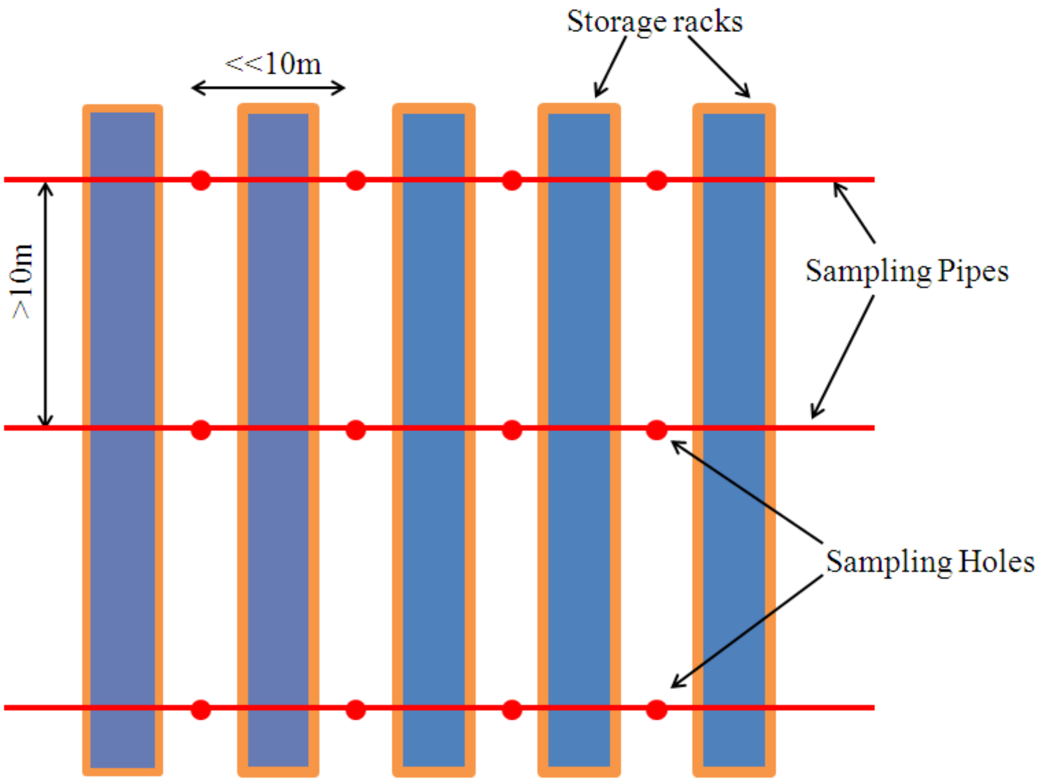


Figure 4: Warehouse ceiling pipes running across the racks.

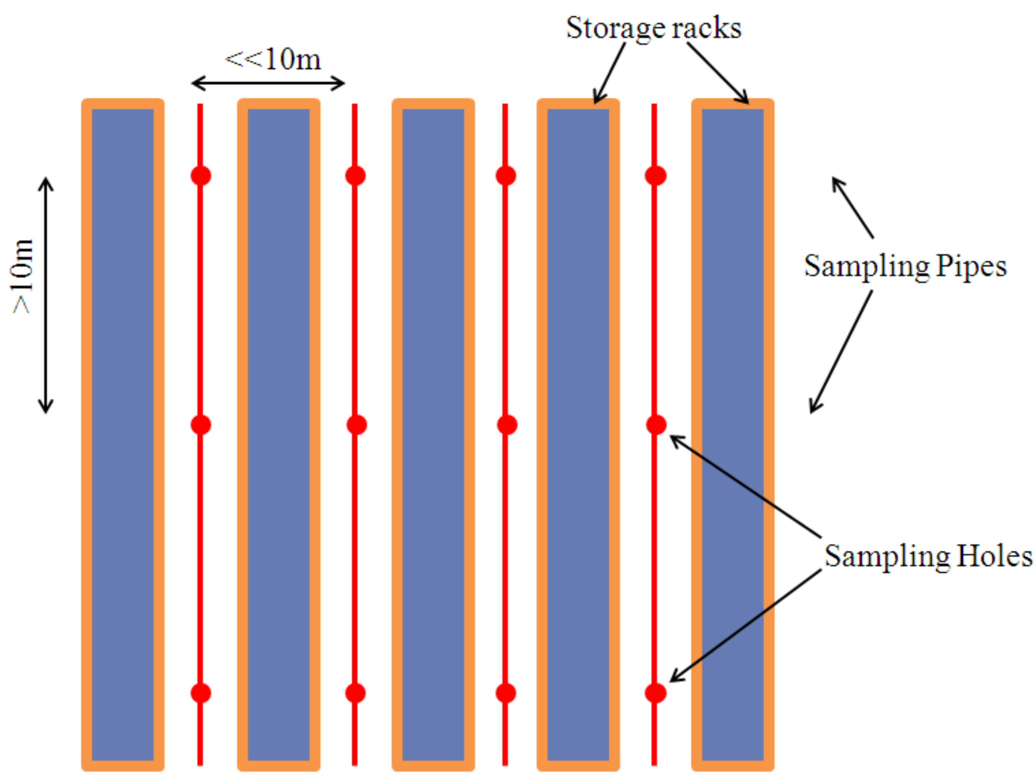


Figure 5: Warehouse ceiling pipes running along the racks.

10.3.2 In-rack detection

For many warehouses, additional detection within the rack is often desirable. The following points provide recommendations which are applicable in whole or part to the majority of warehouses – subject to the particular risks and characteristics of any individual project.

1. When protecting warehouses with high racking/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 three or more levels of sampling.
3. Where multiple levels of sampling are provided, each level should be offset to the one below to minimise the possibility of smoke rising vertically and passing between multiple layers of sampling points.

Note: Where practical considerations suggest that a vertical pipe solution is preferable, this recommendation may be omitted provided that the horizontal spacing (see point 1) is less than 4m.

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 is likely to provide more reliable and faster detection as it closer to the likely ignition source (eg vehicles in the aisles) compared to detection in the central 'chimney' (if present in the space between back-to-back shelving). However, while aisle-side sampling may be easier to install and test, it is more exposed to risk of mechanical damage. The decision needs to be on a case by case basis in the knowledge of the rack design, the fire risk of the materials stored and the operational activities.

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 (eg >3m). However, where multi-level sampling is provided, consideration should be given to offset the levels across the aisles.

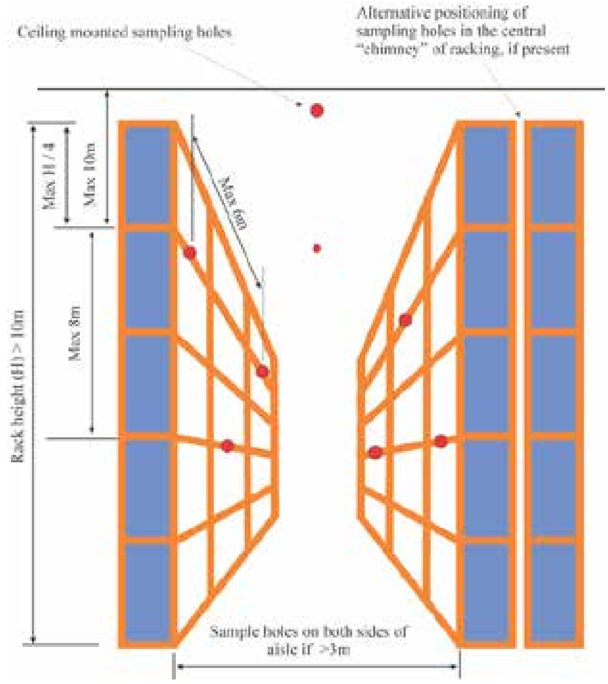


Figure 6: Illustration of sampling hole locations for in-rack detection.

10.4 In-cabinet detection

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

• Sealed.

• Naturally ventilated.

• Forced ventilated.

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 Sealed cabinets

Where cabinets are sealed, internal sampling is required. Dependent upon the sealing integrity, it may be necessary to provide a breather air inlet to ensure circulation of air. If the cabinet is compartmentalised, it is recommended that a sample point for each compartment be installed.

10.4.2 Sample hole location and recommendations

Where detection is required for the monitoring for 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 (ie 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 ventilation vent.

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

c. Multiple sampling points should be provided where the cabinet is large (eg greater than 1200x600mm footprint).

d. Class A or Class B systems should be used when the ventilation rates are such that dilution of the smoke is likely to render normal sensitivity detectors ineffective.

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

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.

10.4.3 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 clause 10.1.2 may be used for determining the number of cabinets protected by a single ASD or the following recommendations may be used:

• For cabinets protected by a Class C system – max five cabinets.

• For cabinets protected by a Class B system – max eight 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

Within heritage buildings, there are a number of issues to be considered in designing the ASD system, such as aesthetics, high ceilings and stratification.

ASD can be utilised within heritage buildings to provide discreet air sampling, not visible to normal occupancy.

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 tubes can be connected to the main pipe network to provide discrete detection at the required location (ie blending in with paintings, forming part of ceiling sculptures or cornice and chandeliers).

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 clauses 8.3.2 and 8.3.4).

The ASD should be installed to the requirements of national Standards with special consideration being 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 that are often as low as -30°C; freezer stores that have less air movement; and chill storage and process areas normally at 3-5ºC. All of 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 pass the air sample through an enclosure that contains a heater or thirdly, to heat a section of the pipe with trace heating tape.

Note: Even if the temperature of the sample entering the detector is within the manufacturer's 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 clause 10.6.2 should be followed.

10.6.1.3 Freezing of the sample points
In general, freezers are dry by the very nature that all moisture is frozen but the following should be considered:

- Sample 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.
- 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 back-flushing 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 and running down to the sample 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. Also, the pipe material must be suitable for use at low temperatures.

10.6.2 Wet areas
Where water can enter sample 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 drain-pipe 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, therefore the installation techniques described in clause 10.6.2 should be used.

10.6.4 Dirty and dusty areas
Most ASD systems incorporate filtration or methods to compensate for 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, and/or air purging systems to keep sampling points and pipe clear. These must be applicable to the application and installed in accordance with manufacturer's guidelines.

Where additional filtration is installed the filters shall 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.

Where air-purging systems are employed they may be operated automatically or manually.

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 it is applied. In the European Union, this is covered under the ATEX Directive and compliant products will be CE marked. 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. The area coverage of an ATEX certified ASD may be less than with a standard ASD system.

Note: An unapproved ASD must not be used to monitor a potentially explosive environment, even if it is located in a remote safe area. This is the case ,even if the sampling and exhaust pipes pass through flame arrestors to the protected area, as the hazardous environment extends into the ASD housing.

10.6.6 Inaccessible or restricted environments

ASD systems can provide reliable smoke detection in environments where access is restricted, because the detection unit can be located remotely from the sampling pipework.

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

Particular examples include:

- Lift shafts and other vertical shafts.
- Floor and ceiling voids.
- Cable tunnels.
- Prison cells.
- Locked or secure areas.
- High voltage risks.
- Industrial or chemical risks.

Such areas should be covered by an ASD system providing remote fire detection

Means should be made for performing routine maintenance from the safe area, by providing a maintenance test point, so that the integrity of the remote pipework in the restricted area can be tested.

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

10.7 Duct detection

As stated in Clause 5.2.5, there are two principle applications for sampling smoke from a duct using ASD; either as a DSD to prevent smoke spread or to provide early warning of a fire condition in an area or piece of equipment from which air is extracted.

Within these applications there are a number of issues to be considered when designing a duct detection system using ASD. The primary ones being:

- Pressure equalisation.
- Maintenance accessibility (flexible joints to allow the pipe to be removed).
- Monitoring upstream or downstream of filters, (generally on the upstream side).

Monitoring is achieved by installing a sample pipe within the duct. To maintain the pressurisation balance, the exhaust sampled air is returned to the duct downstream of the monitoring sample pipe. To provide the ASD with a maintenance facility, it is recommended that the sample pipe spans the width of the duct and protrude the opposite side and be capped. This will allow test smoke to be introduced at this point for commissioning and maintenance purposes. Typically, as ducts have different pressures, it is recommended that only a single ASD monitor a single duct.

A sampling pipe installed within the duct will require the sample points positioned at an angle of 30-60^{o} off-centre, into the airflow, unless directed otherwise by the ASD manufacturer. It is recommended that each sample point shall have a maximum area coverage of 0.4m^{2} of the cross sectional area.

The use of a union socket is recommended to allow the selection of the final orientation during the commissioning of the system. Where possible, the sampling pipe should be installed in the centre of the airflow and away from bends. It is also recommended that the sampling pipe 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.

Due to the dilution of the smoke particles from the protected area due to high airflows, it is recommended that only Class A & B ASDs are suitable for early warning applications.

Note: The preliminary European Product Standard for DSDs (prEN 54-27) defines ASD as a type 5 DSD and requires that they are approved to EN 54-20.

11 Product standards and 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 Directive (CPD). As such, it is a legal requirement in most European countries that an ASD system installed for fire protection in buildings must be approved by an authorised third party (called a 'Notified Body'). The approved product must carry a CE mark underscored by the number of the Notified Body, be clearly marked as complying to EN 54-20 and indicate the relevant sensitivity class(es) applicable. Furthermore, the product must be supported by a Declaration of Conformity (DoC) and sufficient technical information to 'enable correct installation, sensitivity setting and operation' and 'the necessary means to determine the classification of any used configuration'.

Note: Prior to EN 54-20, ASD systems were tested and approved against Standards published by the Comité Européen des Assurances (CEA) – specifically to CEA 4022 and its earlier incarnations (CEA GEI 1-077 and CEA GEI 1-048).

Note: The Construction Products Regulations (CPR) have been published (4 April 2011) which supersede the Construction Products Directive (CPD). The transition period ends on 1 July 2013. The practical consequence of this is that all ASD systems after this date shall be supported by a Declaration of Performance (DoP) which is largely the same as the DoC under the CPD, with some additional requirements. Further information is available in FIA Fact File 48.

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: 2002 section 3 defines 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 conventional point type smoke detectors. As a result, it is sometimes stated that they are more prone to false alarms than conventional systems. However, in the majority of ASD systems, unwanted alarms are uncommon. In fact, there is evidence of a number of instances where the alarm has been raised by an ASD system but on inspection of that area, no obvious signs of a fire have been identified. A false alarm has been recorded but subsequently a fire has developed. Appropriate training is therefore essential – particularly where pre-alarm or condition warnings form part of the intended response plan.

ASD manufacturers have introduced a range of features into ASD systems to minimise the likelihood of such 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 protected 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 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 to 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 (condition warnings) are available on the majority of ASD systems. Trained personnel are able to respond to condition 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 (eg 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 by several ASD manufacturers 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. Manufacturer's instructions should be followed to ensure that reference detectors are correctly configured.

12.1.5 Alarm delays

The majority of ASD systems support 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 transients.

12.1.6 Day night 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.

12.1.7 Software algorithms

Many ASD systems incorporate technology and/or software algorithms to cancel out the effect of spikes in the signal that may be caused by individual dust particles. Such rejection methods ensure that the dust does not contribute to the measured signal.

12.1.8 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.

In addition to the specific features of individual ASD systems, 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 by the use of coincidence detection (clause 8.8).

Note: Any additional component in the sampling pipework should not invalidate the approval of the ASD system to EN 54-20.

12.2 Equipment alarms

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

13 INSTALLATION

Air sampling installations should be given the following considerations and as a minimum, consist of the following:

- 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 should be installed at a location that is easily accessible and gives consideration for 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 removal of sampling pipes should be considered.

Whenever the detector is installed outside the risk, 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. Generally, differences of less than 50Pa do not require return of the exhaust, but this must be confirmed by the ASD manufacturer.

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.

13.2 Electrical installation

Generally, ASD electrical cabling should be to National Standards, in the UK it should comply with BS 5839 Part 1:2008 clause 26. 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 in PVC, ABS or any other material recommended by the manufacturer, should give consideration to the following external influences:

- Undue stress.
- Mechanical impact.
- UV radiation.
- Temperature extremes.
- Future building operations.

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

Installations in red ABS pipe are considered normal but alternatives are permitted as some applications require pipe to be installed to match the building aesthetics.

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

Typical fixings include:

- Open or 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 stanchion.

Installations of pipework in extreme environments should give special consideration to thermal expansion and contraction when supporting and jointing pipe. Guidance should also be sought from the ASD manufacturer and/or the pipe manufacturer.

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

Consideration should be given to the fire compartmentalisation of the building fabric. While the penetrations required for an aspirating sampling pipe are typically deemed to be small (see BS 9999:2008 clause 33.4.17) and so do not require special measures (eg intumescent seals), fire stopping should be used around the pipe to keep the penetration as small as possible. However, where there are multiple pipe penetrations, it is good practice to use intumescent seals in addition to the provisions recommended in BS 9999:2008.

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 tube, using extended sampling pipe or capillary tubes.

13.3.2.1 Extended sampling pipe or capillary tube.

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 tube taken from the main pipe to the sampling point. The sampling points are then at the end of this capillary tube.

The sampling point may be flush mounted or protrude into the space to be protected (see figure 4 page 30). In some cases, it is appropriate to have a concealed sampling point.

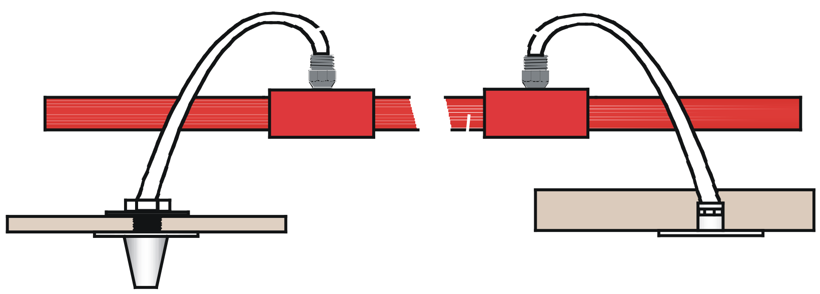


Figure 7: Examples of capillary sample point mounting.

Note: The flush mounted capillary 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 – eg 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 tubes and fittings to minimise the risk of inadvertent disconnection or damage.

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

13.3.2.2 Sampling points

These may be realised, either by drilling custom sizes or drilling common sizes and using reducing ports or sheets. 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. Every sampling point should be clearly labelled.

13.4 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).

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.

13.5 Inspection

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

During inspection, it might be necessary to clean the internal pipe system to remove unwanted 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 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 building 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 and 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 (eg CIE, BMS).
- System handover – including relevant documentation and recorded 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 (eg 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 sample 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 detectors (Class C), ensure the installation (particularly sample point spacing) conforms to the relevant Standard (eg BS 5839-1: 2008) and the ASD sensitivity/alarm thresholds are correctly set, to ensure that the sensitivity of individual holes meet the minimum performance requirements for individual 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.
- Clear identification of sampling points.
- No obstructions to sampling points/remote capillaries.
- All internal and 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, it is very important to check that the installer has cleared the pipe of any foreign articles, eg swarf, dust etc that will impede or stop the ASD performance. (See clause 13.5.)

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 back to the manufacturer for clarification.

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

- Fire signal alarm thresholds and detector sensitivity settings to give 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 – both 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 confirm to prescribed Standards, commissioning tests should include but are not limited to:

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

For ASD systems that are designed to conform to a performance requirement, additional performance tests should be performed.

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 devise used, the 'reaction' is usually a first response of a bar graph, but may also be the first indication of an alarm. However, where an alarm indication is used, it does not generally include any alarm delays, which are temporarily set to zero for the measurement of transport time.

Where there are multiple branches or pipes, it is essential that each branch is tested individually to confirm the full integrity of the pipework.

The maximum transport time shall be less than the maximum time specified within the design documentation (Appendix H2) and shall be less than the maximum limits specified in clause 9.3.3.

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

All measurement should be recorded for later reference during maintenance. 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 be recorded but may exceed the maximum transport time, as long as the transport time from the furthest sampling hole is confirmed to be less than the maximum specified.

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 (ie 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 later reference during maintenance.

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 all 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 clause 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 a 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 based tests are required (clause 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 shall be established and recorded, and it is recommended that videos of tests are shown to those granting permission, so that the scale of smoke and heat are 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.

14.2.4 Signalling
All signalling between the ASD system and 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 conditions 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 shall be recorded. These along with all configuration data, shall be submitted as part of the commissioning certificate.

All relevant drawings shall be submitted to include the pipe layout, hole sizes, sampling point positions and detector locations, and shall 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 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 maintenance/testing of sampling points.

15.1 Frequency of maintenance
Maintenance should be carried out at least annually. The routine to be adopted in individual premises may vary with the use of the premises.

15.2 Recommendations for routine Inspection and functional testing
ASD manufacturer's instructions for maintenance and functional testing should be followed.

In general, the maintenance of an ASD system involves inspection/test of all elements of the system, together with an overall functional test to ensure its continued performance.

15.2.1 Routine inspection
All fault and alarm output functions of the ASD should be tested where practicable and also any interfaces which may form part of the system. 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 and tested in accordance with appropriate national Standards (eg BS 5839-1).

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

It should be checked that there have been no unauthorised changes to the system configuration (eg 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 and for absence of damage and freedom from obstructions.

All systems must be functionally tested.

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, and comparing with the original and all previously recorded results to identify deviations.
- Confirming that the flow monitoring is capable of detecting 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 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 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 this is possible, but it is essential to verify 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 times to respond 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: 2002. Where access to individual holes is restricted it may be necessary to clean the system and re-test in accordance with clause 14.2.3.

5. Where the ASD is specifically installed to provide early warning, regular repetition of the original commissioning performance smoke tests (clause 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 and permission is necessary, even for the smallest amount of smoke/surrogate smoke. 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 make an assessment of the system performance.

16 USER RESPONSIBILITIES

Clause 47 of BS 5839-1: 2008 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 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: 2008, the responsible person shall be trained in identifying potential environmental influences and situations, which might affect the satisfactory performance of an ASD system, and 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 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

Commissioning – ASD System Performance Tests

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.

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 (including 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)	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)	13-18g pellets (B.2) Paper Chimney (C.1) – 5m max	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) 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) may be used.

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 70s.

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

B.1.1.3 Metal chimney, 2mm to 6mm thick, formed into a cylinder of at least 100mm diameter and at least 150mm 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 stop watch, capable of measuring in 1s intervals.

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

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 30s to 60s) 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 180s of the burner being switched off.

The response should be a full fire condition (of the ASD) unless agreed otherwise by the relevant parties, eg 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	Temperature Differential (°C)				
	<30C	3-60C	6-90C	9-120C	12-150C
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 three 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, ie 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 Clause B.1, but a smoke pellet with a weight of 13-18g is used at clause B.1.5.

B.3 System performance test using two 13-18g smoke pellets
The test is identical to that specified in Clause B.1, but two smoke pellets with an individual weight of 13-18g are used at clause 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 8m.

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 70s.

C.1.1.2 Metal chimney, 2mm to 6mm thick, formed into a cylinder of at least 50mm diameter and at least 300mm 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 10mm.

C.1.1.3 Calibrated stop clock or stop watch, capable of measuring in 1s intervals.

C.1.1.4 A4 sheet of white paper ($80g/m^2$)**.**

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 with 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 180s 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 60s of the burner being switched off.

The response should be a full fire condition (of the ASD) unless agreed otherwise by the relevant parties, eg 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 ceilings (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 90 litres 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:

One sheet per meter of height +10 sheets for ceiling heights up to 20m.

One sheets per meter for ceiling heights above 20m.

Note: The above formula is suitable for ambient conditions of 5C to 25C. 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 300sof ignition.

The response should be a full fire condition (of the ASD) unless agreed otherwise by the relevant parties, eg 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 ac variable power supply, capable of supplying 100 A at 8 V.

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

D.1.3 Calibrated voltmeter and ammeter.

D.1.4 Calibrated stop clock or stop watch, capable of measuring in 1sintervals.

D.1.5 Enamel coated wire, 18 AWG.

D.2 Procedure.

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

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

D.2.3 When 180s 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 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 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 five 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 (eg 2m) of the smoke source, personnel should wear appropriate protective equipment, such as an E1 respirator confirming to EN140 and goggles without ventilation conforming to EN166.

E1.1 Apparatus.

E.1.1.1 Wire, either:

- 1m length, of ten 0.1mm strands insulated with PVC to a radial thickness of 0.3mm, the cross-sectional area of the conductor being $0.078mm^2$; or
- 2m 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 600.600mm.

E.1.1.4 Stop clock or stop watch, capable of measuring in 1s 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 6V 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 240V 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 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.2. System performance test 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 0.1mm strands insulated with PVC to a radial thickness of 0.3mm, the cross-sectional area of the conductor being 0.078mm^2; 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 600.600mm.

E.2.1.4 Stop clock or stop watch, 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 240V 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.2.4 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 publicationEH40) of five 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 (eg 2m) of the smoke source, personnel should wear appropriate protective equipment such as an E1 respirator confirming to EN140 and goggles without ventilation conforming to EN166.

E3.1 Apparatus.

E.3.1.1 Two wires, each 1m in length, of ten 0.1mm strands insulated with PVC to a radial thickness of 0.3mm, the cross-sectional area of the conductor being $0.078mm^2$.

E.3.1.2 Transformer, 240 V to6 V, capable of supplying at least 15 A.

E.3.1.3 Insulating board, of non-combustible material, of minimum size 600.600mm.

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 240V 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 (where100% is the fire threshold) sufficient to signal a pre-alarm or warning.

APPENDIX F – OVERHEATED RESISTOR PERFORMANCE TESTS

System performance test using electrically overloaded resistor(s).

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 three times more smoke than F1 and F3 produces about three times more smoke than F2.

Warning: These test produces 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 (eg 2m) of the smoke source then it is recommended that personnel wear appropriate protective equipment such as an E1 respirator confirming to EN140 and goggles without ventilation conforming to EN166.

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

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 and 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 stop watch, capable of measuring in one 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.

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

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

F.2.4 Energise the resistor(s) as follows:

a. Test F1: Energise one resistor for a period of eight 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 54-7:20012.

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

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

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

G.1.4 Stop clock or stop watch, capable of measuring in one 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.

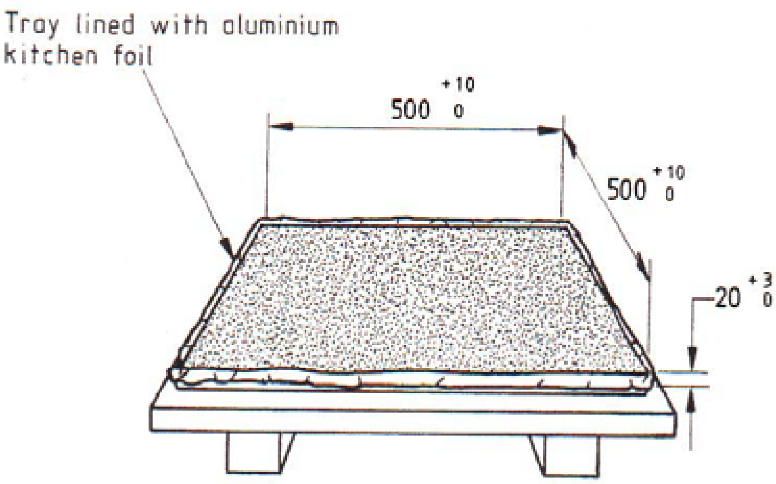


Figure G-1: Test mat on its support.

Reference

2. For information on the availability of suitable foam, contact your aspirating system supplier.

APPENDIX H – POTASSIUM CHLORATE AND LACTOSE PERFORMANCE TEST

This test is used for the performance testing of Response Class B and C systems. Fire is simulated by mixing and igniting two volatile powder chemicals to create white smoke with a strong thermal buoyancy. The mixture burns with an intense heat and is not suitable for confined areas.

Note: 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.

Height (m)	Qty Lactose	Qty Potassium Chlorate
<5m	30g	20g
5m < 10m	45g	30g
10m < 20m	90g	60g
20m < 30m	135g	90g

Table H.1: Lactose and potassium chlorate quantities.

Note: these quantities are suitable for ambient temperatures ranging from 5C to 25C. 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 together.

H.3 Pass/fail criteria.
The system is deemed to have passed the test if the detection system registers a response within 180s of the ignition of the mixture.

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

APPENDIX I – EXAMPLE FORMS

I.1 ASD Planning and 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			
Sample 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……………………………………………………………………………………………………….
………
………
………

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 required	24 Hours		72 Hours		Other	
Battery/Charger Calculations	Battery		Charger			
Expected current consumption						

Pipe configuration	Number of branches		Number of sample points	
In-line features (e.g. filter / water trap / temperature conditioning)				
Pipe/Sample point calculation reference				

Maximum transport time	120 sec		90sec		60 sec		Other	
Predicted transport time(s)								

ASD unit settings

Sensitivity								%Obscuration / metre	
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/Sample 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		
Sample Points	In pipe		Capillary		Drop pipe	
	Drilled / sized in accordance with design calculations					
	Sample 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. See 36.2m of BS 5839 Pt1.	

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/Sample point calculation reference	
Installation form reference	

Inspection

Type of System	Primary	Air handling		Duct sampling	
	Secondary	Number of sample 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 / metre
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……
……………………………………………………………………………………
……
……
……
……
……
……
……
……
……
……

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/Sample 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)	Previous times				
	Current times				
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………
…………………………………………………………………
……
……
……
……

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……………………………………………………………………

DISCLAIMER
The information set out in this document is believed to be correct in the light of information currently available but it is not guaranteed and neither the Fire Industry Association nor its officers can accept any responsibility in respect of the contents or any events arising from use of the information contained within this document.

Fire Industry Association

Tudor House, Kingsway Business Park, Oldfield Road, Hampton, Middlesex TW12 2HD
Tel: +44 (0)20 3166 5002 • www.fia.uk.com