Guidance Note

Fire Industry Association

Fire Detection in High Airflow Environments Including Electronic Equipment Installations

FIA Guidance document – Fire Detection in High Airflow Environments Including Electronic Equipment Installations

1. SCOPE

This guide reviews best practice and the Standards underpinning contemporary fire detection systems for use in high airflow environments, including those used to automatically activate fixed gaseous fire extinguishing systems. It focuses on UK practice, identifying relevant codes and describing how they are used to achieve effective detection systems in these challenging environments.

The document does not consider special hazards with liquid fuel fires and fast flaming fires which may not have a significant and detectable incipient stage.

The document considers detection in high airflow used for equipment cooling with a focus on electronic equipment. However, the principles are applicable to other forced ventilated situations and may be relevant to free or naturally ventilated conditions.

2. DEFINITIONS

For uniformity, a common language has been used in this document. Terminology may be the same in meaning or in application, or the scenario in case, and varies depending on the nature and age of the publication. The following is used as the generic vernacular in this document:

- **AHU**: Air Handling Unit, be this Computer Room Air Conditioning (CRAC), Air Conditioning (AC), Heating, Ventilation and Air Conditioning (HVAC), and any forced air ventilation system.
- **Cold Aisle**: where cooled/conditioned air is supplied – this may be physically contained by a structure or conceptually achieved by the layout (see figure 4).
- **EDP**: Electronic Data Processing is considered to include Data Centres as well as Electronic Equipment Installations as used in BS 6266.
- **Fixed Gaseous Fire Extinguishing Systems**: the common terminology used in this document which also includes “fire suppression systems” referred to in BS6266.
- **Hot Aisle**: where heated air is removed – this may be physically contained by a structure or conceptually achieved by the layout (see figure 3).
- **Void**: be this above a suspended ceiling [ceiling void] or below a raised floor [floor void] or any other construction used as a supply or exhaust plenum where airflow velocity is appreciably fast (i.e. far greater than the 4m/s presently recognised in BS 6266).

3. REFERENCES

The following documents/standards are referred to in this guidance document without reference to the publication dates. Where specific clauses are cited the dates given in this section apply.

DOCUMENT REFERENCE	DOCUMENT TITLE	PUBLISHER
BS 5839-1:2017	Fire Detection and Fire Alarm Systems for Buildings Part 1: Code of practice for design, installation, commissioning and maintenance of systems in non-domestic premises.	BS
BS 6266:2011	Fire protection for electronic equipment installations – Code of practice.	BS
BS EN 54-7:2018	Fire detection and fire alarm systems Part 7: Smoke detectors that operate using scattered light, transmitted light or ionisation.	BS/CEN
BS 7273-1:2006	Code of practice for the operation of fire protection measures Part 1: Electrical actuation of gaseous total flooding extinguishing systems.	BS
ASD CoP Feb 2012	Design, Installation, Commissioning & Maintenance of Aspirating Smoke Detector (ASD) Systems.	FIA
Guidance for coincidence Dec 2014	Guidance for Coincidence Connection of Detectors for Triggering Extinguishing Systems.	FIA
EN 50600-2-3:2016	Information technology – Data centre facilities and Infrastructures. Part 2-5: Security systems.	BS/CEN

4. BACKGROUND

Automatic point type smoke detectors emerged many years go but only became mainstream in the latter decades of the 20th century. The Standards for assessing the performance of point detector became established in parallel; initially in the BS 5445 series and more recently in the EN 54 series of Standards. Part 7, for the smoke detectors, includes several test fires to ensure that they are sensitive to a variety of smoke/fire types and it is widely reported how ionisation devices are relatively sensitive to flaming fires while optical types are relatively more sensitive to smouldering fires.

In addition to these product standards, codes of practice have been developed and published, providing guidance on how to deploy the detectors. These codes establish the recommended spacing of detectors. For example, in the UK, clause 22.3 of BS5839-1 provides baseline spacing for ceiling mounted detectors in general areas expressed as follows;

> *"Under flat ceilings, the horizontal distance between any point in a protected area and the detector nearest to that point should not exceed:*
>
> *7.5 m if the nearest detector is a smoke detector;*
>
> *5.3 m if the nearest detector is a heat detector."*

Many other codes of practice exist – some follow the approach of BS 5839-1 while many express the spacing in terms of the area covered by each detector or by specifying a maximum distance between detectors. They tend to focus on applications where airflow movement is minimal and only advise caution and consideration of airflows.

BS 6266 is a notable exception and is specifically written for EDP type facilities where high airflows are generally present. However, the prescriptive recommendations, specifically the recommendations for detector spacing given in A.2.1 and exemplified in annex I, originate from still or slow to faster moving air and may not be suitable or best suited to the very fast velocities experienced nowadays.

Where coincidence detection is recommended the conservative argument is that the density of detection should be doubled (clause 5.2.4 BS 7273-1) – following the logic that smoke should not have to travel further in order to trigger two detectors. While this may be relevant in still air environments it may not be considered appropriate for very high airflow environments.

Of importance too is the commentary to A.2 of BS 6266, which reminds us that high airflow will inevitably lead to increased dilution of smoke as it is transported away from the fire at a faster rate than occurs in still air, thereby requiring increased sensitivity to compensate for this.

5. DESIGN PHILOSOPHY

The design of a detection system for high airflows can be broken down into the following basic tasks:

i. Understand the airflow – direction, speed, makeup and consistency/variability.

ii. Position detectors to ensure they are effective when the airflow is present.

iii. Consider whether the airflow is "always" present and if not determine appropriate detection for these other instances.

iv. Select a suitable sensitivity for the prevailing airflow.

v. Consider maintenance aspects and mitigate the potential for unwanted alarms.

It is helpful to consider the general concept of air cooling referring to Figure 1. In particular identifying the cold supply upstream of the electronic equipment, the hot air extraction, the use of a fresh air intake and a corresponding vent/outlet to atmosphere.

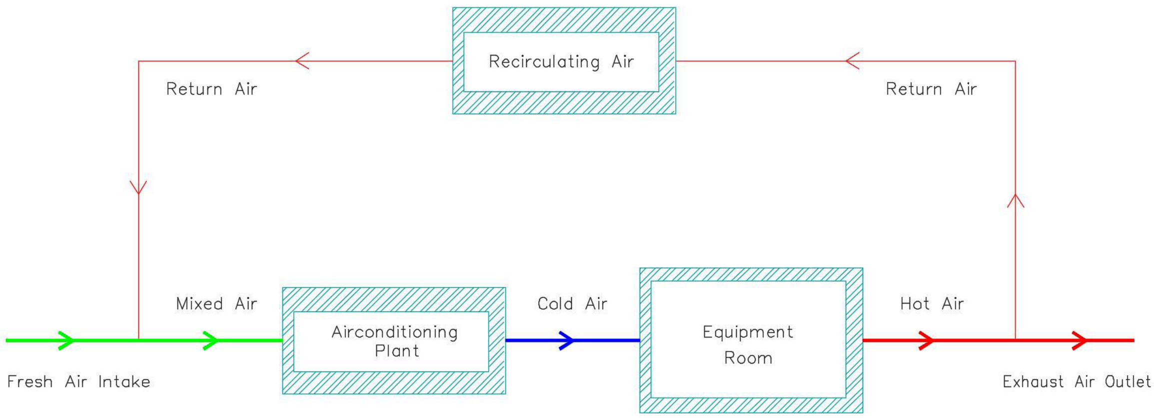


Figure 1 – Generalised layout of room with high airflow used for equipment cooling.

It important to appreciate that a good detection solution needs to follow a holistic design process rather than simple application of the prescriptive recommendations given in one or more installation codes.

6. INTRODUCTION TO THE STANDARDS

Guidance for the provision of fire detection systems for non-domestic premises in the UK are given in BS 5839-1 The focus is on the protection of life and property.

This is generally for still air environments where convection carries smoke to a ceiling where it is detected. The most recent revision (2017) now makes it clear (in clause 22.1) that

"Guidance on protection of ceiling voids in this part of BS 5839 is based on still air within the voids. Where there is significant air flow within a void, such as where the void is used as an air handling plenum, special consideration might need to be given to the spacing, siting and sensitivity of detectors within the void."

Moreover, it explains that

"Air conditioning and ventilation systems with high air change rates might adversely affect the response of detectors by drawing fresh air over them, by drawing heat, smoke and combustion gases away from them, or by diluting the smoke and hot combustion gases produced by a fire. It might be necessary to seek specialist advice."

And that

"Certain very high-sensitivity smoke detection systems (often of the aspirating type) are sensitive enough to detect smoke that has been substantially diluted with clean air. Experience has shown that such systems, when used to monitor return air to air conditioning units by means of air sampling points mounted directly in the airflow, are capable of detecting very small, incipient fires, involving, for example, smouldering of electronic components within equipment cabinets in the protected space. This arrangement is usually regarded as supplementary to other forms of fire detection in the protected space (including aspirating systems with air sampling points sited in accordance with practice normally adopted for point smoke detectors), owing to its limited response capability once the air movement ceases".

It is important to note that the "supplemental detection" described here (which relies on the airflow to the return air grilles) is typically the only effective detection if the smoke is diluted when the airflow is operational, because smoke of a sufficient concentration may never reach the ceiling mounted detectors.

It should be noted that, BS 6266 describes this as "air return" detection and cites the Aspirating Smoke Detection code of practice which refers to it as "primary detection" – reflecting that it is likely to be the first to operate when the AHU is operational.

DETECTION IN THE AIRSTREAM...	
BS5839-1	Supplemental detection
BS6266	Air return detection
FIA CoP	Primary detection

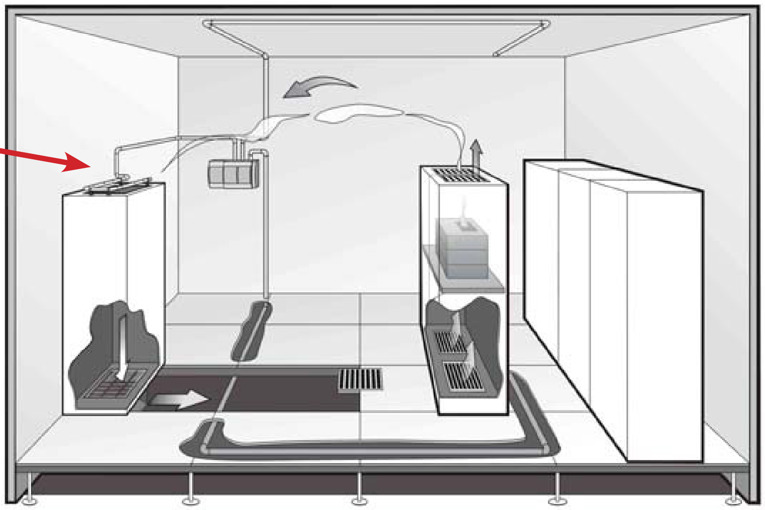


Figure 2 – Illustration of different terminology used for the detection in the airstream – Copyright 2019 Xtralis. Used with Permission.

Most importantly, BS 5839-1 refers to BS 6266 citing "Recommendations for fire detection and fire alarm systems in electronic data processing installations and similar critical electronic equipment rooms are given in BS 6266, which provides recommendations **over and above** those given in this part of BS 5839."

It also defines "coincidence" detection, but only discusses it in relation to reducing false alarms and automatic escalation of a staff alarm. It does not discuss coincidence detection or fixed gaseous fire extinguishing systems directly but refers to BS 7273-1 for operation of fire protection measures – which recommends coincidence detection for the actuation of gaseous total flooding systems. Usefully this BS code provides recommendations on the different coincidence arrangements and there is an FIA guidance document (Guidance for Coincidence Connection of Detectors for Triggering Extinguishing Systems) which emphasises that the selection of detectors and coincidence arrangement depends on the fire risk and on the objectives of the fire system. However, BS 7273-1 follows the conservative approach that coincidence detection requires double the density of detectors. which may not be appropriate in high airflow environments.

The focus of BS 6266 is not on the protection of life but on the protection of property, and business continuity and explains that "The extensive use of fire protection systems in electronic installations arises not from a high probability of fire, nor from a significant hazard to life, but from the consequences of fire loss."

It therefore starts by categorising the risk "to determine the type and level of fire preventions and protection deemed appropriate".

BS 6266 acknowledges the importance of air movement and it also seeks to reinforce this beyond BS 5839-1 as Annex A.2.2 notes "BS 5839-1 does not cover ventilated voids. For ventilated voids, the recommendations given in list item 3) … take precedence over those in BS 5839-1.". In the context of Electronic Equipment rooms, Clause 8.2.1 of BS 6266 reminds us of the challenges of fire detection within airflows. It can also be interpreted that these challenges are not just within Electronic Equipment rooms but also in other specialist areas. Both of which could feature air movement and also high airflow scenarios.

Another standard sometimes cited in relation to fire protection in high air flow environments is EN 50600-2-3. This document is prepared by a European committee (CENELEC TC 215) and in one in a series which *“specifies requirements and recommendations to support the various parties involved in the design, planning, procurement, integration, installation, operation and maintenance of facilities and infrastructures within data centres”.* Part 2-3 specifically *“addresses the physical security of data centres based upon the criteria and classifications for “availability”, “security” and “energy efficiency enablement within EN 50600-1”.* It addresses both physical security, protection against fire and protection against other environmental events, and defines 4 classes (1-4) for each aspect. For fire protection section, the main emphasis is on physical protection and fire extinguishing systems. The section relating to fire detection (7.1.3) is short and high level. It specifies EN 54 components and system compatibility (Part 13), mentions EN 54-20 for ASD and CEN TS 54-14. However, it makes two specific recommendations; that the pre-alarm should not be used to shut down the airflow and that the time between detection and activation of suppression shall allow time for egress.

It is beyond the scope of this guidance note to review other non-UK codes but the following may be relevant; VdS 3152, NFPA 76, NFPA 75 and FM Datasheet 5-32.

7. EXAMPLES, SCENARIOS AND APPLICATION OF THE CODES

While the prescriptive recommendations are present in the codes they are often quite general; BS 6266 has a useful annex to determine detector spacing, yet rigid adherence to this may be inappropriate; it is all about balance and design for the specific application.

The following examples are to illustrate how the UK codes might be applied and adjusted for a specific scenario. In addition, frequently asked questions (FAQs) are found later in this document.

7.1. Detector selection

As stated in BS 5839-1 (clause 21), is it imperative to consider the type of combustible and fire products produced. In EDP most combustibles will have an incipient stage giving lighter coloured smoke, most effectively detected by forward scatter optical type detectors as well as aspirating type devices.

Multi sensors can comprise a combination of optical, CO and heat sensors to decide if the probability of a fire being present is sufficient to raise an alarm. Clause 21.1.6 of BS 5839 part 1 explains the benefits of multi-sensor fire detectors in specific situation. It is accepted these too can readily react to certain fire scenarios in a similar way to an ionisation type device in still air. However, multi sensors which include heat sensors may have challenges in high airflow environments; usually the purpose for high airflow is to dissipate heat, such as that from a processor in EDP, and thus a detector which is monitoring for changes of temperature will be compromised and could be rendered ineffective. The heat will rapidly disperse from a fire as it does the processor. Clause 8.2.1 of BS 6266 recognises this. It is therefore important to consider the mode of operation and the reasons for using a multi-sensor in such environments.

Furthermore, care and consideration must be given to the consequences of an interruption of the air flow, such as AHU failure, where the resulting thermal ramp could trigger an unwanted / false alarm from a heat or multi-sensor detector.

The use of heat detection as a means of detecting a fire or triggering the release of a fire extinguishing system is normally considered inappropriate. Point type heat detection should not be used in electronic equipment environments with forced ventilation due to their considerably slower response than smoke detection. This is echoed in BS7273-3 for watermist systems where "heat detectors are not normally considered appropriate". This is due to the time taken for the thermal energy to accumulate at the detector in sufficient quantity to trigger its operation. It is not the detection of heat that is the issue but the period of time taken to trigger this type of detector that is considered an unacceptable delay when compared to other types of detection.

The ability of a heat detector will be affected by the direction and speed of the air flow. This would not only apply to a point type heat detector but also a thermal bulb used in watermist and sprinkler systems where the automatic nozzles are equipped with an integral thermal release element that must operate before any water can flow.

Caution is given to watermist systems as their effectiveness might also depend on shutting down any forced ventilation prior to discharge. Successful protection requires rapid detection and prompt activation of a fire extinguishing system. If the cooling and channelling effects of high airflow environments are not considered together with the mode of detection used then the risks of a delayed fire extinguishing systems response could be unacceptable, or potentially operating of the wrong watermist nozzle far downstream and away from the actual fire seat.

Some might even argue that if the air is not stilled the use of thermally activated bulbs should not be used.

7.2. Plenums and voids used as plenums

Effective detection of smoke or heat in airflow voids is critically dependant on the airflows present and needs careful consideration; not only during the periods when the airflow is present but also when the airflow is absent.

For a critical data centre with 24x7x365 operation, one can expect constant airflow; any interruption to the airflow would then be considered to be an abnormal condition invoking the attendance of persons who can assess the situation and initiate a manual alarm and intervention where necessary. Where such rapid attendance is assured it might be deemed unnecessary for any other detection system to be needed when the air flow is absent.

However, when following the prescriptive guidance (in BS 6266 and BS 5839-1) it is expected that the detection system will operate effectively when the airflow is absent. Thus where the void is >800mm in height (or contains a significant fire risk) it should have detection. In particular BS 5839-1 (clause 22.2 note 2) states that it is common practice to protect voids in EDP installations regardless of their depth if the void contains cables or a fire load. Additionally, clause 22.2 note 4 acknowledges that detection in a void may be omitted where there is no fire risk present but that this should be recorded as a variation.

There is no guidance provided with BS 5839-1 for the positioning of detectors in an air plenum (see clause 22.1) but, in relation to detection in ducts, it includes a recommendation to have detection "to cover as much of the duct as possible" (clause 22.10 c) which provides an indication as to the coverage needed for voids with airflows (i.e. an air plenum) which transfer (duct) air from one location to another. However, this phrase is ambiguous and can be mis-interpreted to recommend coverage along the duct whereas it is widely understood to mean coverage across the duct.

BS 6266 Annex A.2 comments that "Where the direction of airflow within the room, floor or ceiling is well defined and consistently in one direction, it is reasonable to arrange for the greatest density of detectors (or sampling points) perpendicular to the main direction of flow". Inference also made to where (rich) streams of smoke are likely to pass.

BS 6266 (clause 8.3.2.2 para 6) also recommends "If the air-conditioning is fundamental to the operation of the electronic equipment area and is designed with appropriate power back-up systems to operate 24/7 (minimum 24 h according to BS 5839-1), a high sensitivity smoke detection system in the return air to the air-conditioning system may be used as the sole means of detection."

Perhaps further thought can include the initiation of remote viewing – e.g. via CCTV – in the event of an alarm or airflow interruption.

With so many recommendations it is difficult to establish an optimum general solution; in many cases detection within the whole void may be the default position of many, but where the AHU is assured detection across the void is likely to be more than sufficient, and less expensive. Also this may be easier to test and maintain noting BS 6266 Annex A.2.2 1) states that "Detectors should be accessible for maintenance and regular testing".

The concept of shutting down air movement upon the first signal of a fire event is documented in previous versions of BS 6266. However, the present trend towards uninterrupted operation of EDP is leading to an increased reluctance through to intolerance to shutting down of critical cooling plant.

BS 6266 reminds us "it is important to ensure there is coordination between all parties involved in the design of the electronic equipment area, so that relevant information relating to the anticipated airflows is provided to the designer of the fire detection system." and specifically in 8.2.1 e) "The detection strategy in relation to the air flows and cooling requirements in the area needs to be clearly defined…" Notably, an understanding of airflow direction, speed and consistency should be predetermined, to enable the fire detection design.

Two particular challenges with void spaces which need to be considered are:

7.2.1. Coffered slabs and compartmentation due to services

It is common in voids used for the channelling of supply or return airflow to have compartmentalisation or pockets as a consequence of beams, partitions or other building structures. This presents potential for confusion or over-specification in rooms with high airflows. Conventional theory may suggest the positioning of detector(s) within each compartment or pocket at even spacing and consistent density. However, the physics of this high air flow and the restriction in the void caused by the structure may bring one to conclude that any smoke or heat from a fire would not reach the highest point in sufficient quantities to be of any significance for standard detector positioning. In this scenario and where there is certainty that the air flow is fully maintained, a higher sensitivity detector or sampling point which is densely positioned at key convergent airstream points – such as directly downstream of high risk areas and at the return air grilles – may be better suited. The detection strategy to concentrate smoke detection in harmony with well-defined and guaranteed air flow movement should provide sufficient coverage and limit the effects of smoke dilution. BS 6266 Annex A confirms this: “Detectors or sampling points need to be sited in optimum positions and of sufficient number to best detect smoke from a fire whilst in its early stages” and also “positioning of detectors and/or sampling points should be undertaken only with full knowledge of the air flows in the protected area.”

7.2.2. When AHU is not operational

Whilst the main focus may be on how best to detect within an airflow, BS 6266 clause 8.2.5 reminds us that fires can originate in associated equipment that are not always at the forefront of a designers mind and therefore “Detectors should be positioned to take into account all these possibilities”. Moreover, the designer should consider periods when the airflow flow is not present - such as during periods of modification, decommissionining or integrated system testing. At such times fire effluent will behave normally under convection and consideration must be given to whether there is a residual risk to life which needs to be mitigated. This necessitates an understanding of the manning level present and the likely duration of such periods. In particular, for voids it may be appropriate to revert to BS5839-1 recommendations for still air - protecting those voids with sufficient height or those containing combustibles while excluding voids primarily used as (now dormant) air plenums. Possibly, the design could be engineered specifically to the hazards (and anticipated personnel present) and a justification made to omit a significant number of superfluous devices that strict adherence to the Standard would require.

7.3. Fire cooling and other scenarios which prevent normal smoke accumulation or behaviour

The cooling concept employed in EDP can be based upon saving energy by drawing fresh or “free” air from outside. If conditions permit, filtered fresh air is introduced into the EDP area. Such modern cooling concepts differ from traditional methods where air would be recirculated, with cooling, before being reintroduced as cooled supply air, as was commonplace when many of the relevant Standards were originally authored.

When designing detection systems for the protection of EDP employing free air cooling, consideration should be given to the high volumes of fresh air constantly being introduced into the space and the hot air expelled. Consequently, the rate of smoke build up within modern “free” air/cooling systems could be kept far lower than that of traditional recirculating systems, avoiding accumulation and it may therefore be appropriate to use a different sensitivity and positioning strategy. Such detection locations and sensitivities need to be optimised for the changing scenario and preferably automated.

Even in traditional recirculating systems the build-up of smoke may be slow because smoke might be separated out during recirculation – either by the fans themselves or, where provided, by filtration. Thus it is not usual to rely on smoke accumulation and detectors are selected to be sufficiently sensitive to respond to transitory events.

Due to the potential rapid dispersal of smoke within “free” air/cooled environments the sensitivity and selection of detection type should be considered. For example; aspiration type detection may be well suited to the application due to its enhanced sensitivity characteristics and also due to the accumulative effect derived from incorporating a number of sampling apertures within the same compartment.

Primary detection should indisputably be positioned at the pressure / exhaust vent grille when “free” cooling is employed. However, do consider any imbalance of airflow when protecting multiple ducts/grilles.

Furthermore, consideration should be given to possible external pollutants as set out within BS 6266, clause 8.3.1.5 which states that “In cases where a high sensitivity aspirating smoke detector is used and there is potential for the fresh air system to introduce pollution into the space, the risk of false alarms should be mitigated by using a reference aspirating smoke detector in the fresh air system. This is in order to adjust the sensitivity of the detectors within the room(s) when pollution is present – remembering any filtration employed.

If there is to be a mixed or more than one mode of operation, the detection must be designed for both and ideally automated (in sensitivity change) for the prevailing operating scenario.

Detection at hot aisle entry points may facilitate faster detection and localisation of the source, compared with to primary sampling further downstream and may also provide adequate detection in still air conditions depending on the physical arrangement.

BS 6266 suggests (8.2.1 d) that the cold/hot aisle is an extension of the floor/ceiling plenum supplying but this could be challenged nowadays; there is little value in detection at the top of the cold aisle during normal operation as this is a relatively stagnant area.

Before commencing design work, the airflow direction and sources of fire risk within them should be established and considered in the context of detection location. For example, if high levels of fresh/cool air are to be directed through electronic equipment (the fire risk) and the hot air extracted to atmosphere, detection should be placed downstream of the fire risk – and ideally as close as possible to the fire risk. In general, the further the detection is from the fire risk, the more opportunity there is for dilution and hence the more sensitive (and/or cumulative) the detection needs to be.

Consideration should also be given to the orientation of airflow travel through the equipment and detection placed accordingly. This is addressed further in the following section.

7.4. Contemporary airflow containment systems and their implications for detection

With the ever-increasing demand for data storage, ensuring power is available for data processing and not consumed by other support functions is essential. One of the biggest loads in a modern data centre is air conditioning. As a result, new techniques are deployed to improve the efficiency of cooling and reduce the power demand for AHUs thereby freeing up more power for data processing or keeping service delivery costs competitive.

In most modern EDP, equipment cabinets are positioned to benefit from containment aisle cooling as opposed to uncontained general cooling of the whole room. This is where floor vent tiles are positioned between two rows of data cabinets, installed face to face, creating a targeted cooling zone. The cold air is fed into this cold aisle where it travels horizontally through the equipment cabinets. This is a more efficient method of cooling as more electronics are exposed to the cool air than original methods where the cold air was supplied to the bottom of each cabinet, passing vertically through the cabinet.

Once the air has passed through the equipment cabinets, it enters the 'hot' side. This hot side could be physically ducted to the ceiling plenum (hot aisle containment Figure 3) where it then returns to the AHUs or may use the general space (cold aisle containment Figure 4). The physical enclosure is either cold or hot but rarely both.

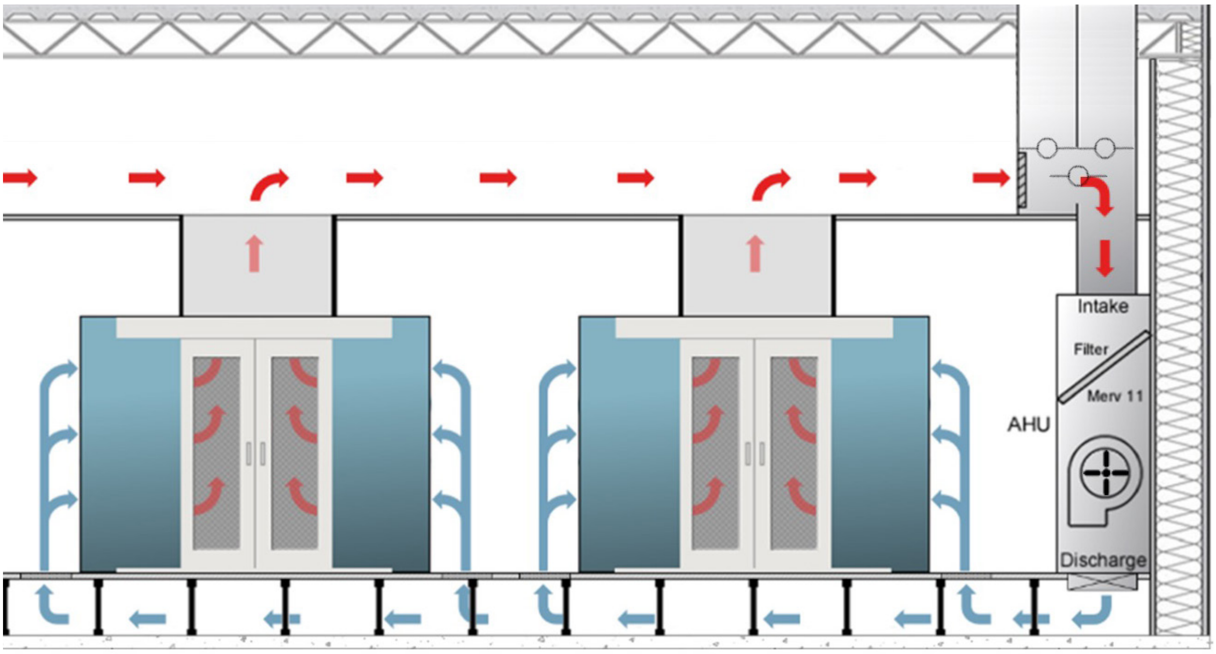


Figure 3 – Hot aisle containment with air returning through ceiling plenum – Copyright 2019 Xtralis. Used with Permission.

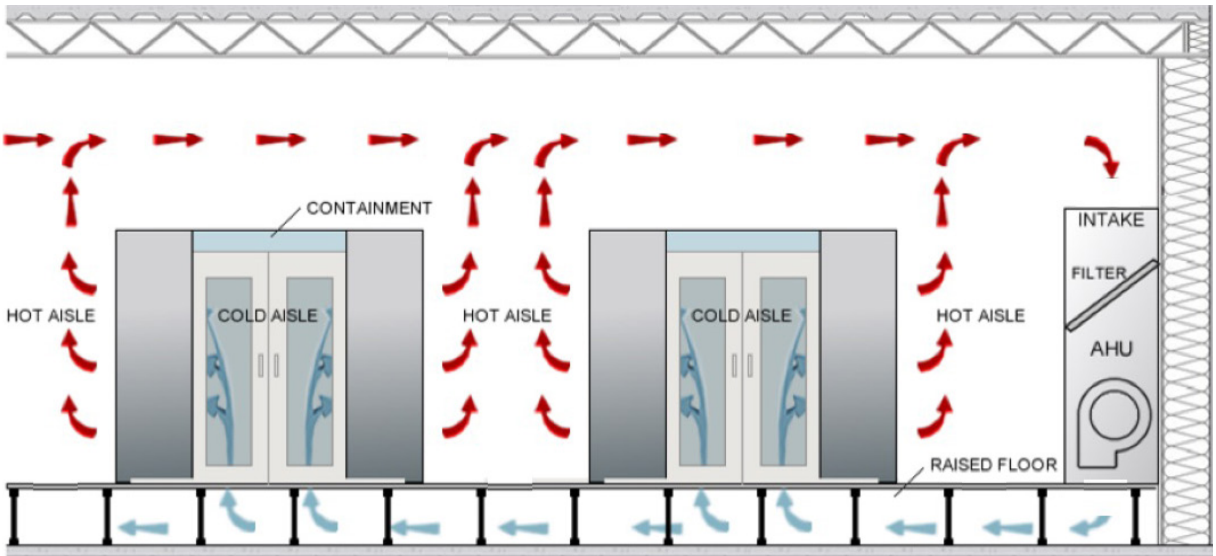


Figure 4 – Cold aisle containment – Copyright 2019 Xtralis. Used with Permission.

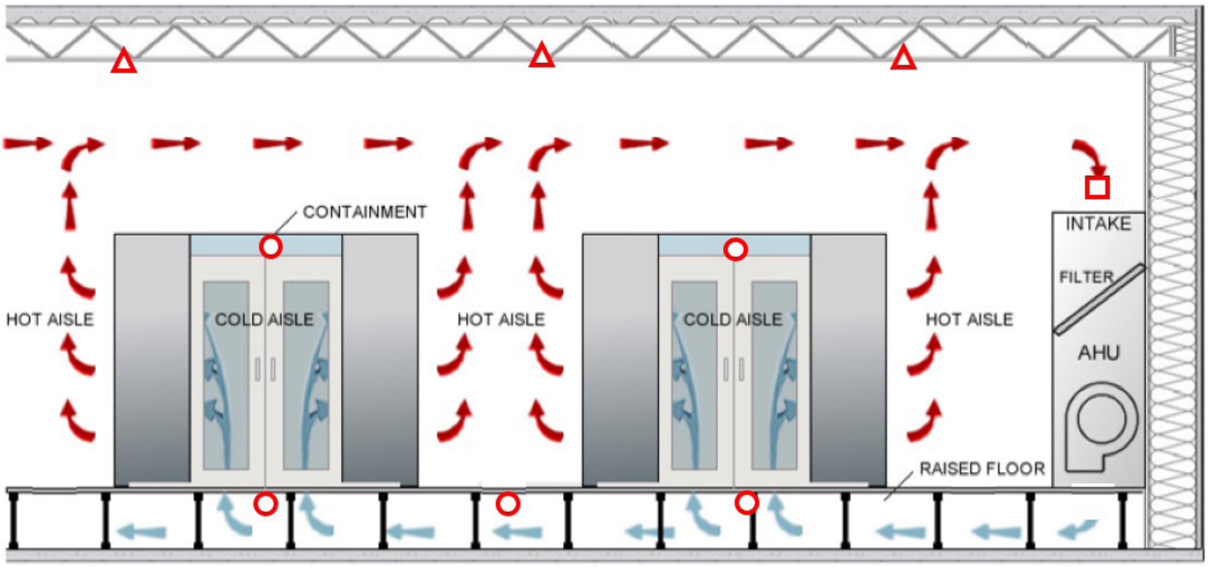
For the most effective detection, the hot side is logically where we want to deploy detection as it is the most likely location that smoke (emanating from the equipment) will first be present.

Essentially the design consideration for detection isn't much different to a traditional computer room with return air vents in the room. Following the basic principle that detectors need to be located downstream of any fire load, and of sufficient density and sensitivity to be effective, smoke detection would be located in either the hot aisle, the cold aisle, the return air vent of the AHU or a mix of all. The three points below discuss the main areas and offer a suggestion of detector location:

1. Cold aisle and floor void:

The floor void should be protected where the power and data services enter the cabinets from the floor void. The higher rate of flow in the floor void would require a denser coverage of smoke detection, unless the void has no fire load. ASD is possibly a better system in floor voids as it allows an easier increased coverage of the void due to multiple holes in sample pipes, and the detection unit can be located outside of the floor void to aid future maintenance.

Stated previously in some cases (referring to BS6266 clause 8.2.1.d) it is appropriate to treat the cold aisle as an extension of the floor void – as such, whatever is specified in the floor void should presumably be in the cold aisle too. In this case, the hot side of the equipment is effectively the main room space and detection should be applied as per BS6266. Based upon this, a suggestion of detection for a cold aisle would be as per Figure 5 below.



□ Return Air Vent Detection
△ Ceiling Level Detection
○ Floor Void/Cold Aisle Detection

Figure 5 – Suggested detection location for a cold aisle containment – Copyright 2019 Xtralis. Used with Permission.

In some scenarios, installation of detection/sampling at the top of the cold aisle, as recommended in BS6266, may be a moot point, as the top of the cold aisle might be regarded as a stagnant zone (unless there is an interruption to the cooling) and detection might be better optimised by locating detectors/sampling points within the floor void where the airflow enters the cold aisle.

2. Hot aisle:

Typically a hot aisle will be a physically ducted path up to a ceiling void being used as a return air plenum.

It is recommended that the extract duct should be covered as a primary detection location as well as the detection at the return air vent of the AHU. The benefit here is that smoke detection can be pinpointed to a single containment aisle considering the protected area could have many separate containment aisles. It may be that the client is only interested in primary detection for the total room, then just detection is positioned at the AHU return air vents.

An example of detection within a hot aisle containment facility is shown in Figure 6.

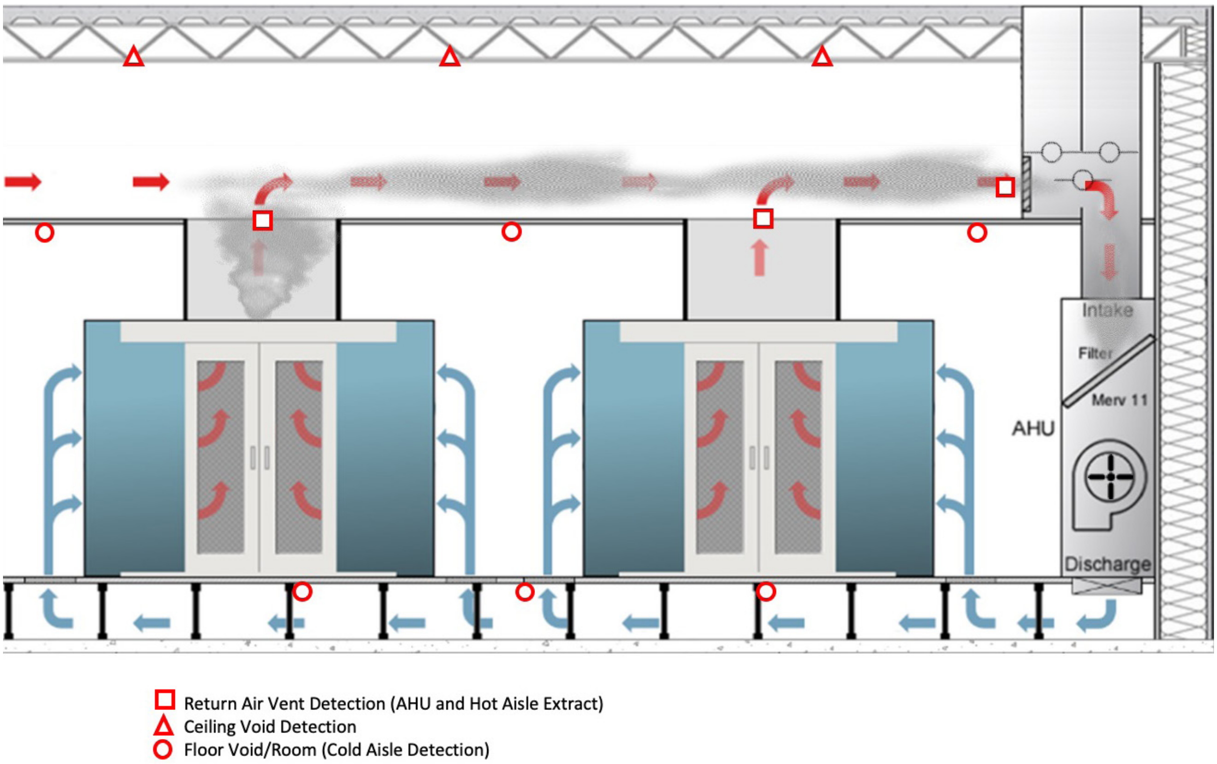


Figure 6 – Suggested detection location for a hot aisle application showing primary detection at the return air vent of the AHU and also on the hot aisle chimney – Copyright 2019 Xtralis. Used with Permission.

3. AHU return vent and pressure/exhaust vent for free cooling:

This requires detection, even if the hot aisle chimney is covered, due to the potential of fire in the ceiling plenum from fire load within the void or reverse flow convection from AHU when the airflow is off. This approach may also be appropriate for an uncontained cold aisle. AHU return air coverage is reflected in Figure 5 and Figure 6 above.

Fresh air make-up has previously been discussed in this document. It is important to establish that the AHU return air vent is the only return air location as sometimes when fresh air is being drawn in to the protected space for cooling, a separate pressure/exhaust vent may also need primary smoke detection. In the simple schematics above, the return air vent operates in return air and fresh air modes. However, the image below shows a scenario where the pressure/exhaust vent is located in a separate location to the AHU.

Note: this venting may be separate from the over-pressure venting as required for extinguishing systems.

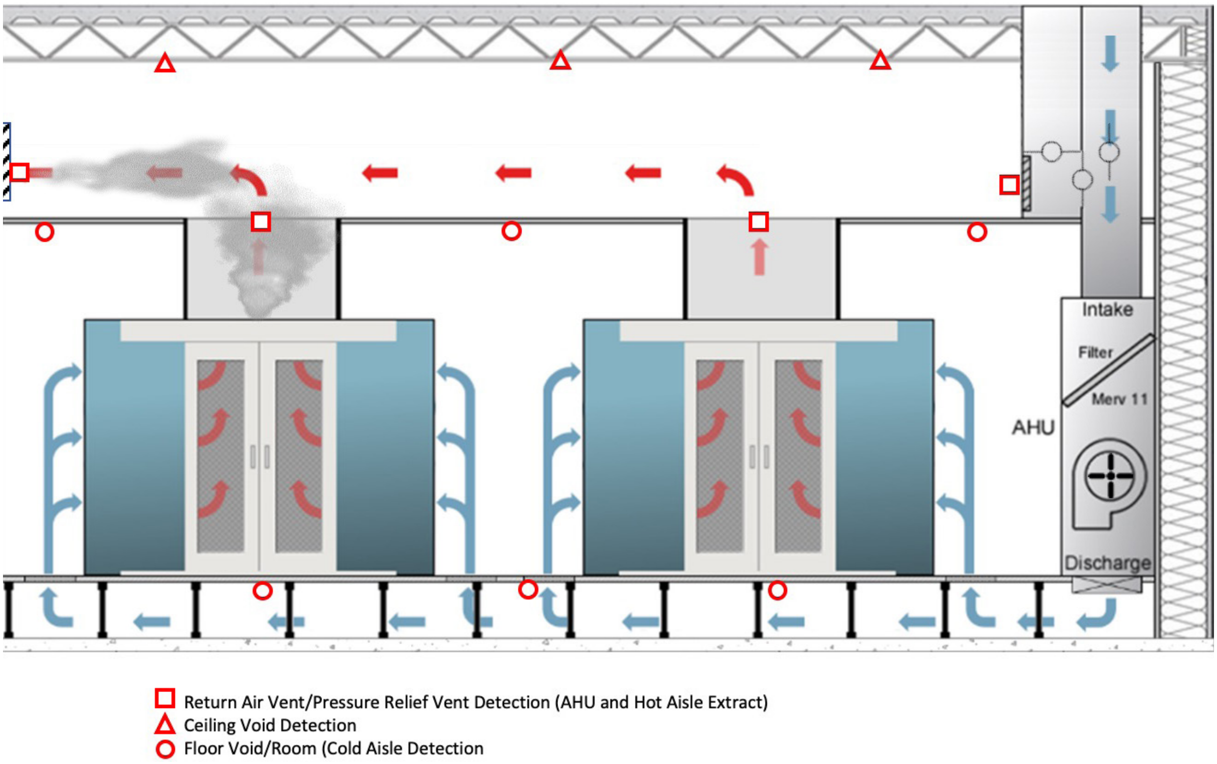


Figure 7 – Example of fresh air make up and pressure relief vent separate to the main return air vent. Copyright 2019 Xtralis. Used with Permission.

8. CONCLUSION

Key points to consider and evaluate are the suitability of Standards and the specific scenario include:

- Prescriptive rules are useful, but more often need to be challenged where high airflow prevails.
- Understanding the air flow is paramount; speed and direction in addition to where products of combustion will be created and thus most reliably detected.
- Strategic positioning of detection is advantageous – rather than strict adherence to the spacing recommendations. This will often provide better and less costly solution.
- Sensitivities must be considered, evaluating rate of smoke generation / fire growth apropos air velocity in addition to any impact of filtration or “free” cooling.

To enable the fire designer to address these challenges, the building’s fire strategy needs to clearly define when the high air flow conditions will prevail and what is expected of the system when they do not.

Closing remarks:

- consideration must be given at both the design and installation phases to maintainability as cited in BS6266 Annex A.2.2 point 1) “Detectors should be accessible for maintenance and regular testing”,
- also documenting the design concept and its pre-requisites is essential, so that it is understood by all parties, stakeholders and, later, by any other party contracted to work upon, modify or service the system.

9. FAQS

QUESTION / SITUATION	RESPONSE	GUIDANCE	COMMENT
Is the airflow always present?	Yes	Position detection in the air streams, not on the ceiling / soffit.	Engineered approach – return air detection across the airflow, suitably positioned (e.g. see 6266 clause A.2.2. point 3).
	No	Will this prompt immediate human intervention / interrogation (i.e. in person or remotely e.g. CCTV).	Engineer and document the engineered solution and strategy if human intervention is expected, and can be relied upon.
		Additional detection for the still air condition is required, this needs to be suitably placed for the still air environ, and so positioned (i.e. on the soffit / ceiling).	Designing for the still air conditions.
			Where coincidence detection is required allow for this spacing, but as still air.
Do I need coincidence detection to trigger fixed gaseous fire extinguishing systems?	Yes	Good practice is to use coincidence to afford the below mitigations.	See FIA document: Guidance for Coincidence Connection of Detectors for Triggering Extinguishing Systems.
	Maybe not	Generally the reasoning for coincidence detection is to: avoid unwanted system discharges through a momentary/spontaneous and non-escalating event; and/or to allow time for human intervention to avert an unwanted system release.	Where the protected area is so small, such as a small EDP room, it could be unrealistic for many devices, for example a single ASD with different alarm thresholds could be justified.
Do I have to use different detection technologies? e.g. for coincidence	No	You must have detectors suited to the products of combustion. Historically ionisation and optical were needed as computer rooms traditionally had printers attached (and a paper risk). Where coincidence is required two devices [which will respond to the products of combustion] will be expected, or possibly a single ASD with different thresholds (see above).	Use only/at least the types of devices to detect the anticipated products of combustion. For fixed gaseous fire extinguishing systems control, this will normally comprise a minimum of two number, but there may be exceptions to use fewer. See FIA document: Guidance for Coincidence Connection of Detectors for Triggering Extinguishing Systems.
Can I use multisensor detectors – and if so, how do I decide which to use?	Yes – caution	High airflow is normally associated with heat removal, in which case the thermal signature required by the multi-sensor detector using heat may be rendered ineffective and could significantly compromise the detector's performance.	Perhaps suitable where coincidence is required, with increased mitigation, and still air is invoked on first detector operating (suited to the high-airflow scenario – e.g. ASD or optical smoke devices).

QUESTION / SITUATION	RESPONSE	GUIDANCE	COMMENT
How sensitive should the detectors be?	Engagement of a competent contractor. **Note**: commissioning once the airflow is operational is fundamental.	To be determined by the fire strategy. With high airflow, products of combustion will become more dispersed or diluted, therefore the more sensitive a detector must be or sited nearer to the fire risk to reduce dispersal.	Engineered approach using the expertise of the system integrator and consultant's understanding. To be documented. System performance should always be backed up by on-site performance based (site acceptance) tests, as detailed in BS 6266.
What sensitivity do I set my ASD system at if it is to trigger fixed gaseous fire extinguishing systems?		Subject to the fire strategy, it can be suitable to use ASD with different thresholds, for instance with the upper limit, or a suitably timed double knock (delay) set for this condition to mitigate unwanted alarms or premature release of fixed gaseous fire extinguishing systems.	
How can one confirm that the fixed gaseous fire extinguishing system will operate satisfactorily?		Competence of the vendor (e.g. LPS 1204 / BAFE SP 203) and the rigorous challenging and documenting by a suitable Consultant.	
Should the detection system shut down (or affect) the air handling system? How so?	Yes (including legacy systems)	If so, relay triggered. Note: this used to be common practice to invoke still air for convection to other devices on the soffit / ceiling of the compartment. However, nowadays this is unlikely to be acceptable where high airflow is present, as the reason for the high airflow is an intolerance to any lack of cooling.	If the air handling unit is itself the cause of fire, then to remove this power will act as a measure itself and may decelerate propagation.
	Note for water mist and pre-action sprinklers	Where a quartzoid bulb or heat operated element is part of the extinguishing release mechanism then still air will probably be essential.	This is to enable adequate heat to initiate the system and also prevent air flows affecting the local application of extinguishing media reaching the seat of the fire.
	No	In this instance all detection needs to be located where the products of combustion will be carried and detection sited across the airflow downstream of the combustible.	The client's fire strategy needs to specify the steps from initial detection through extinguishing, F&RS attendance and resumption of business and clearly identify when the AHU shut down shall occur.

DISCLAIMER
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