



Early Warning Fire Detection for the Datacom Industry

SecuriSmoke ASD

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1 Introduction

Data centres and associated telecommunications facilities are growing not just physically, but also in terms of capacity and in importance as critical infrastructure. With surging demand pushing the limits of the industry's growth potential, outages caused by fire become ever more undesirable due to their knock-on effects. This makes Very Early Warning Fire Detection (VEWFD or Class A fire detection) essential for this industry even though human life is not generally in danger.

The demand for data processing and storage is driven by an unrelenting march to digitisation, both in developed and developing economies. To meet growing demand for internet usage, new data centres are being built and older ones are being upgraded to increase the amount of data they can carry. Current air-cooled aisles of racked servers holding high-capacity microchips are still the mainstay of the industry, albeit with ever more power through them. At the same time, new liquid cooling technology applications in data centres [1] focus on improved thermal cooling for ever growing high-density storage with precision cooling consistency. As such applications of liquid cooling become commercially viable for large scale adoption, it impacts how fire detection system can be effective.

Whichever cooling system is used, aspirated smoke detection remains the most effective tool for VEWFD, allowing smouldering components to be detected early enough that power-down procedures can be implemented, and incidents extinguished before fire damage spreads beyond the affected rack. In the case of liquid-cooled systems, there still remains a danger around any dry components, high power input cables, and the cooling systems themselves. The more advanced the system, the higher the asset value and the more critical it is likely to be in terms end usage of the data. Robust and fail-safe protection is therefore required for the entire facility.

The data centre industry as a whole is growing at a compound annual growth rate of 4.5% and is projected to be worth € 235 billion by 2026 [2]. The fast-growing liquid-cooled data centre segment is expected to itself hit a value of around € 230 billion by 2035 [3]. However, this figure does not necessarily imply a reduction in capacity for more traditional air-cooled models.

The driving force behind data centre innovation is twofold: on the one hand, ever greater speeds and processing capacities are required; at the same time, the industry is under considerable economic and political pressure to reduce energy usage or at least ensure that sustainable energy sources are used. Cooling is the biggest energy requirement in data centre operations, and the need for cooling generally increases processing capacity and power density. Therefore, the two defining trends in the data centre industry are somewhat at odds. From a fire detection perspective, both these trends manifest in measures such as better cold-aisle/hot-aisle compartmentalisation and other efficiency measures with an impact on airflow patterns and speed. The use of liquid cooling can alter the fire detection design for the main open space where the racks are hosted due to changing airflow patterns and much lower air flow. Nevertheless, the advantages of using EWFD systems remain unchanged.

The advent of edge computing has opened a further series of locations for data centre infrastructure. Edge refers to the tendency to locate some data processing capacity near the point of use, and these small data terminals generally use advanced systems to achieve high power density. From a fire protection perspective, they are both a critical asset and a fire risk to the building as a whole.

Telecommunications facilities provide the same if not more critical services than these from the Data Centres, they generally are lower power density with a variety of DC-powered network equipment. The cooling methods and room configuration can be different, but with their own unique risk profile (such as geographically remote and unmanned locations), the need to protect and to ensure business continuity is equally paramount from fire detection, protection and risk management perspectives. Although data centre outages can be due to various causes, such as power failure or human error, potential losses from business disruption, loss of revenue and end-user productivity among other tangibles and intangibles due to a fire incident could far outweigh the average outage duration of one and half hours. With near US\$ 1 million per incident according to the latest Uptime Institute annual survey, losses from incidents rise as high as US\$ 50 million [4] and more.

With dramatic changes in the equipment housed in these facilities and increased demands for sustainable energy efficiency with flexible yet increased HVAC¹ cooling capacity, airflow containment (commonly known as cold-aisle/hot-aisle) solutions are being introduced. The use of equipment cabinet row containment creates a unique high and turbulent airflow environment that not only pose significant challenges to the early detection of diluted smoke but impact on the timely human intervention to the incidents and the actuation of a pre-action sprinkler system, water mist or clean agent gaseous release.

When designing an advanced fire safety system to protect mission critical facilities in the Datacom Industry², general Deem-to-Satisfy (DtS) prescriptive building and fire codes for building protection and life safety are essential.

¹ HVAC: Heating, Ventilation and Air Conditioning

² Datacom Industry: Telecommunications Facilities, Data Centres & Related Built Environment

But most important is applying Performance-based Design (PBD) methodologies to safeguard business continuity through risk and situational assessment, early yet reliable smoke detection to enable suppression system interaction and integrated site incident and emergency response.

The purpose of this Design Guide is to provide fire safety and protection consultants, qualified fire system specifiers, design engineers or technicians recommendations of application and use of SecuriSmoke Early Warning Fire Detection for data centres and datacom facilities. Its scope covers detailed recommendations, design considerations and practices for Securiton Early Warning Fire Detection systems (SecuriSmoke ASD 531, 532, 533 and 535 Aspirating Smoke Detectors and REK 511). It is also suitable for facility management and end-customers alike to gain a high-level insight into cost-effective, fit-for-purpose fire detection and protection solutions. The aim is to implement advanced fire detection methods to enhance life safety, avoid damages to the building and invaluable medical equipment due to fires, and mitigate risks through best fire prevention practices.

Although it is far from exhaustive to references to codes and standards and relevant local/regional industry Code of Practices, this Design Guide recommendations cover major international and industry codes and practices related to fire detection for Datacom facilities such as NFPA 72, FM 5-48 or ISO/AS 7240-20 (from DtS perspectives) and NFPA 75, NFPA 76, BS 6266, FM 5-14 and FM 5-32 (from PBD perspective), as well as other codes covering Inspection, Test and Maintenance (ITM) such as EN 54-20, FIA Code of Practice, ISO 7240-14, BS 5839-1, AS 1851, VdS 2095 and FM 5 48.

To facilitate best risk management practices and reliable emergency response procedures through early intervention and elimination of potential fire incidents, this Design Guide touches on:

- Use of Early Warning Fire Detection for suppression actuation
- Securiton 360° Fire Protection Solution (FACP and ECP³)
- Securiton Software for local and remote monitoring

The Design Guide also provides key requirements on Inspection, Testing and Maintenance (ITM) of SecuriSmoke Early Warning Fire Detection system.

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2 Aspects of fire safety and prevention

Datacom facilities house a significant amount of high-density power, electrical and electronic equipment often sensitive to overheating and combustion. Additionally, the high power and high-density electrical support and distribution network to presents challenges to risk mitigation and risk management under some very unique hazardous conditions.

In terms of detection, the ventilation systems in data centre racking systems means that smoke is both rapidly spread through delicate electronic components, and rapidly diluted. Fire can spread quickly in these conditions if unchecked, but even before it does, relatively low levels of smoke can already cause irreparable damage to expensive but delicate chips and circuit boards, potentially putting a critical telecommunications or data centre operation out of action for a significant time period.

For this reason, very early warning of a fire is desirable. Given that there should be no smoke in the cleanroom environment of data centre racks, high sensitivity can be used. However, care is required to avoid false alarms because even short losses of availability can lead to financial and reputational penalties for a data centre operator and severe knock-on effects to client businesses.

Figure 1 illustrates key aspects and advantages of using a reliable Early Warning Fire Detection system:

- How the intensity and destructive power of a blaze grows exponentially, from an incipient stage, through a growth period and into a fully-fledged fire which will rapidly cause a total loss as well as being extremely dangerous to persons.
- How operation interruptions and potential losses due to fire damage may be minimised by EWFD, compared to standard detection and the even greater damages when only sprinklers are used, with no prior detection.
- Suitable points for a staged response where EWFD is coupled with multiple stages of alert and alarm

³ FACP: Fire Alarm Control Panel, also known as Fire Alarm Systems (FAS) or Fire Indication Panel; FACP is often categorised into Main and Sub panel; Related devices include Mimic Panel and Repeater Panel. ECP: Extinguish Control Panel.

In the case of data centres, it is worth bearing in mind that serious damage will be incurred even in the later part of the growth period, both through smoke and the effects of suppression depending on the method used.

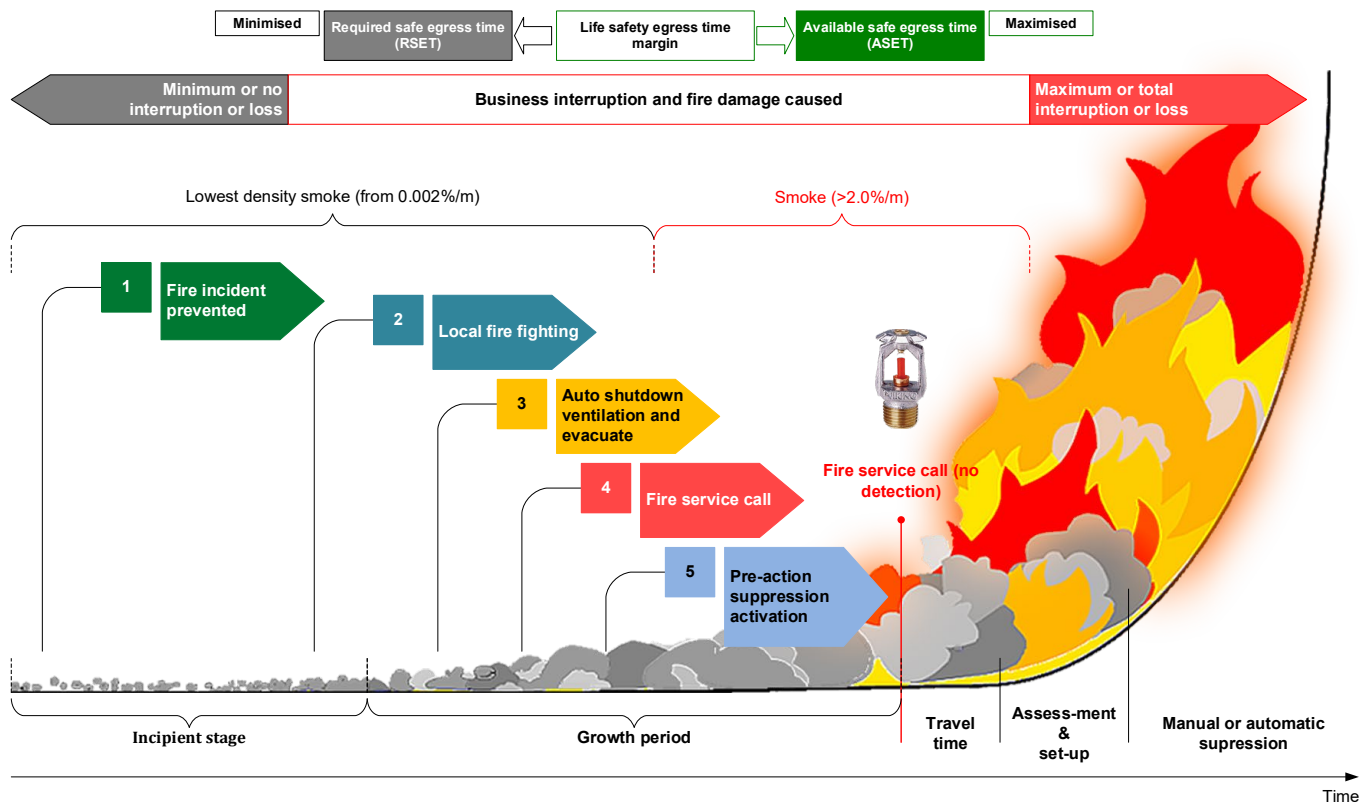


Figure 1: Impact of a detection system on life safety and loss due to fire damages

2.1 Risk profile and high service level

Fire hazards inside datacom facilities are generally of Fire Class A (ordinary combustibles) and Fire Class C (fires involving live electrical equipment such as electrical cables, PCBs and storage medias) [5]. Refer to [6] for slight variation of hazardous classification in different countries. As such, suitable types of smoke detection are required. Generally, prescriptive codes recommend optical-type smoke and high sensitivity intelligent type detection for areas with such a risk profile.

Business continuity is paramount to deliver promised high levels of services. Based on Uptime Institute's data centre tier classification [7], annual availability with site-caused end-customer downtime (hours/year) for Tier I to Tier IV are 99.67% (28.8 h/y), 99.75% (22.0 h/y), 99.98% (1.6 h/y) and 99.99% (0.8 h/y) respectively. Fire, along with unintended operation of Emergency Power-Off (EPO) remains the single Point-of-Failure even for a Tier IV facility, assuming a site outage occurs no more than once every 5 years. Any operation interruption due to a fire event – or even a false fire alarm – could lead to an unacceptable extended downtime to customers.

Apart from the need for on-site security, 24/7 monitoring, routine scheduled inspection and maintenance as well as access to a reliable network and communications infrastructure, datacom facilities operation reliability is subject to the rigorousness of:

- Power resilience (e.g. transformers, generators, UPS)
- Mechanical resilience (e.g. HVAC/Cooling, backup power)
- Fire resilience (e.g. Early Warning Fire Detection, passive fire-rated protection measures, fire suppression and logic controls)

Most datacom facilities are designed to deliver managed services, co-location services or large corporate host-services of its own business eco system. An SLA (Service Level Agreement) is a common form of commitment from service providers to end-customers with defined, measurable criteria for specific level of high service availability. The reliability of datacom operation is the key to fulfil SLA commitments. Naturally, any fire or non-fire incident, such as a false fire alarm can result in significant downtime of the facility operation and services. Figure 2 illustrates how Mean Time to Recovery (MTTR) is interrupting regular operation (outages) when there is a fire (Case 1) or a false fire alarm (Case 2) situation. Even though a false alarm event may be recovered faster, it affects the service availability nevertheless. While Early Warning Fire Detection is more sensitive, a reliable EWFD system such as

SecuriSmoke ASD provides pre-signal alerts so potential fire incidents are dealt with well before any interruption to the service occurs.

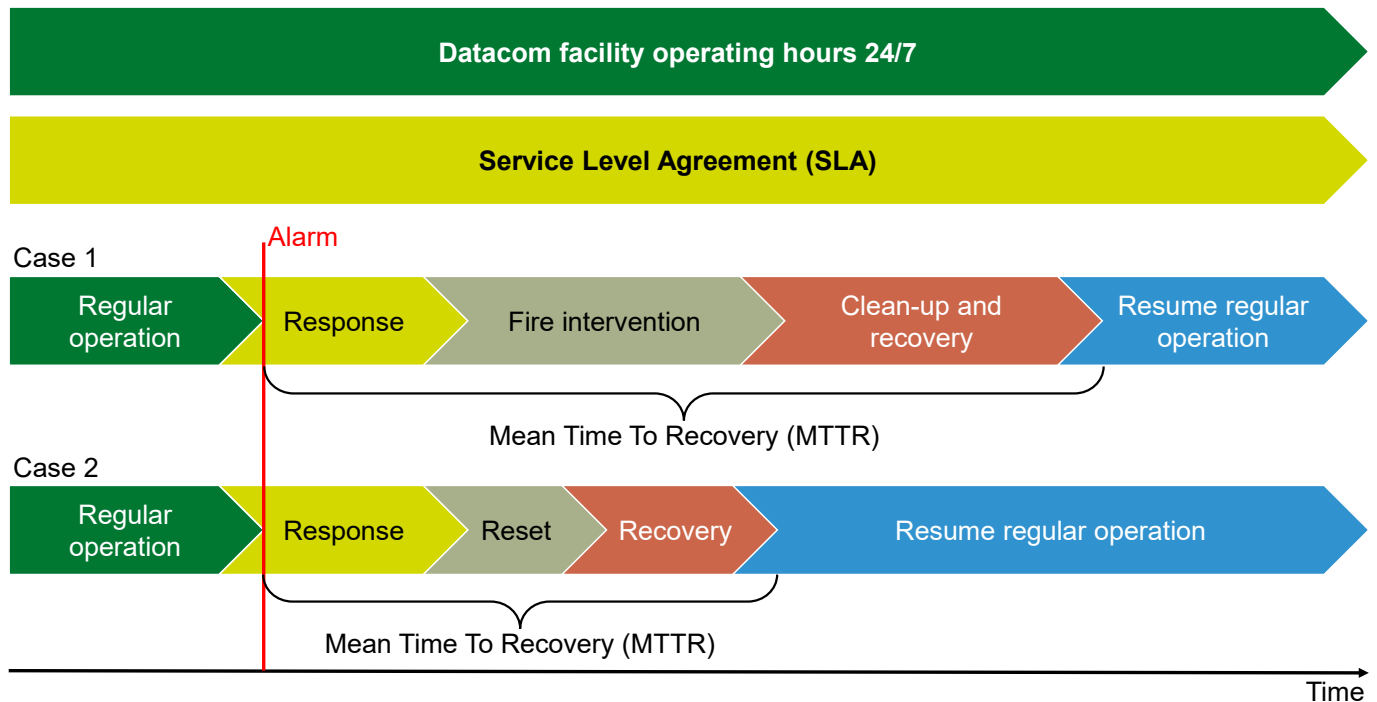


Figure 2: Impact of real fire or false alarm incident on service levels

Higher kW/cabinet densities require a greater ratio of support space to computer floor because large volumes of cold air need to pass through the equipment cabinets at any given time. According to the Uptime Institute [7], at least a ratio of 1:1 at 3 kW/cabinet, 2:1 at 6 kW/cabinet, 3:1 at 9 kW/cabinet, etc. is required, which leads to deeper raised floors for higher heat load densities. Therefore, apart from what is inside the ICT equipment rooms deemed as highly sensitive areas, a vast support space is equally critical and requires suitable early warning fire protection.

In datacom facilities with ceiling plenums for air circulation, the protection of both raised floor space and above ceiling voids are important when there are service cablings and other electronic/electrical control devices installed.

2.2 HVAC characteristics

In its simplest form, cold-aisle/hot-aisle data centre design involves lining up ICT cabinets in alternating rows with cold air intakes facing one way and hot air exhausts facing the other (Figure 3 (a)). The rows composed of cabinet fronts are called cold-aisles. Typically, cold-aisles face air conditioner supply ducts. The rows the heated exhausts pour into are called hot-aisles. Typically, hot-aisles face HVAC return ducts.

A containment system is used to isolate cold-aisles and hot-aisles from each other and prevent hot and cold air from mixing, achieving much higher cooling and energy efficiency. Containment systems started out as physical barriers that simply separated the cold-aisle and hot-aisle with vinyl plastic sheeting or acrylic glass covers. Today, vendors offer plenums and other commercial options that combine containment with variable fan drives (VFDs) to prevent cold air and hot air from mixing (Figure 3 (b)).

Best practices for cold-aisle/hot-aisle containment include:

- Raising the floor 0.45 m (1.5 ft) so that air being pushed by air conditioning equipment can pass through
- Deploying high CFM cabinet grills that have outputs in the range of 17 CMM (600 CFM)⁴
- Locating devices with side or top exhausts in their own part of the data centre
- Installing automatic doors in the data centre

With space cooling (HVAC), in legacy data centre design, heated air from ICT cabinets mixes with other air in the space and eventually makes its way back to a CRAC/CRAH⁵ unit. The air transfers its heat, via a coil, to a fluid within the CRAC/CRAH. In the case of a CRAC, the fluid is a refrigerant. In the case of a CRAH, the fluid is chilled water. The refrigerant or chilled water removes the heat from the space. The air coming out of the CRAC/CRAH often has a discharge temperature of 13-15.5°C (55-60°F). The CRAC/CRAH blows the air into a raised floor

⁴ CFM: cubic feet per minute; CMM: cubic meter per minute.

⁵ CRAC: Computer Room Air Conditioner; CRAH: Computer Room Air Handler

plenum – typically using constant-speed fans. The standard CRAC/CRAH configuration from many manufacturers and designers controls the unit’s cooling based on return air temperature [8].

The cold-aisle/hot-aisle containment involves the physical separation of cold and hot airflow in the room. In a cold-aisle containment system, cool supply air from HVACs is contained, while hot ICT cabinet exhaust air is allowed to return freely to the air handlers. In a hot-aisle containment system, hot exhaust air from cabinets is contained and returns to the HVACs, usually via a ceiling return plenum [9]. Variations of hot-aisle containment also include Open Collar or Chimney type, or individual ICT cabinet self-cooling configuration.

Compared to a normal built environment where mechanical forced ventilation (such as an HVAC⁶ system) usually deliver no more than 60 ACH⁷, in modern data centres, well over 100 ACH is common [10]. When cold-aisle/hot-aisle containment design becomes popular (due to rapid demand for much more high-power ICT equipment to be installed within the same confined physical footprints and need to conserve energy at the same time), airflow and air turbulence within these essentially compartmented spaces increase dramatically. Hence early and reliable smoke detection in these high-risk areas become difficult due to fast moving and highly diluted smoke.



Figure 3: Examples of air- and liquid-cooled server racks

The advent of liquid-cooled data centres adds a number of possible dynamics to this HVAC mix but in many cases the ultimate characteristics from a fire detection point of view remain the same. The term ‘liquid-cooled’ is a vague one and is currently used to mean a number of very different things. These range from traditional HVAC systems which are themselves cooled by a natural cold water source through a matrix, to systems where the entire server racks are immersed in in a bath of non-conductive, dielectric coolant (Figure 3 (c)). The former will be treated as air-cooled for the purposes of this guide; there are no fire safety standards for immersed server tanks yet, although many will likely be installed in a mixed centre alongside traditional air-cooled racks. Where they exist in isolation,

⁶ For simplicity in this Design Guide, HVAC is used to describe CRAC (Computer Room Air Conditioner) or CRAH (Computer Room Air Handler) units commonly found in Datacom facilities.

⁷ ACH (Air Change per Hour) measures air circulation frequency within an enclosed room or area.

these systems are perceived to be lower risk than conventional data centre server racks, but from a fire safety and asset protection perspectives, an EWFD system remains highly recommended..

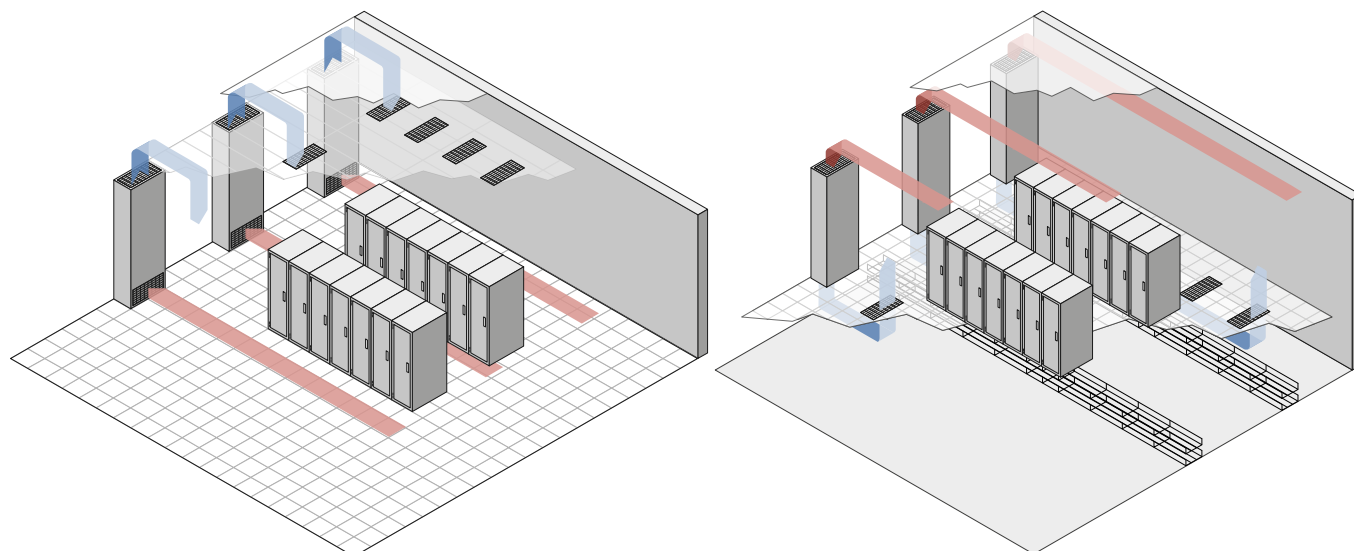
At the time of writing the liquid cooling technology with the widest uptake is 'direct-to-chip', seen in [Figure 3 \(d\)](#). Di-electric coolant fluid is pumped onto a sealed area around the chip, the element most prone to overheating and the usual bottleneck in terms of processing speeds. Manufacturers claim this can enable power of up to 70kW per rack, compared to 30kW for the most modern air-cooled options. These systems are still exposed to the air, and servers sit in a conventional cabinet with many cables and electrical elements. They usually feature an additional element of air cooling. These high-value server racks can therefore be protected with ASD according to the HVAC/racking configuration without containment that is used, albeit with a less strict requirement on closer sampling hole spacing due to relatively lower air flow.

For the purpose of fire detection system design, the following two categories of HVAC airflow characteristics are the focus of this Design Guide. Note that either can be used for liquid-cooled as well as air-cooled racks:

- 1 Without aisle containment
- 2 With containment

2.2.1 Without containment or compartmentation

[Figure 4](#) illustrates datacom facilities without deploying cold-aisle/hot-aisle containment or other form of compartmentation, resulting in no physical obstruction or separation within the protected space. As efforts are made to improve cooling and energy efficiency, this approach is becoming less common in air-cooled data centres. However, this is the likely model for liquid-cooled data centres with direct-to-chip or other in-rack cooling systems, and therefore both airflow patterns can be relevant to data centres where liquid cooling technology is adopted.



(e) Telecommunication (ceiling plenum)

(f) Data centre (raised floor space)

Figure 4: HVAC airflow (without containment or compartmentation)

2.2.2 With containment or compartmentation

Figure 5 illustrates datacom facilities deploying cold-aisle/hot-aisle containment or having other forms of compartmentation due to physical obstruction (e.g. cable trays on top of telecommunication switch cabinets) or separation (e.g. partitions designed to guide the direction of airflow). Effective aisle separation is an important aspect of energy efficiency in modern data centres, and aisle containment structures are also commonly retrofitted to older centres in order to improve performance and efficiency.

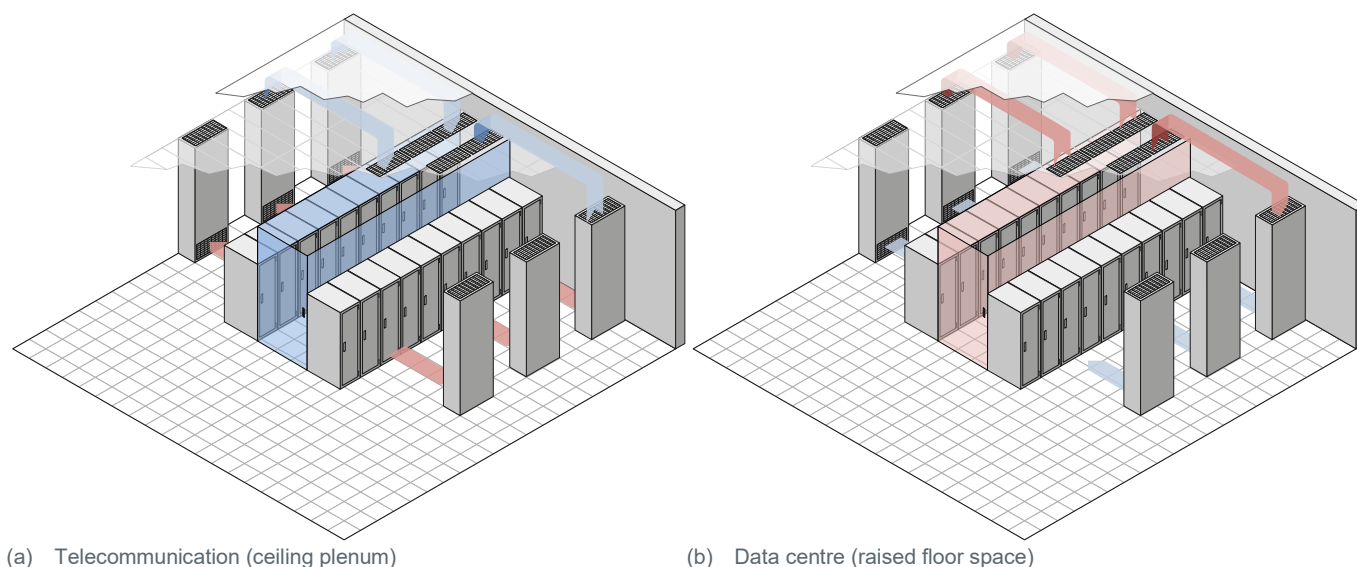


Figure 5: HVAC airflow (with containment or compartmentation)

Refer to [Appendix B](#) for illustrations of various HVAC airflow patterns for both no-containment configuration (common in telecommunication facilities and small server rooms) and with cold-aisle/hot-aisle containment (common in large data centres).

2.3 Challenges to Early Warning Fire Detection

While statistically causes for overall outages of Datacom facilities due to fire are low, the risk of a fire in the electronic equipment areas remains very high, in particular from the electrical power distribution related apparatus. Potentially delayed power-downs or changes of HVAC operation for effective automatic suppression activation when needed, may result in a fire spreading beyond its location of origin. Therefore, the consequences of a fire not being detected early, increases significantly.

Designing an Early Warning Fire Detection for specific fire risk mitigation is of fundamental importance to ensure business continuity. While there are practical difficulties in choosing suitable detection products, SecuriSmoke ASD Early Warning Fire Detection systems address all the key challenges in order to deliver early and reliable fire detection in Datacom facilities (see [Table 1](#)).

Challenge	SecuriSmoke ASD and SecuriSmoke REK
High airflow	Active aspirating sampling with powerful fans and approval listings
Forced ventilation	Flexible placement of sampling points and spacing between them
Diluted smoke	Very high, consistent detection sensitivity for incipient fires
High operational temperature	For hot-aisle or collar containment with no limitation to detector installed location and sampled air drawn
Complex design considerations	Unique features (e.g. option of dual detection chambers, maximum number of sampling holes for all levels of sensitivity, add-on intelligent pinpoint detection for better addressability and control)
Obstructed access	Active sampling technology with detectors and testing points often located in easy access areas in or outside the protected areas
False alarms	Built-in features for false alarm rejection, redundancy design options (e.g. SecuriSmoke ASD 535 with two detectors, designed to cover one single protected zone)
Design	From simple out-of-box set up to the use of Securiton design tools for large scale projects

Table 1: EWFD challenges and solutions

2.4 Performance-based Design with Securiton

Fire protection professionals must work within the prescriptive constraints of the applicable building codes and standards such as NFPA 101 [11] and The International Building Code [12] while applying best engineering practices to address industry and building occupancy specific needs⁸. In particular the risks and uninterrupted mission critical business operation requirements in Datacom facilities must be adequately addressed. In this regard, a PBD approach to the optimisation of fire detection, fire protection and human interaction to supplement prescriptive baseline design, is the key to meeting the requirements for building and life safety as well as risk management.

Performance-based Design is typically implemented in one of two methods [13]:

- 1 As a means to determine equivalency to a prescriptive code or standard
- 2 As an approach to achieve broadly defined fire safety goals and objectives

3 Early Warning Fire Detection Design

When combining the prescriptive and PBD approaches to design a fit-for-purpose fire detection system for a Datacom facility, it is important to select advanced SecuriSmoke ASD detection products. SecuriSmoke ASD products allow full flexible design with quantifiable and reliable detection performance. Advantages include a wide range of models, maximum number of holes with each sensitivity class, long aggregated pipe length, 5-levels of staged responses and signal interface to suppression and BMS components. In addition, they offer pinpoint high sensitivity addressable detection when incorporating SecuriSmoke REK in-line intelligent smoke detectors.

This chapter outlines design recommendations and methods using SecuriSmoke ASD and REK products to protect datacom facilities in the following application scenarios:

- General areas without containment or compartmentation
- Areas with cold-aisle/hot-aisle containment or compartmentation
- Additional risk-based protection and detection methods

3.1 Securiton detection product portfolio

This Design Guide focuses on Securiton Early Warning Fire Detection ([SecuriSmoke ASD and REK portfolio](#)) systems, mainly for critical areas. In order to select the correct SecuriSmoke products for the intended design and maximise efficiency the performance parameters in terms of maximum permitted pipe length and number of sampling holes should be taken into consideration, as shown in [Table 2](#) below.

Model	Key performance parameters ⁹			
Sampling holes, pipe length, spacing/Sensitivity				
	Total # of holes (Class)			
	A	B	C	Aggregated pipe length
SecuriSmoke ASD 531	6	8	12	75 m (246 ft)
SecuriSmoke ASD 532	8	12	16	120 m (394 ft)
SecuriSmoke ASD 533	16	50	50	200 m (656 ft)
SecuriSmoke ASD 535-1/3	18	56	120	300 m (984 ft)
SecuriSmoke ASD 535-2/4	36	112	240	2 x 300 m (984 ft)
SecuriSmoke ASD 535 (HD)	2 x 36	2 x 112	2 x 240	2 x 300 m (984 ft)
REK 511-1S	1.2% obs/m (0.366% obs/ft)			Point type addressability for sampling holes located downstream to REK
REK 511-3S	0.3% obs/m (0.091% obs/ft)			

⁸ Each country or state/province might have its own (or adopted) building and fire code or directives. Examples are the Muster-Verwaltungsvorschrift Technische Baubestimmungen (MVB TB) in Germany or The Regulatory Reform (Fire Safety) Order 2005 in the UK.

⁹ Highlight performance parameters as per EN 54-20 (ASD), and REK point-type detector sensitivity per EN 54-7. SecuriSmoke ASD sampling hole class sensitivity and corresponding hole coverage are as shown in [Table 3](#).

Model	Key performance parameters ⁹	
Rating and operational data		
SecuriSmoke ASD	IP54 (IP66 for SecuriSmoke ASD 535 HD)	
REK	IP30	
	Operating temperature	# of Relays: Built-in (Expanded – Module)
SecuriSmoke ASD 531	-10 to +55°C (14 to 131°F)	2 (5-1xRIM36)
SecuriSmoke ASD 532	-20 to +60°C (-4 to 140°F)	2 (10-2xRIM36)
SecuriSmoke ASD 533	-20 to +60°C (-4 to 140°F)	3 (10-2xRIM35)
SecuriSmoke ASD 535	-30 to +60°C (-22 to +140°F)	3 (10 – 2 x RIM35)
REK	0 to +50°C (32 to 122°F)	1 (NA)

Table 2: Performance parameters of SecuriSmoke range and REK

3.2 Design criteria and remarks

Airflow and detection sensitivity are two main factors that affect SecuriSmoke ASD sampling hole spacing. Table 3 summarises some key design criteria for deploying Early Warning Fire Detection to buildings with hazardous areas.

To provide clarity, below are some key terminologies related to:

- **Transport Time:** time for (smoke) aerosols to transfer from a sampling hole to the ASD detector.
- **Maximum Transport Time:** maximum time for (smoke) aerosols to transfer from the furthest sampling hole to the ASD detector.
- **Response Time:** time between the generation of combustion aerosols at their source and the indication of their presence at the ASD detector.
- **Reaction Time:** time between (smoke) aerosols reaching a defined level of obscurity (e.g., End-of-test EOT condition) and the notification of their presence at the ASD detector.

Pipe network layout and length of single or aggregated pipe length also determine the transport time from each sampling hole to the detector, hence a maximum transport time from the furthest sampling hole(s). Both sampling hole sensitivity and transport time are calculated with SecuriSmoke ASD PipeFlow design tool. PipeFlow offers to calculate a pipe layout in two modes:

- 1 EN 54-20 (also its derivatives ISO 7240-20 [14] and AS 7240.20 [15]): PipeFlow optimises its calculation for transport time, balance (same air volume at each sampling hole) and takes the characteristic curves of all EN 54-20 test fires into consideration. PipeFlow then indicates the sensitivity to which the detector must be set in order to allow for each sampling hole to reach the required sensitivity according to the selected class.
- 2 NFPA: PipeFlow optimises its calculation for the required transport time for VEWFD, EWFD or SFD.

Design recommendations described in this chapter assume the transport time meets the respective sampling hole or detector unit sensitivity level in Table 3 for target Class A (VEWFD), Class B (EWFD) or Class C (SFD) design.

Model	Key design criteria		
NFPA/FM Global	VEWFD	EWFD	SFD ¹⁰
Hole sensitivity	3.28% obs/m (1.0% obs/ft)	4.92% obs/m (1.5% obs/ft)	Point type over number of holes
Hole coverage	18.6 m ² (200 ft ²)	37.2 m ² (400 ft ²)	83.6 m ² (900 ft ²)
Transport time	<60 sec	<90 sec	<120 sec

¹⁰ SFD/Class C refers to point type detectors, usually tested to an alarm sensitivity of 2.0 dB/m (36.9% obs/m (11.247% obs/ft)).

Model	Key design criteria		
EN/AS/ISO/BS	Class A	Class B	Class C#1
Hole sensitivity ¹¹	0.4% obs/m (0.12% obs/ft)	1.16% obs/m (0.35% obs/ft)	6.67% obs/m (2.0% obs/ft)
Hole coverage ¹²	15-25 m ² (166-269 ft ²)	25-35 m ² (269-388 ft ²)	Up to 7.5 m (25 ft) radius
Transport time ¹³	<60 sec	<90 sec	<120 sec
Reaction time ¹⁴	<60 sec	<60 sec	<60 sec

Table 3 Key design criteria (SecuriSmoke ASD)

In general, simply follow relevant codes and standards for the design of smoke detection system to meet prescriptive requirements. Two key considerations in design are:

- 1 Sensitivity requirements versus detection requirements in relation to the height of the ceiling.
- 2 The smoke detector spacing (or ASD sampling hole spacing as equivalent) in relation to the airflow.

Parameters	Key design considerations		
EN 54-20 Class	Class A	Class B	Class C
ASD Sampling Type and Smoke Characteristics	Smoke is not visible due to low quantity of smoke and/or high dilution caused by air movement or LOS ¹⁵	Smoke is visible but insufficient to be detected by point or beam technologies (per EN 54-20)	Smoke visible and sufficient to be detected by point or beam technologies (per EN 54-20 or EN 54-7)
Primary Detection (sampling where smoke is likely to travel)			
	Best	Appropriate (Small areas only)	Not appropriate
Secondary Detection (positioning sampling holes per 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 high risk	Appropriate for low risk	Not appropriate
Duct Sampling			
	Appropriate for high risk	Appropriate for low risk	Not appropriate

Table 4 Sensitivity requirements vs. detection requirements

ASD Type 1	ASD Type 2	ASD Type 3	ASD Type 4
10.5-18 m (34.4-60 ft)	15-26 m (49.2–85 ft)	25-43 m (82-141 ft)	40-43 m (131.3-141 ft)

Table 5 Recommended ceiling heights

Table 4, Table 5 and Table 6 illustrate the design parameters commonly referred to when designing Early Warning Fire Detection with SecuriSmoke ASD in accordance with the codes NFPA 72 and FIA Code of Practice.

Note that individual countries may have different provisions regarding height limits or multilayer detection prescribed as Deem-to-Satisfy (DtS). Examples of maximum height for the use of ASD in Germany is 20 m (65.5 ft) (DIN VDE 0833-2), in the Netherlands it is 45 m (147.6 ft) (NEN 2535) and in France it is 12 m (39.4 ft) (R7). When the ceiling heights exceed the respective maximum limit, the use of ASD is considered a PBD engineering design which often requires proof with a successful fire test during the commissioning and acceptance phase.

¹¹ For Securiton ASD products. Individual hole sensitivity can be determined using SecuriSmoke ASD PipeFlow design tool.

¹² Hole spacing is more a mixture of DtS (per point type detectors in BS 5839-1 or VdS 2095) and PBD (BS 6266, FIA Code of Practice or VdS 2095 Appendices) provisions with adjustments based on airflow and design to required sensitivity Class A, B or C.

¹³ Transport Time of AS7240-20 conformed Class A, B and C are 60 sec, 90 sec and 120 sec respectively in AS1670-1.

¹⁴ Reaction Time of 60 sec after EOT refers to EN 54-20 test requirements for relevant tests to Class A, B or C sensitivity.

¹⁵ LOS: Large Open Space

Recommended ceiling heights for ASD types¹⁶ (Table 5) varies from generally applicable (low limit) to ceiling with design for property protection with rapid fire service attendance time of 5 min. includes sloped ceilings with slopes not greater than 10% of ceiling height (high limit).

Air changes per hour (ACH)	Spacing [m ² (ft ²)]
60	12 (125)
30	23 (250)
20	35 (375)
15	46 (500)
12	58 (625)
10	69 (750)
8.6	81 (875)
7.5	84 (900)
6.7	84 (900)
6	84 (900)

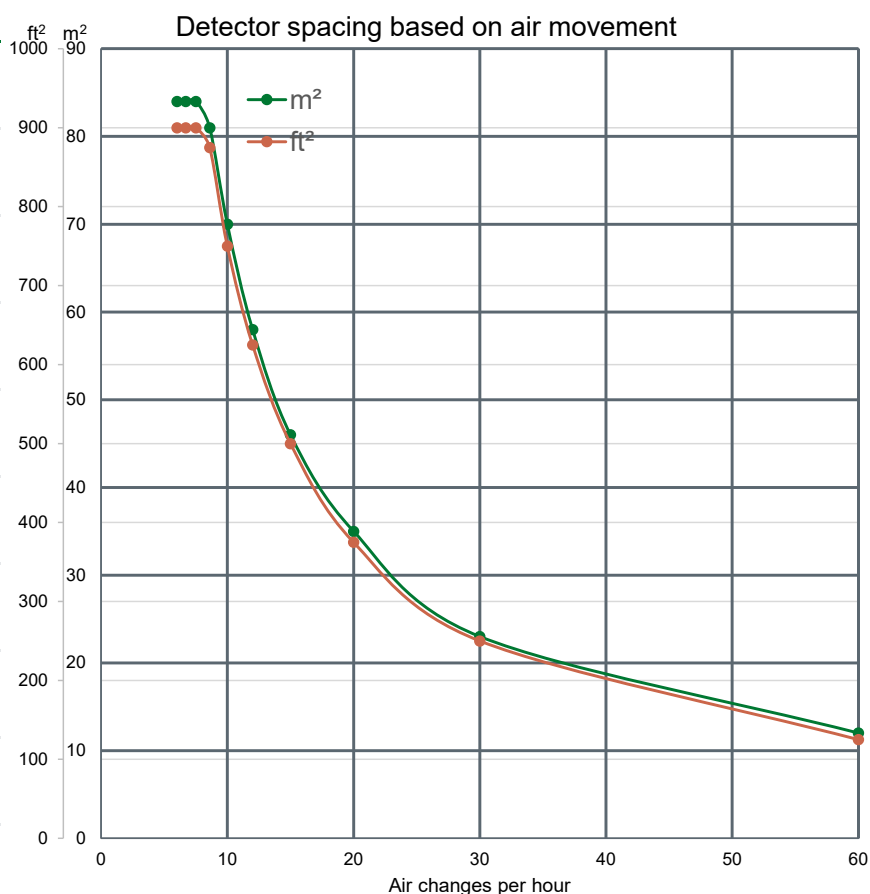


Table 6 Smoke detector spacing based on air change rate (NFPA 72 [16]/FM DS 5-48 [17])

Other key parameters for general Early Warning Fire Detection design are the ceiling height and the height of raised floor and ceiling plenum. However, this Design Guide recommendations work on the majority of datacom facilities with the following attributes, hence there is no mention of design changes when the height of the protected space exceeds these prescribed in codes and practices (such as [18] or [20]):

- Raised floor: typical raised floor height for Tier I facility is 0.3 m (12 in), Tier II 0.45 m (18 in), Tier III 0.76-0.9 m (30-36 in), Tier IV 0.76-1.1 m (30 to 42 in) [7], hence one layer of detection inside the raised floor space is adequate.
- Ceiling plenum: up to 1.0 m (3 ft) height [10], hence one layer of detection inside the ceiling plenum is adequate.
- Ceiling Height: in general, Datacom facilities net ceiling height is in the range of 3.0 m (10 ft)¹⁷ and 6.0 m (20 ft)¹⁸ [10]. Hence ceiling height limitation to the design and use of ASD in general is not considered. For instance, as per FIA Code of Practice [20], no ASD sampling holes spacing or sensitivity limited for ceiling height up to 10.5 m (35 ft) or 8.0 m (26 ft) for enhanced sensitivity application of Class A and B respectively for general off-site response. As for Very High Sensitivity applications, adjustments to sampling hole spacing due to extreme high airflow provide the required detection performance.

Because each ASD sampling hole (or sampling point) in effect represents a single point type detector, the key criteria or variables included in this chapter focus on SecuriSmoke ASD design with regards to:

- 1 Sampling hole spacing
- 2 Sampling hole placement
- 3 Sampling hole orientation (in relation to direction of incoming airflow)

¹⁶ ASD Type include: Type 1: Any ASD system approved to EN 54-20; Type 2: ASD system with: at least 5 Class C holes or at least 2 Class B holes; Type 3: ASD system with: at least 15 Class C holes or at least 5 Class B holes; and Type 4: ASD system with: at least 15 Class B holes

¹⁷ between top of the raised floor to underside of the ceiling

¹⁸ between bottom of the floor to ceiling

3.3 Detection design: General open space

In low power density facilities such as legacy data centres or future data centres with liquid cooling technology, areas hosting low-voltage telecommunications equipment and support areas with critical equipment or storage, containment is not required. For rooms with raised floor space and/or ceiling plenum for the purpose of air circulation, these spaces are deemed as “open area” without consideration of compartmentation for the purpose of smoke detection system design. Full immersion liquid data centres may also fall into this category, as there are no aisles or controlled airflow. In the case of protecting a room of immersion cooling tanks, attention should be paid to the cooling matrices and cable channels as well as considering the methods outlined below.

This chapter describes the following three detection methods:

- 1 Underside ceiling for flat ceiling
- 2 Ceiling with deep beams/joist
- 3 Inside air plenum space (raised floor and above ceiling void)

3.3.1 Underside ceiling (flat)

Figure 6 illustrates how SecuriSmoke ASD sampling holes are located under a smooth ceiling.

Variable	Design recommendation
Spacing	For airflow < 60 ACH: From 84 m ² (900 ft ²) @6 ACH down to 12 m ² (125 ft ²) @60 ACH in accordance with NFPA72 [16]). If a higher detection sensitivity is required, refer to Table 3 for recommendations for Class A (VEWFD) and Class B (EWFD) For airflow ≥ 60 ACH: Refer to Table 3 for Class A (VEWFD) and Class B (EWFD). The area covered may be adjusted up to ± 5 m ² (± 54 ft ²) depending on the prevalent airflow in the protected rooms
Placement	Underside the ceiling
Orientation	Perpendicular downwards

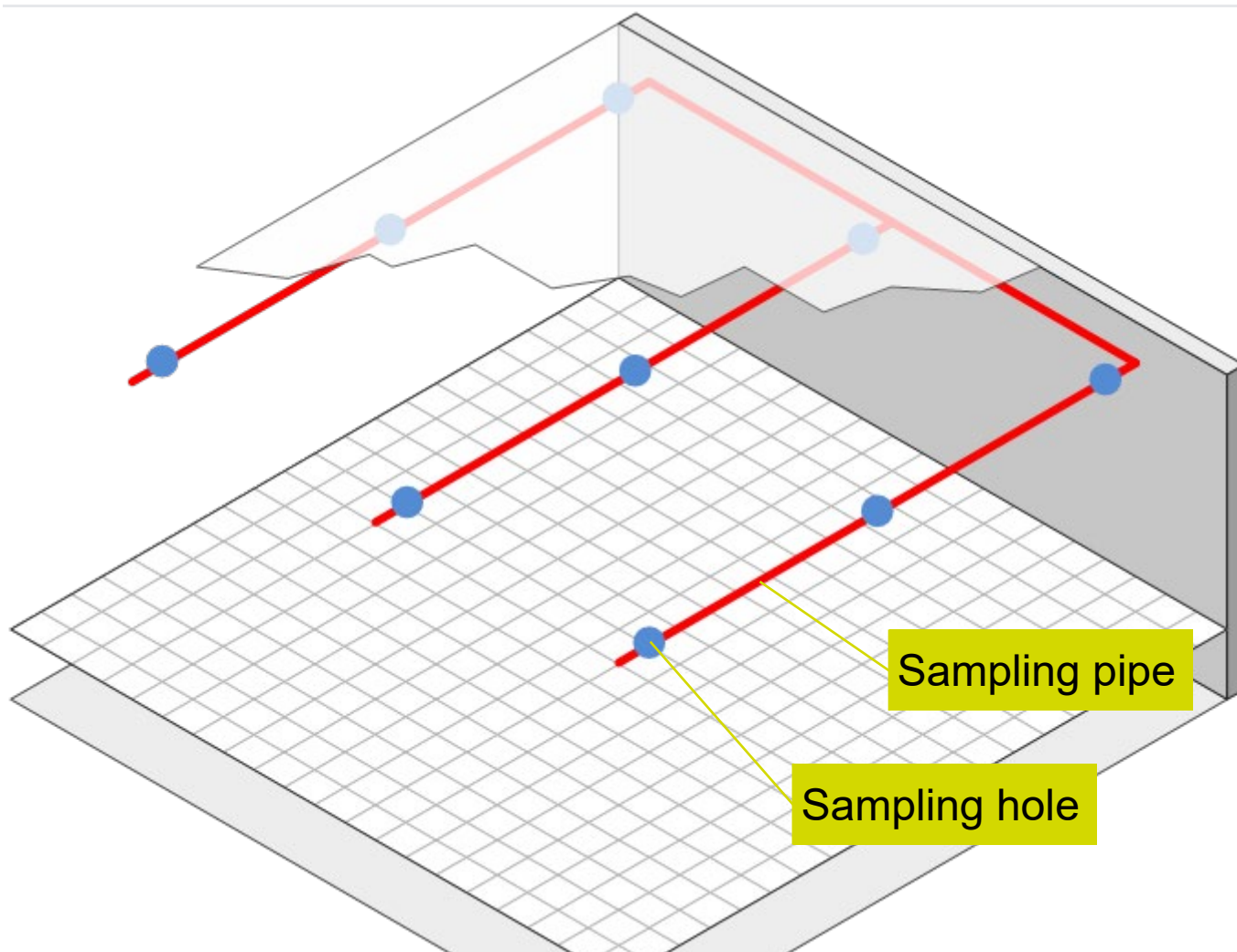


Figure 6: Fire detection placement (underside ceiling – flat)

3.3.2 Underside deep beam/joist

Figure 7 illustrates how SecuriSmoke ASD sampling holes are located under the beams/joist or inside deep beam pockets. The airflow speed must be taken into consideration when designing the spacing and the placement of the sampling holes. It is recommended to choose the spacing and placement recommendations that best fit the design parameters.

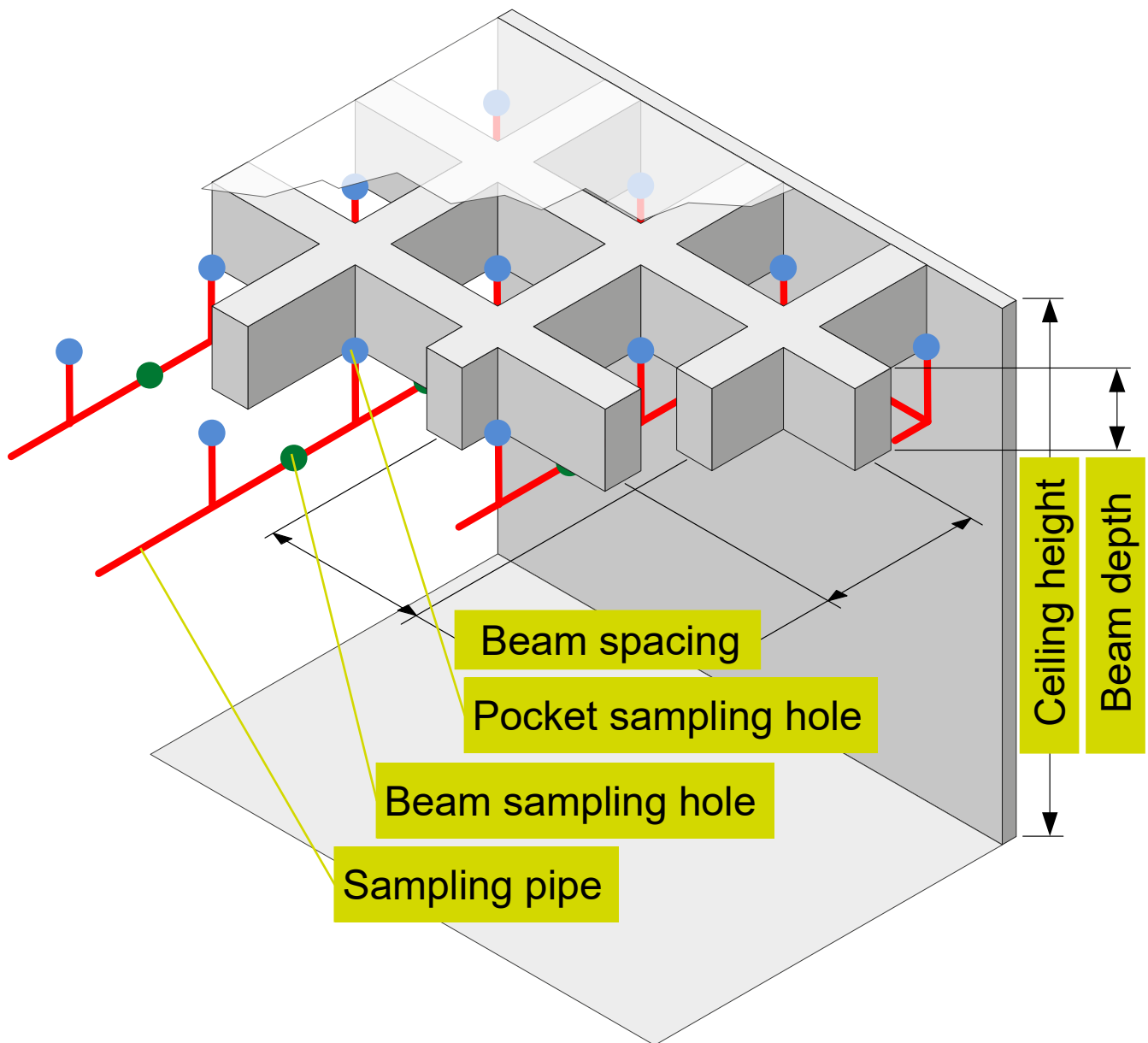


Figure 7: Fire detection placement (underside ceiling – deep beam/joist)

Variable	Design recommendation
Spacing	In relation to airflow, refer to chapter 3.3.1 above Beam depth < 10% of ceiling height: smooth ceiling spacing is applied, on the bottom of the beams (see sampling holes in blue) Beam depth ≥ 10% of ceiling height: - Beam spacing < 40% of ceiling height: use smooth ceiling spacing parallel to the beams and half the spacing perpendicular to the beams, on the bottom of the beams (see sampling holes in blue) - Beam spacing ≥ 40% of ceiling height: a sampling hole shall be placed on the ceiling within each beam pocket (see alternative sampling hole in green). Note that more than one sampling hole may be required to cover a given beam pocket.

Variable	Design recommendation
Placement	Refer to PBD design approach per [19] or prescriptive codes such as NFPA 72 [16], summarised above
Orientation	Perpendicular downwards

3.3.3 Air plenum (raised floor & above ceiling)

Figure 8 illustrates how SecuriSmoke ASD sampling holes are positioned at the top of raised floor or above ceiling void when there are cablings and electronic control devices installed within these spaces. The same design recommendations for these spaces apply to data centres which have adopted liquid cooling technology.

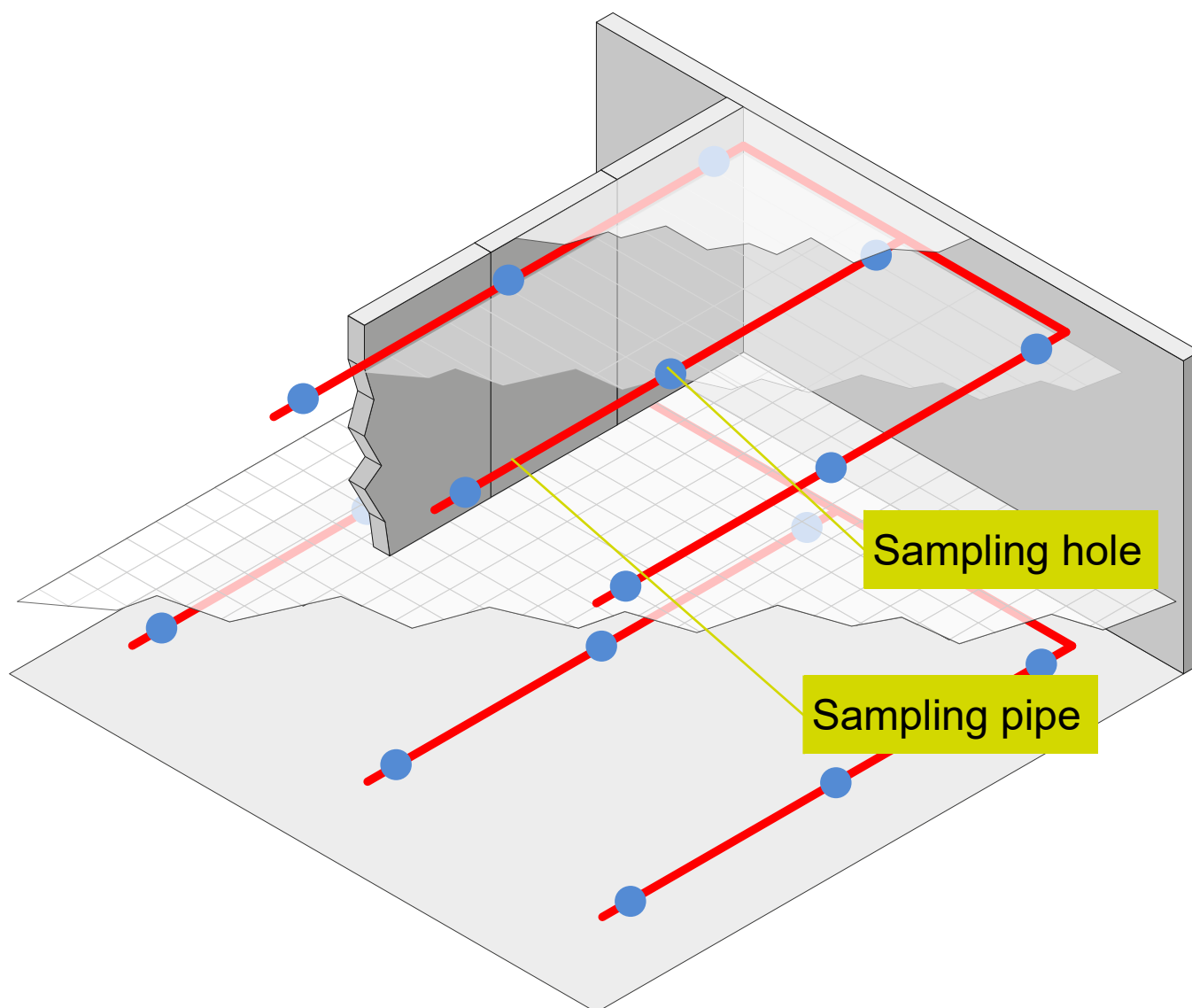


Figure 8: Fire detection placement (raised floor or ceiling plenum)

Variable	Design recommendation
Spacing	In relation to airflow, refer to chapter 3.3.1 above It is recommended to design SecuriSmoke ASD for VEWFD (Class A), especially if it is the only smoke detection system installed without other forms of detection, e.g. related duct or air vent protection.
Placement	Inside the raised floor or above the ceiling plenum with detector units in the main room space. A blind end-cap also located in the main room space serves as a commissioning and maintenance test point for easy access.
Orientation	Facing the incoming airflow; where possible, consider using Securiton sampling funnel SF ABS.

For the initial commissioning and ongoing ITM, the blind end-cap is replaced temporary with an end-cap with a predefined sampling hole.

Measurements of transport time from the 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 [20].

3.4 Detection design: Containment/Compartmentation

This section is applicable to data centres with cold-aisle/hot-aisle containment or compartmentation due to physical obstruction or separation require special design considerations.

This chapter describes detection methods to cater for majority of the containment or compartmentation configuration, namely:

- Hot-aisle containment (row)
- Hot-aisle containment (chimney)
- Cold-aisle containment (row)
- Cold-aisle containment with ceiling plenum only
- Physical separation/compartmentation

Sampling holes in this chapter refer to these inside the hot-aisle containment areas or general sampling hole placement in relation to cold-aisle/hot-aisle containment layout. The actual sampling hole spacing, orientation and sensitivity design recommendations are referred to relevant detection methods described in chapter 3.2 above and chapter 3.5 below.

3.4.1 Hot-aisle containment (row)

Figure 9 illustrates how SecuriSmoke ASD sampling holes are positioned in a hot-aisle containment (row) configuration.

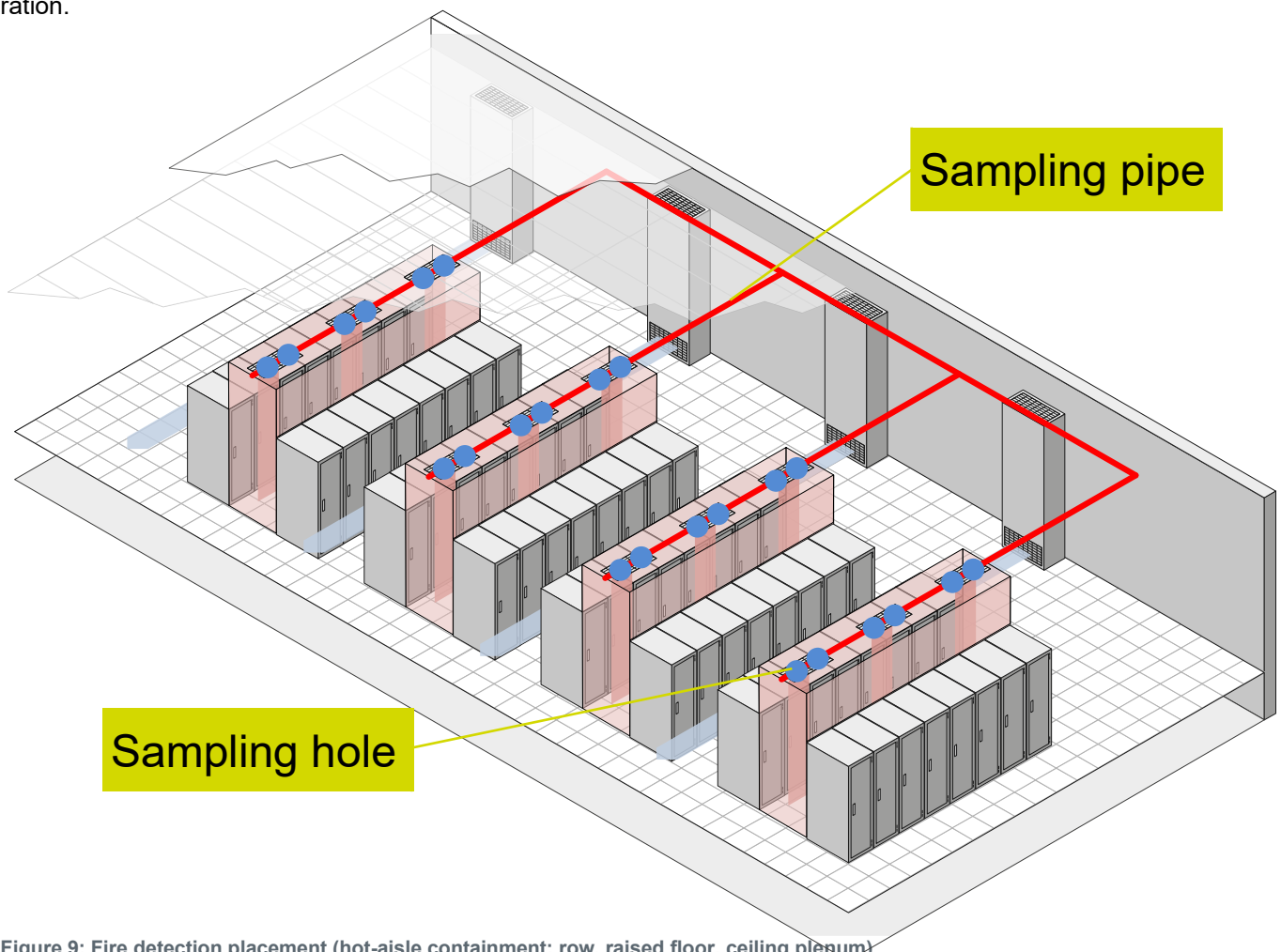


Figure 9: Fire detection placement (hot-aisle containment: row, raised floor, ceiling plenum)

For (cold air supply) open space detection, refer to the design recommendations in chapter 3.2 regarding spacing, placement and orientation of the sampling holes at the room ceiling level, raised floor space and ceiling plenum where applicable. Below design recommendation is for additional detection inside each enclosed hot-aisle containment.

Variable	Design recommendation (hot-aisle row)
Spacing	2 to 4 sampling holes per ceiling return air vent (see also chapter 3.5.1).
Placement	Inside each enclosed hot-aisle containment area designed as return air vent.
Orientation	Facing the incoming airflow; where possible, consider using Securiton sampling funnel SF ABS.

3.4.2 Hot-aisle containment (chimney)

Figure 10 illustrates how SecuriSmoke ASD sampling holes are positioned in a hot-aisle containment (chimney) configuration.

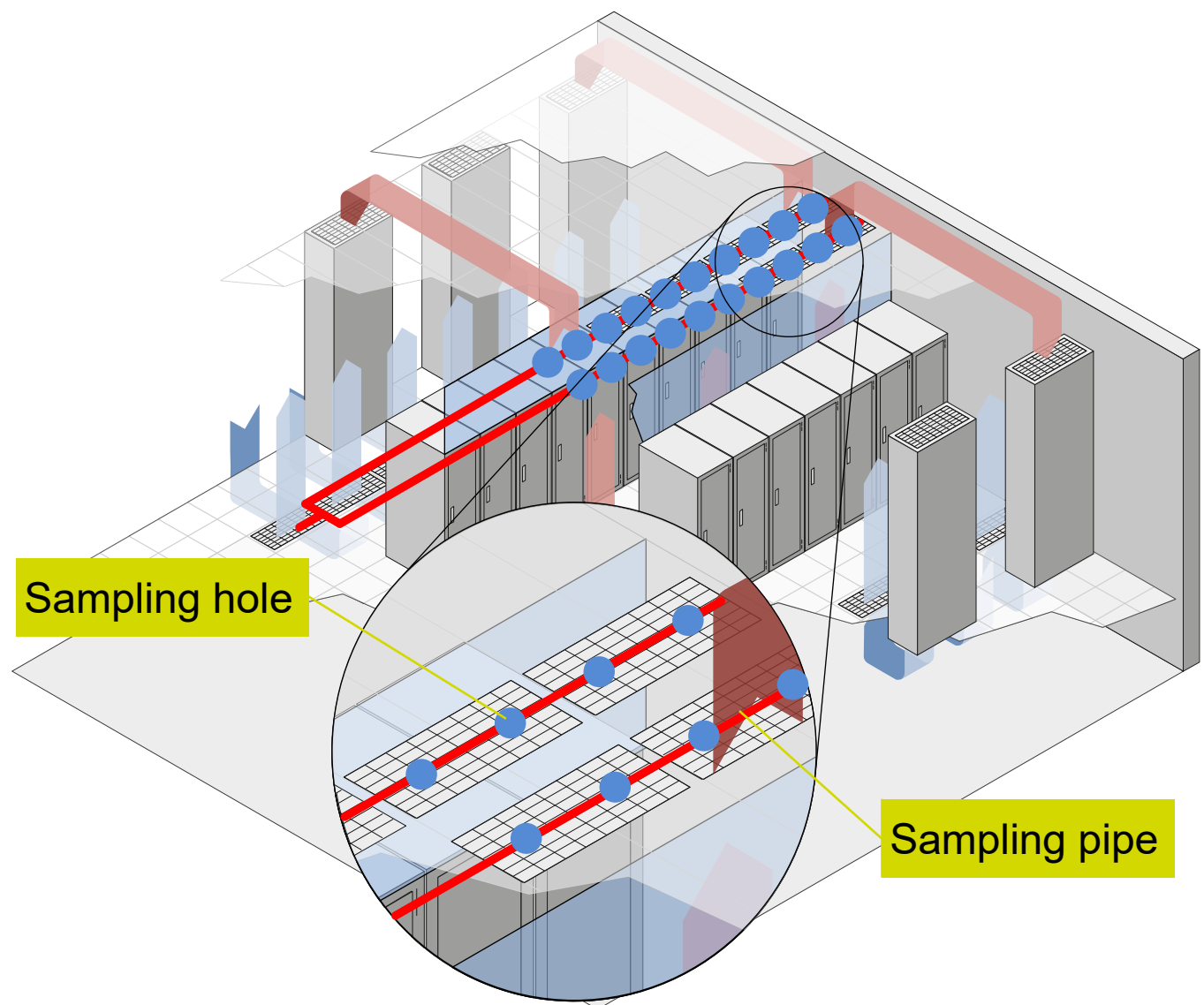


Figure 10:Fire detection placement (hot-aisle containment: raised floor with chimney duct)

For (cold air supply) open space detection, refer to the design recommendations in chapter 3.2 regarding spacing, placement and orientation of the sampling holes at the room ceiling level, raised floor space and ceiling plenum where applicable. Below design recommendation is for additional detection for hot-aisle containment chimney ducts.

Variable	Design recommendation (hot-aisle chimney)
Spacing	2 to 4 sampling holes per ceiling return air vent (see also chapter 3.5.1).

Placement	Inside each chimney duct designed as return air vent.
Orientation	Facing the incoming airflow; where possible, consider using Securiton sampling funnel SF ABS

An alternative design approach (particularly for smaller ICT equipment rooms with low airflow speed) is to use SecuriSmoke REK in each vertical duct, for the purpose of location, while another branch of SecuriSmoke ASD aspirating pipe is used to protect ceiling plenum as the plenum is serving as air return in this configuration.

3.4.3 Cold-aisle containment (row)

Figure 11 illustrates how SecuriSmoke ASD sampling holes are positioned in a cold-aisle containment (row) configuration. The cool air flows up through the raised floor space, force the warm airflow merging into the open area from the rear of the cabinets while hot air returns either directly to the HVACs in open space or closed circulation via ceiling plenum.

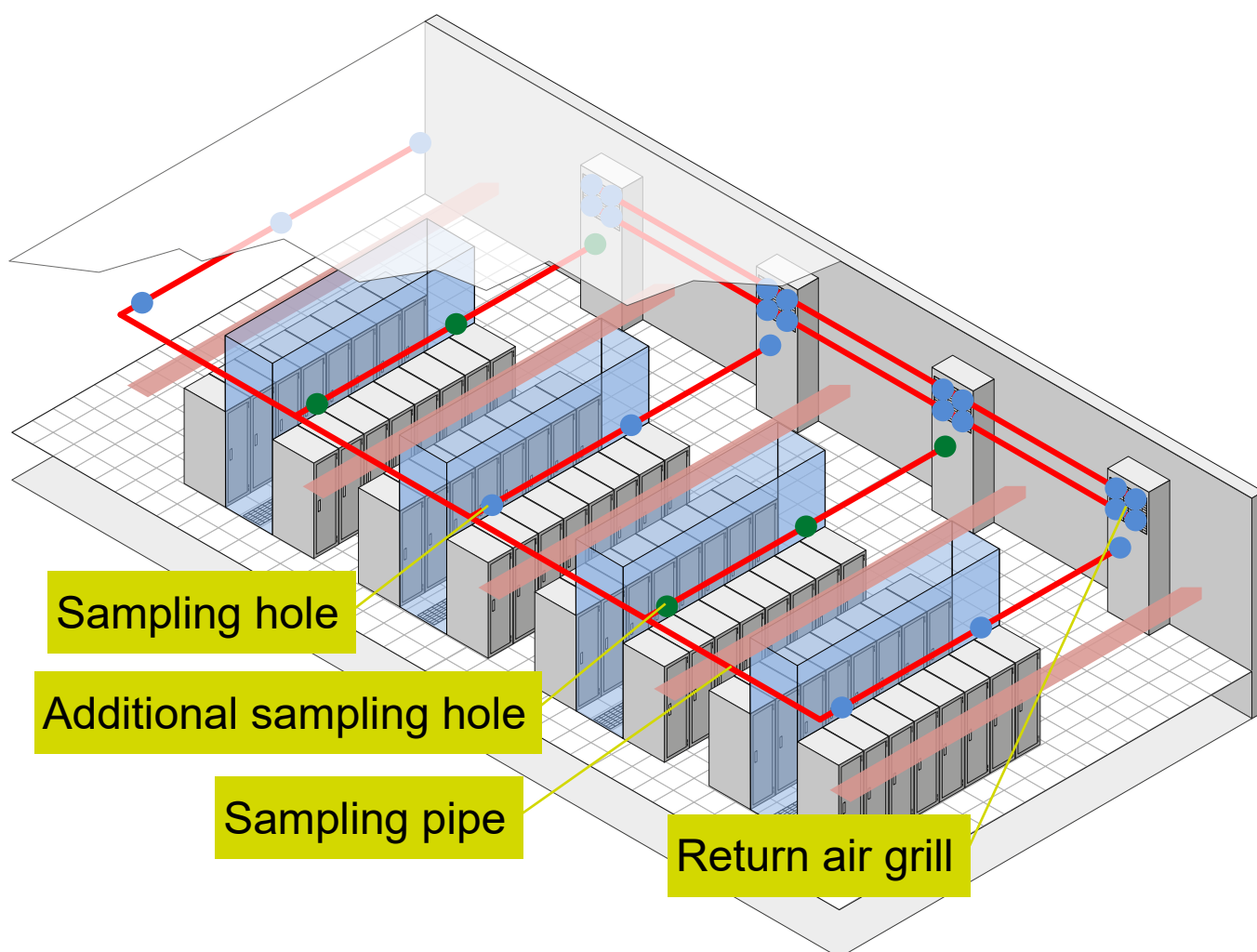


Figure 11: Fire detection placement (cold-aisle containment: raised floor, with or without ceiling plenum)

For open space detection, in particular the sampling hole spacing in relation to airflow speed, refer to the design recommendations in chapter 3.2 regarding spacing, placement and orientation of the sampling holes. Below design recommendation is a summary for general ceiling and HVAC return air vents or grills protection.

Variable	Design recommendation (in line with hot-aisle row spacing)
Spacing	Align the sampling pipes with every 2 nd row of hot-aisles (see sampling holes in blue) as a minimum. When the airflow is high, align a sampling pipe in every row, thus reducing the spacing to less than 4.8 m (16 ft) (see additional sampling holes in green).
Placement	Underside the ceiling At HVAC return air grills for open space circulation or ceiling return air vents for closed circulation via ceiling plenum; with 2 to 4 sampling holes per HVAC return air vent or grill.

Orientation	At ceiling level, perpendicular downwards
	At return air grills or vents, facing the incoming airflow; where possible, consider using Securiton sampling funnel SF ABS

Typical hot-aisle & cold-aisle width is 1.2 m (4 ft), ICT cabinet depth is 0.91 m (3 ft), hence hot-aisle centre-to-centre distance is 4.3 m (14 ft), centre-to-centre spacing for every second hot-aisle is 8.6 m (28 ft).

3.4.4 Cold-Aisle Containment with Ceiling Plenum

Figure 12 illustrates how SecuriSmoke ASD sampling holes are positioned in a cold-aisle containment, no raised floor with ceiling plenum only configuration. The cold air is supplied from the ceiling void, force the warm airflow merging into the open area from the rear of the cabinets while hot air returns directly to the HVACs in open space.

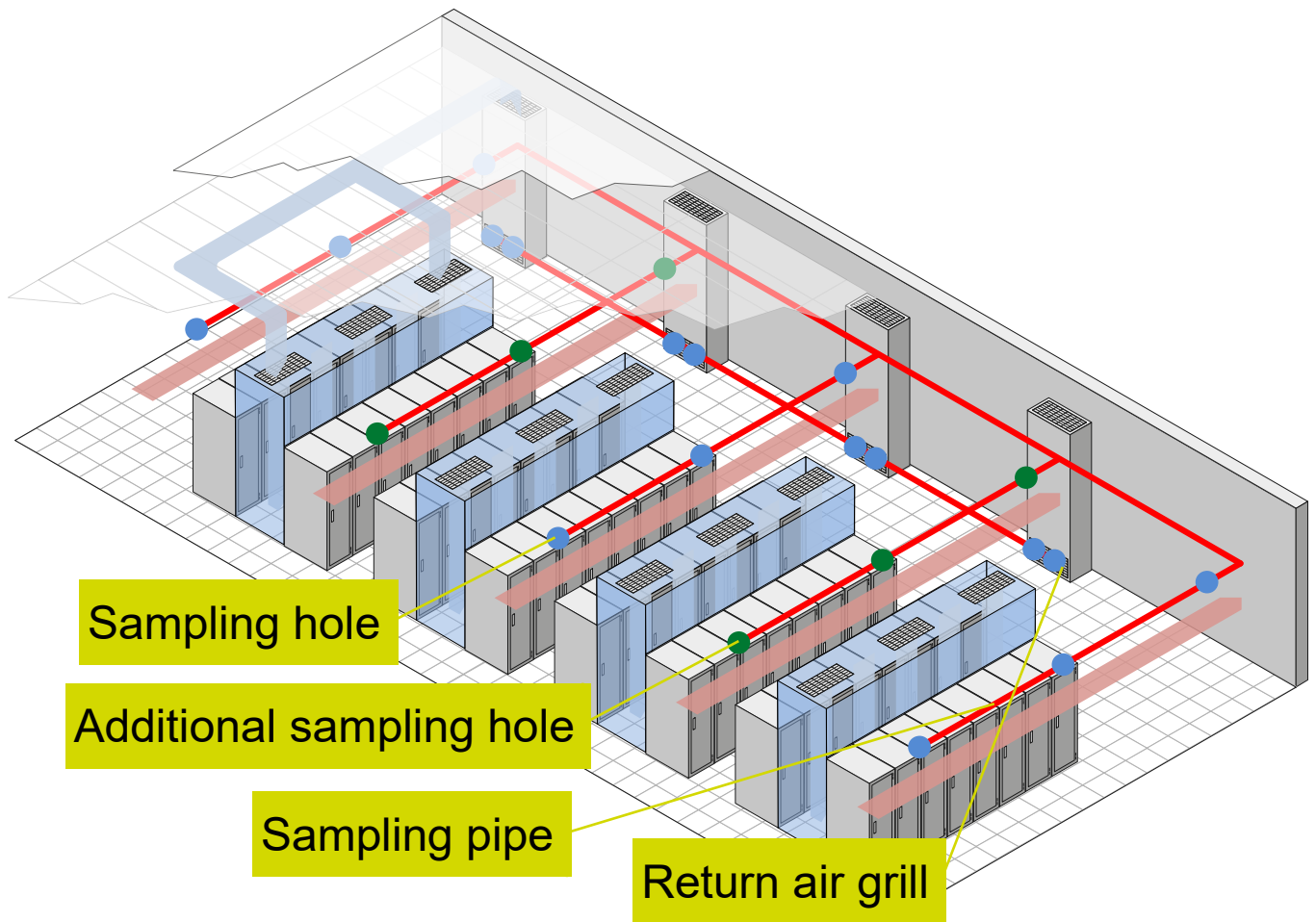


Figure 12 Fire detection placement (cold-aisle containment: ceiling plenum, no raised floor)

For open space detection, in particular the sampling hole spacing in relation to airflow speed, refer to the design recommendations in chapter 3.2 regarding spacing, placement and orientation of the sampling holes. Below design recommendation is a summary of general ceiling and HVAC return air grills protection.

Variable	Design recommendation (cold-aisle containment with ceiling plenum only)
Spacing	Align the sampling pipes with every 2 nd row of hot-aisles (see sampling holes in blue) as a minimum. When the airflow is high, align a sampling pipe in every row, thus reducing the spacing to less than 4.8 m (16 ft) (see additional sampling holes in green).
Placement	Underside the ceiling At HVAC return air grills with 2 to 4 sampling holes per HVAC return air grill
Orientation	At ceiling level, perpendicular downwards At return air grills, facing the incoming airflow; where possible, consider using Securiton sampling funnel SF ABS

3.4.5 Physical Separation/Compartmentation

Figure 13 illustrates how SecuriSmoke ASD layered sampling holes are positioned when there are physical separations, such as stacked cable trays from the under the ceiling above ICT cabinets, which in effect create compartment separations for the purpose of fire detection.

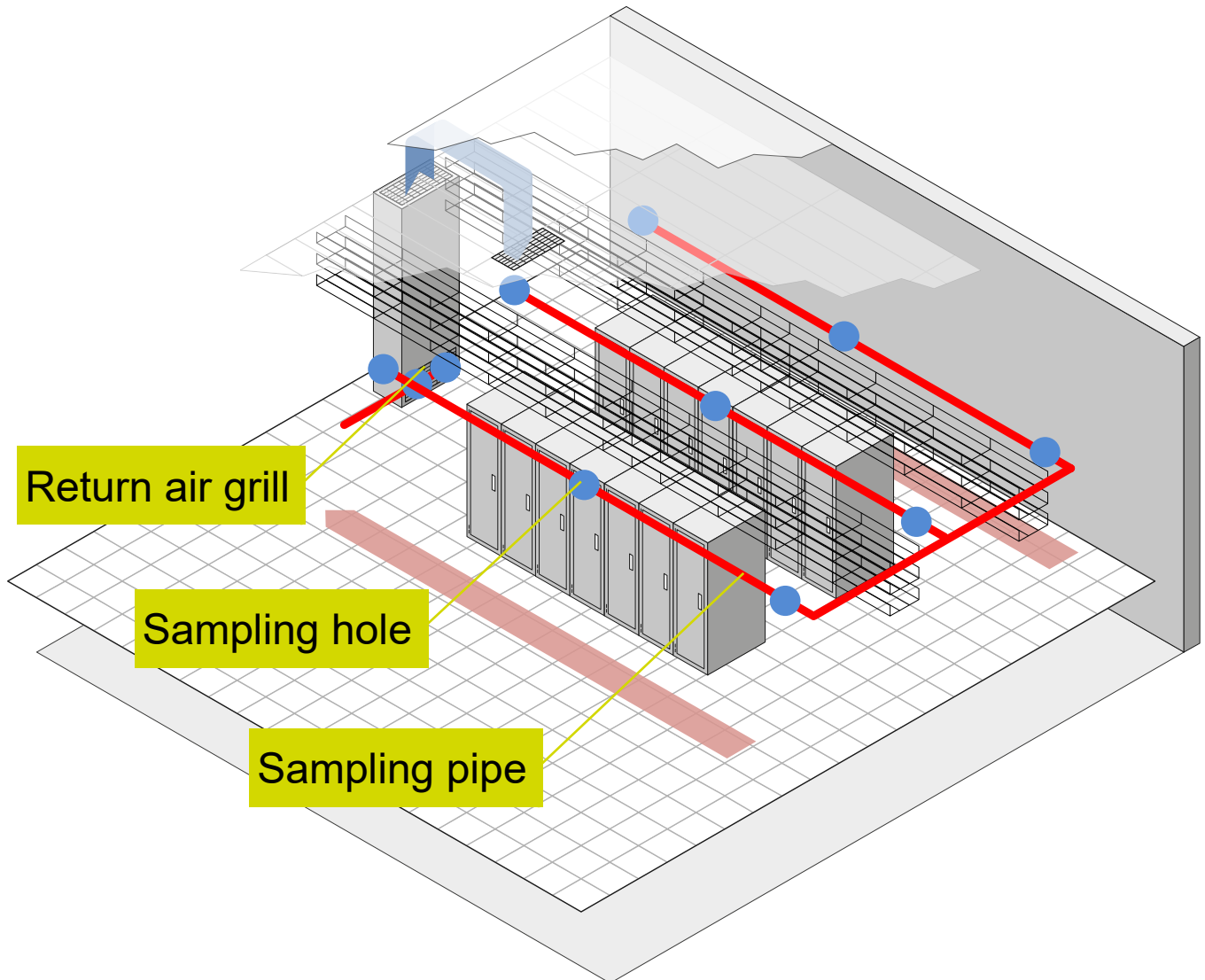


Figure 13: Fire detection placement (physical separation, cable trays on top of ICT cabinets)

Variable	Design recommendation
Spacing	Align the sampling pipes with equipment aisles in every row compartment, at ceiling level and between the cable trays for areas where there is no ceiling sampling holes
Placement	Underside ceiling At HVAC return air vents with 2 to 4 sampling holes per HVAC return air grill
Orientation	At ceiling level, perpendicular downwards For return air grills, facing the incoming airflow; where possible, consider using Securiton sampling funnel SF ABS

3.5 Detection design: risk-based detection

Apart from room open space protection, containment/compartment space protection and air plenum protection, other risk-based detection methods are usually highly effective and complement to provide early and reliable detection. The concept of the risk-based protection method is to detect smoke where smoke originates and propagates.

This chapter describes four detection methods, namely:

- 1 Return air vents
- 2 Combination of ceiling and return air grills
- 3 Localised protection
- 4 Duct detection

3.5.1 Return air grills

Figure 14 illustrates how SecuriSmoke ASD sampling points are positioned in front of return air grills.

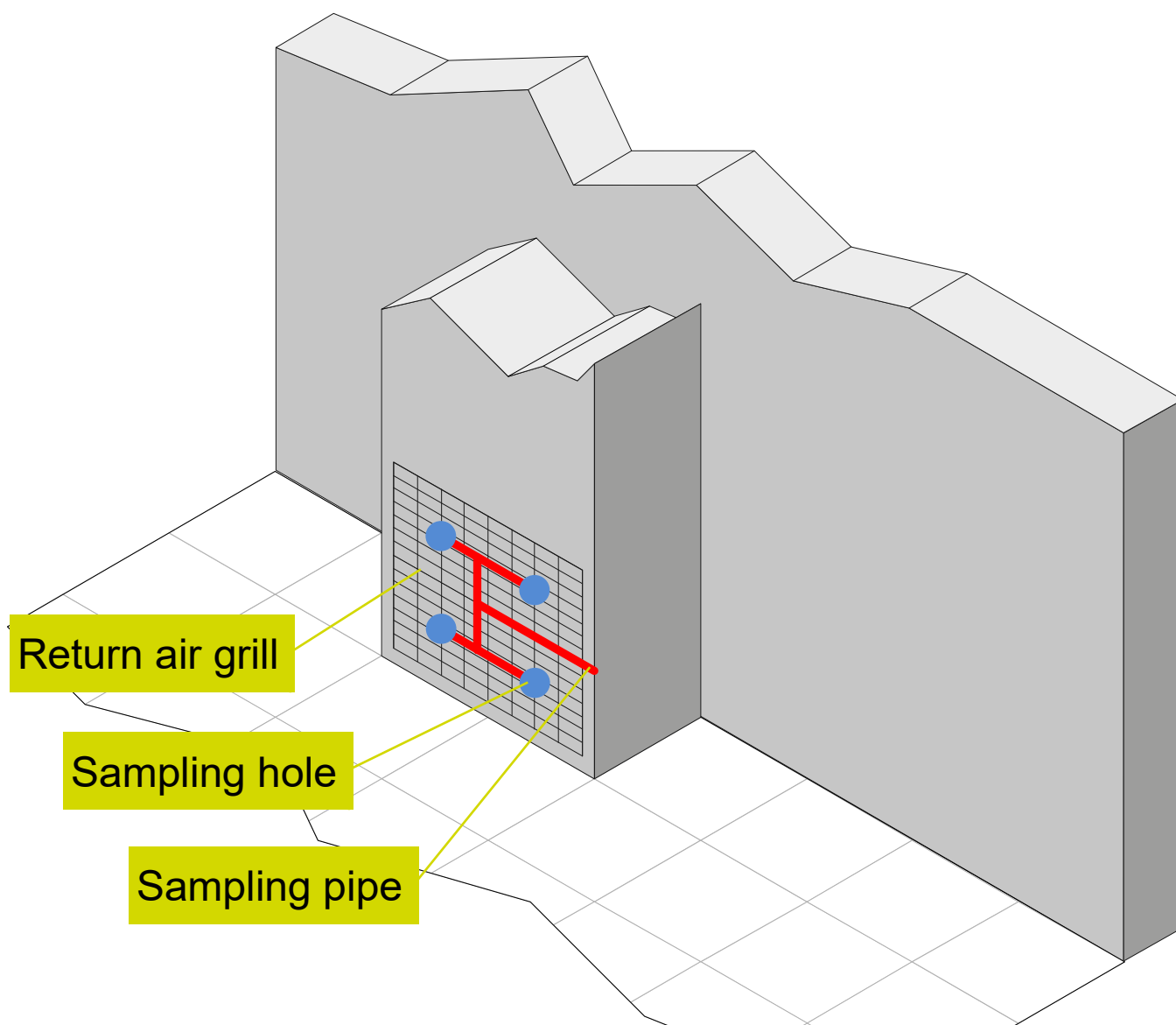


Figure 14: Fire detection placement (return air grills)

Variable	Design recommendation (return air grills)
Spacing	Maximum area coverage of 0.4 m ² (4.3 ft ²) of the air grille per sampling hole. Typically, 2 to 4 sampling holes are used to cover a single air intake [20]. When two or more rows of sampling pipes are needed for larger grills, sampling pipes are designed to form an 'H' shape
Placement	Installed across the grille with pipe stand-off of ~2.5 cm (~1.0 in)
Orientation	Facing the incoming airflow; where possible, consider using Securiton sampling funnel SF ABS

3.5.2 Combining return air & ceiling detection

Figure 15 illustrates how one SecuriSmoke ASD can be used for both ceiling level and return air grills detection. This is practical for small size rooms or large rooms, with moderate airflow speed, where the locations of the return air grills can be covered with the same ASD detector for part of a large room or the whole of a small room space.

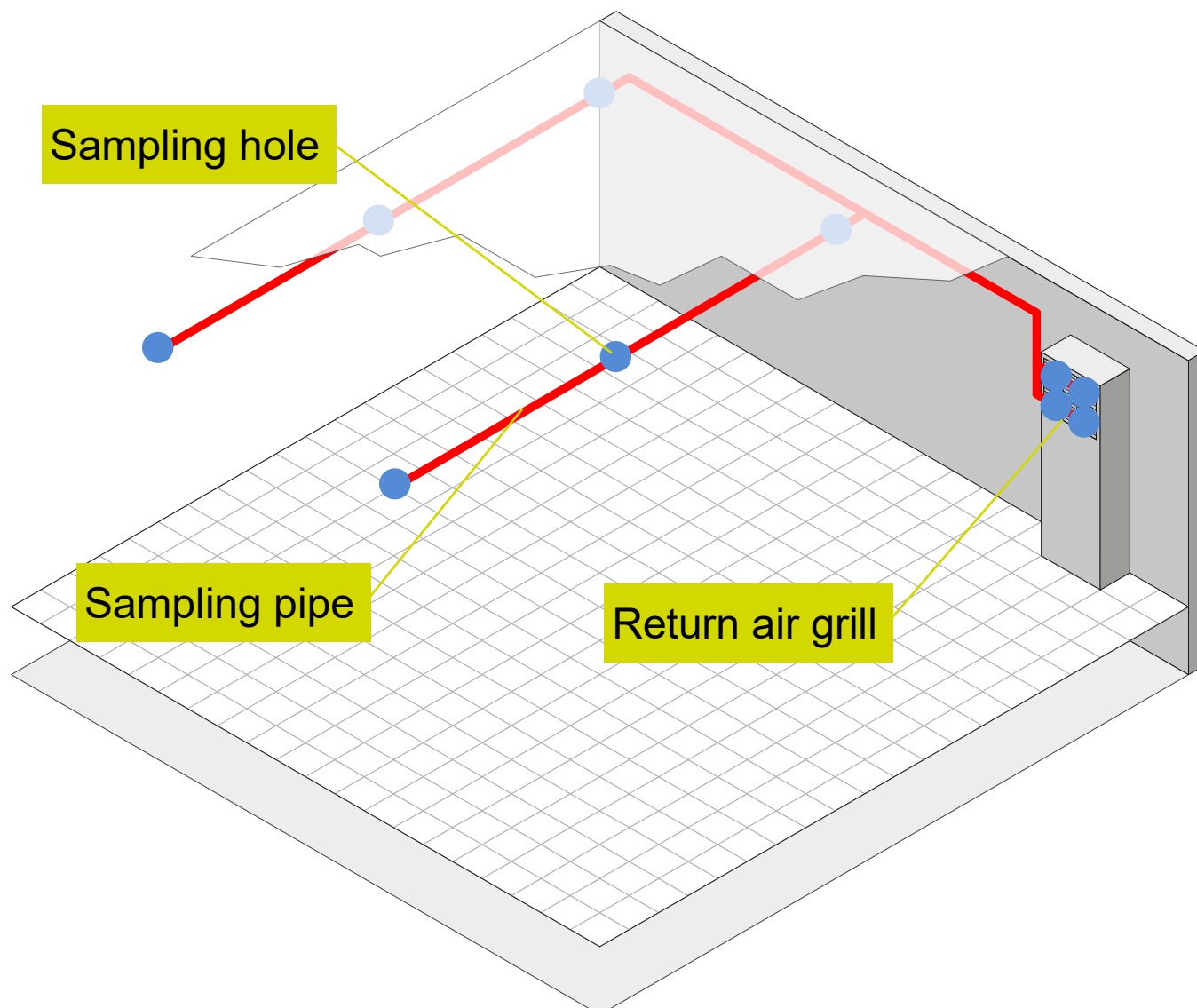


Figure 15: Fire detection placement (small room)

Variable	Design recommendation
Spacing	Refer to underside ceiling detection in chapter 3.3.1 and return air grills in chapter 3.5.1 for spacing, placement and orientation of the sampling holes.
Placement	
Orientation	

3.5.3 Localised protection: cabling, ICT/power cabinet & HVAC

Common ICT cabinet systems with a standard rack height¹⁹, are configured to have airflow either from the front to rear (for cold-aisle/hot-aisle containment) or from front to top (usually higher power density with forced ventilation to push hot air out of the top-mount vertical exhaust duct in usually a closed return air circulation application). Hence, when considering localised protection, take into account where the hot airflow exits from the cabinets.

Figure 16 illustrates how SecuriSmoke ASD sampling points are positioned at the hot air exhausts of the ICT cabinets for localised protection. For other electrical cabinets such as power distribution equipment, the concept of localised protection and method is the same.

¹⁹ For example, typical 42U and 52U ICT cabinets height is 201.6 cm (79.4 in) and 246.0 cm (96.9 in) respectively

If detection addressability to individual cabinets is required, simply add on SecuriSmoke REK 511, one for each zone for alarm notification purpose.

Cable trays are protected using SecuriHeat d-LIST Line Type Heat Detection (LTHD). The individual temperature sensors within the cable allow for both monitoring of temperature changes in the cable tray and localisation of the heat source alongside the tray.

Variable	Design recommendation
Airflow front to rear exit	
Spacing	Nominal 100 cm (40 in), 2 or more sampling holes per inside cabinet
Placement	Inside at the rear of cabinet where hot air exhausts (see sampling holes in green)
Orientation	Perpendicular and facing to incoming airflow exhausts
Airflow front to top exit	
Spacing	Immediate above the protected cabinet as per return air grills or per duct detection
Placement	
Orientation	
When air filtration is present	
Spacing	Position sampling holes in or near the hazardous area downstream before the air hits the filtration elements. For instance, sampling holes are positioned between the HVAC system and its air supply grills where air filters are installed
Placement	
Orientation	

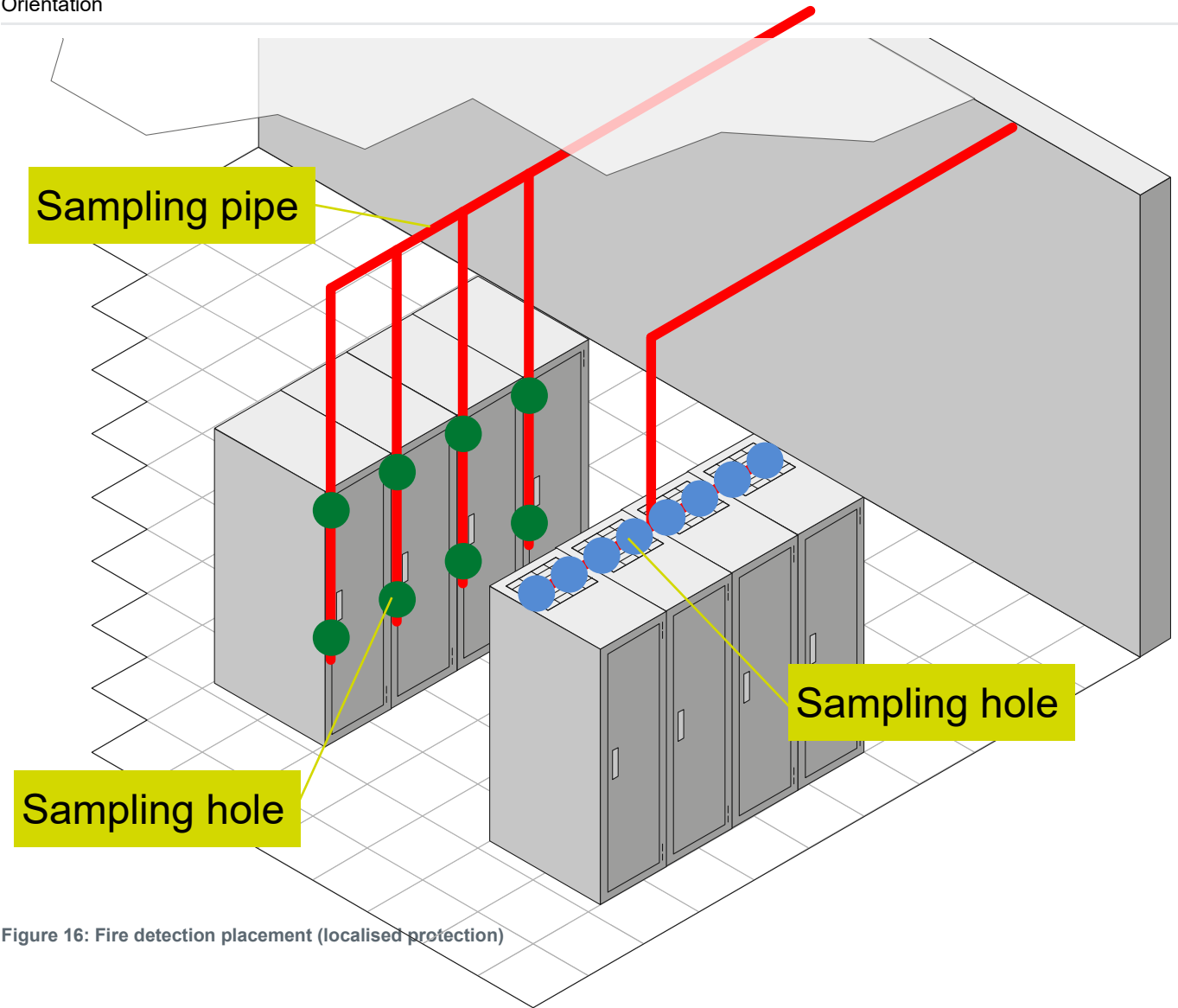


Figure 16: Fire detection placement (localised protection)

3.5.4 Duct detection

NFPA 72 [16] specifically requires that, unless a smoke detector is recognised for use in specific airflow environments, it should not be used in airflow environments above 1.52 m/s (300 ft/min). Both BS 6266 [21] and NFPA 72 recognise the challenges of detecting smoke in high-airflow environments and stipulate reductions in spacing of detection points in such high-airflow conditions.

SecuriSmoke ASD can be used for high airflow duct detection (approved to UL268A [22] with maximum airflow of up to 20.3 m/s (4,000 ft/min). Figure 17 is a cross-section view of a duct with the sampling pipe and pipe from the exhaust port inside the duct, when using SecuriSmoke ASD for in-duct smoke detection.

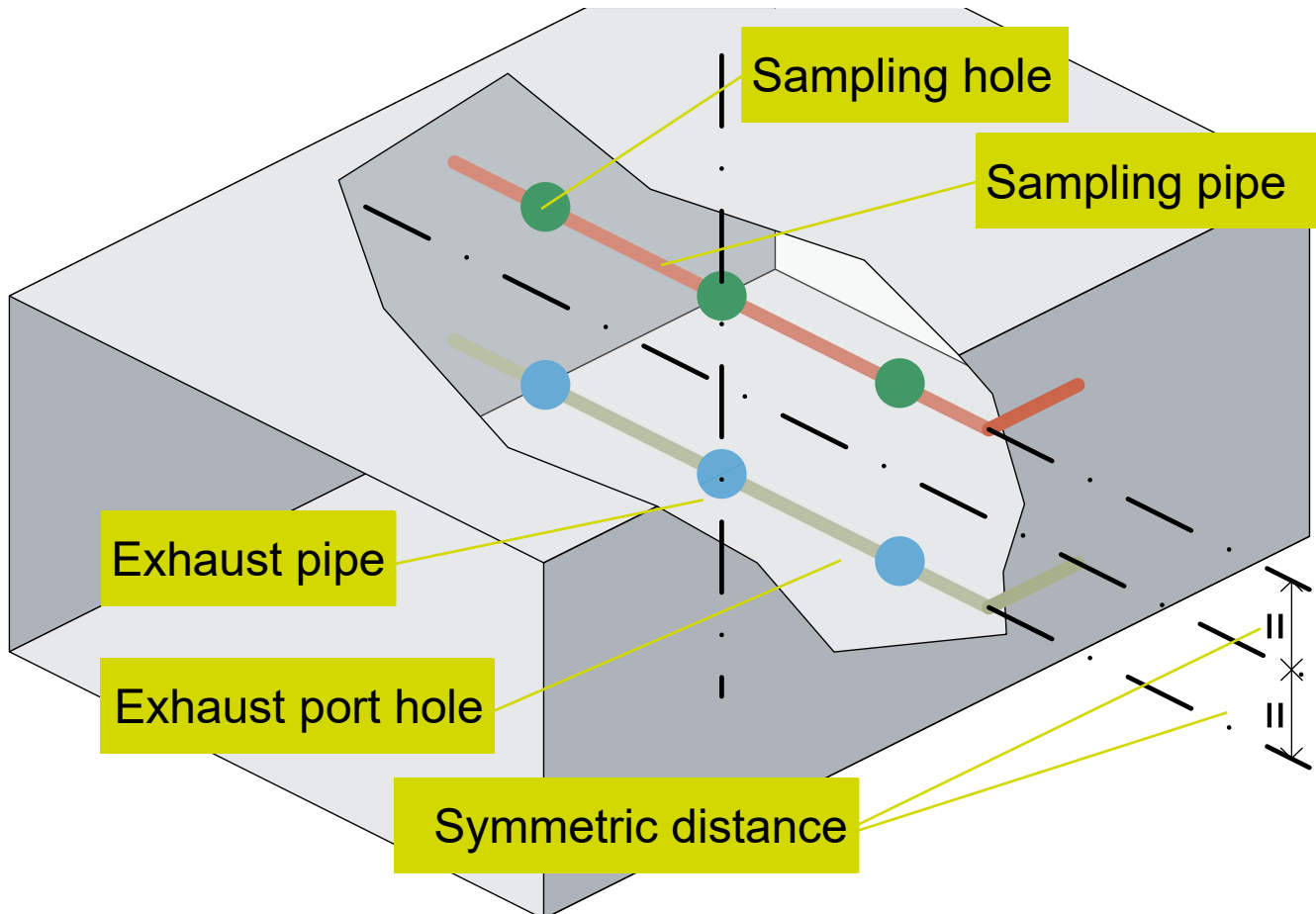


Figure 17: Pipe layout and sampling hole placement, duct detection

Refer to selected Securiton Aspirating Smoke Detector Technical Description manual for design details. As an example, SecuriSmoke 532 model Technical Description is shown in [23]. It is recommended per NFPA 72 [16] that duct smoke detectors be located in a duct section that is between 6 and 10 equivalent duct diameters from bends or openings. The total length of the sampling pipe and exhaust port pipe should be no more than 20 m (~65 ft).

Variable	Design recommendation
Sampling pipe	
Spacing	2 to 4 or more sampling holes are used, hole spacing ranges from 10 to 80 cm (~4 to 30 in)
Placement	Inside the duct, perpendicular and symmetric to the central line of the duct in relation to the pipe from exhaust port below
Orientation	Facing the incoming airflow using Securiton sampling funnel SF ABS
Exhaust port pipe	
Spacing	Exact same number of holes and identical spacing as in the sampling pipe above
Placement	In parallel and symmetric to the central line of the duct in relation to the sampling pipe, spacing is no less than 10 cm (4 in)
Orientation	Facing the incoming airflow using Securiton sampling funnel SF ABS

4 Optimising level of protection

Optimising the level of protection for Datacom facilities, when using advanced SecuriSmoke ASD-based Early Warning solutions, consists of the following three key design considerations:

- 1 Where to use SecuriSmoke ASD
- 2 How other detection technologies could complement for a fit-for-purpose detection solution
- 3 How SecuriSmoke ASD work seamlessly and reliably with the control of certain BMS components (such as containment doors), power-down processes and suppression actuation

4.1 General areas

A summary of Securiton detection products for general areas in or around Datacom facilities, including SecuriSmoke ASD for some highly sensitive areas, is shown in [Table 7](#) below.

General Area	Design considerations
Administration (offices & hallways)	SecuriStar point type multi-criteria detectors for other areas and high nuisance or false alarm areas such as kitchen areas
Storage areas & loading docks	SecuriBeam projected-beam detectors for high ceiling areas SecuriSmoke Early Warning ASD for high-sensitive storage areas (e.g. records, storage media)
Other operation support rooms	SecuriHeat Line-Type Heat Detection for loading docks and underground parking lots

Table 7: Detection design considerations (general areas)

4.2 Critical areas

[Table 8](#) is a summary of Securiton detection products for mission critical areas within datacom facilities.

Critical Area	Design considerations
Server & data processing equipment rooms	Mainly use SecuriSmoke ASD Early Warning Fire Detection system SecuriHeat Line Type Heat Detection (LTHD) systems for cable trays, raised floor space or above ceiling void where powered cables are installed
Emergency power & battery	High sensitivity intelligent point type optical smoke detectors may be installed in selected areas or where coincidence/cross-zone ²⁰ smoke detection is required for suppression systems (pre-actuation sprinkler, water mist or clean agent gaseous suppression)
Electrical switching & distribution	
Mechanical, plant & safety equipment	Where local fire/building codes require smoke or heat detection for building safety, point type smoke and heat detectors are used in conjunction with Early Warning Fire Detection
Security & control room	
Mobile & offsite backup facilities	

Table 8: Detection design considerations (critical areas)

²⁰ A.k.a. 'double knock' or interlock or double-interlocked

4.3 Controls and integration

One of the advantages of using SecuriSmoke ASD detectors is the five levels of alerts ('Pre-signal1', 'Pre-signal2', 'Pre-signal3') and alarm signals ('Alarm', 'Alarm2'). Staged alerts escalating to alarms from an overheat incident provide the needed early warning to prevent the situation from developing into a real fire event. Table 9 below shows a typical use of these alarm signals. Level 1 to 5 in the sequence from the time when the incident is initially originated.

Level	Signal	Typical use
1	Pre-signal1	Verify & control (manual extinguishing as needed)
2	Pre-signal2	Manual shutdown of HVAC if required; call emergency team
3	Pre-signal3	Auto shutdown of HVAC & related BMS; evacuate the site
4	Alarm	Actuate clean agent suppression; initiate fire alarm
5	Alarm2	Actuate pre-action sprinkler; call fire brigade

Table 9: Typical use of SecuriSmoke ASD multi-level alarms

The objective of early detection is to provide personnel with the opportunity to investigate and intervene as soon as possible in the event of a fire so that smoke damage or damage resulting from automatic power-down or actuation of fire extinguishing system can be avoided. On the other hand, activation of automatic fire suppression systems or other BMS components (such as power-down to computer equipment, the control of fire doors, smoke ventilation, HVAC, etc.) require a reliable fire detection system. In general, SecuriSmoke Early Warning detection systems are considered to be adequate to detect smouldering overheat or fire at its incipient stage for the prevention of the majority of fire outbreaks.

There may be slightly different requirements on how smoke detection is used in the emergency response and automatic actuation of various suppression systems. FM Global Datasheet 5-32 [24] is used as one main reference for the purpose of detail description of design recommendations in this chapter.

4.3.1 Early warning incident response

SecuriSmoke Early Warning 'Pre-signal1' and 'Pre-signal2' signals can be used in a datacom facility's Incident & Emergency Response Plan to effectively facilitate site security personnel to investigate, intervene and prevent a fire outbreak from developing.

Supported with the 'Pre-signal3' alert, 'Alarm' and 'Alarm2' fire alarm signals, a simple yet reliable interaction of manual and fully automatic control of fire detection and protection systems in the emergence response procedure can be executed in an early, timely and orderly fashion, together with both internal response teams and external fire services.

4.3.2 Power-down and building system control

SecuriSmoke ASD 'Pre-signal2' and 'Pre-signal3' alerts can be designed for manual HVAC or other BMS components power-down or automatic process-related controls. SecuriSmoke 'Pre-signal3' alert and 'Alarm' can be used for automatic power-down. Table 10 is a summary of typical detection and automatic power-down schemes using SecuriSmoke 'Pre-signal3' alert or 'Alarm'.

Suppression	Automatic power-down (SecuriSmoke 'Pre-signal3' or 'Alarm')
Clean agent only	Initiation of a power-down sequence of the data processing equipment, either automatic or automatic with time delay
Automatic sprinkler system only	Initiation of an automatic power-down sequence of the data processing equipment, from either detection alarm or water flow alarm from a pre-action type sprinkler system
Both clean agent & automatic sprinkler system	Initiation of an automatic or automatic with time delay power-down sequence at 'Pre-signal3' alert for discharge of the clean agent system; use the 'Alarm' signal with or without time delay for automatic sprinkler system related power-down sequence
Water mist system	Initiation of an automatic power-down sequence

Table 10: Typical detection and power down schemes

For discharge of clean agent suppression system, HVAC power-down will be subject to the system design for incoming air which may dilute the concentration of extinguishing agent.

4.3.3 Detection and suppression actuation

Regardless where and what type of suppression systems are installed, a suitable (and recommended per relevant codes and standards such as [20]) smoke detection system such as SecuriSmoke ASD is required to either actuate the related suppression zones or allow for a timely intervention to prevent the need for suppression. The use of detection equivalency to point type detectors for the purpose of co-incidence (or interlock, double interlocked) suppression actuation [25], SecuriSmoke ASD is an ideal solution. Table 11 is a summary of typical detection and suppression actuation schemes using either SecuriSmoke 'Alarm' or 'Alarm2' alarm signals.

Suppression	Suppression actuation (SecuriSmoke 'Alarm' or 'Alarm2')
Clean agent only	Initiation of an automatic power-down or automatic with time delay power-down sequence of the data processing equipment.
Automatic pre-action sprinkler only	Activate pre-action valve with smoke detectors and control panel in accordance with FM Global Data Sheet 5-48 [26]. When Coincidence detection is required for a double-interlocked pre-action sprinkler system, select one SecuriSmoke ASD detector with two independent detection chambers or two independent detectors for cross-zone detection actuation design. In certain cases, such as a small room or a compartmented suppression zone, use of SecuriSmoke REK511 with a SecuriSmoke ASD would be a cost-effective solution.
Both clean agent & automatic pre-action sprinkler	Provide two independent SecuriSmoke ASD detection systems to actuate pre-action sprinkler and clean agent system respectively.
Water mist system	Use SecuriSmoke ASD detection systems to power-down the HVAC to affected zone(s), upon reach of the next level alarm, activate the water mist system.

Table 11: Typical detection and suppression actuation schemes

4.4 Summary: Use of Securiton Fire Detection

Table 12 summarises the use of Securiton Early Warning Fire Detection systems in terms of the areas for which they are recommended and the placement of detection for the optimal level of protection.

Detection location	Detection design considerations			
	Ceiling	Ceiling void	Raised floor	Return air
General areas				
Admin (offices & hallways)	Point / LTSD	n.a.	n.a.	n.a.
Storage areas & loading docks	ASD / Point / LTHD	n.a.	n.a.	n.a.
Other operation support rooms	Point	n.a.	n.a.	n.a.
Critical areas				
Server & data processing equipment rooms	ASD + Point	ASD	ASD	ASD
Emergency power & battery	ASD + Point	ASD	n.a.	ASD
Electrical switching & distribution	ASD + Point	ASD	n.a.	ASD
Mechanical, plant & safety equipment	ASD + Point	n.a.	n.a.	ASD
Security & control room	ASD / Point	ASD	ASD	ASD
Mobile & offsite backup facilities	ASD + Point	n.a.	n.a.	ASD

Table 12 Summary (use of SecuriSmoke Early Warning Fire Detection)

5 Securiton 360° fire protection solution

Securiton 360° Fire Protection Solution is built on its advanced **Securiton Fire Alarm Systems (FAS)**. SecuriFire is not just reliable in operation with its modular, decentralised system architecture, it is also versatile and expandable to cater for current and future needs to connect all approved fire safety devices such as signalling, alarming, display and control units.

Table 13 is a list of Securiton Fire Alarm Systems (FAS) with its baseline approvals. All of these FAS work in conjunction with SecuriSmoke Early Warning ASD and REK detectors to protect data centres.

Model	Key performance parameters ²¹	Approvals
SecuriFire 3000	FACP, ECP or FEP; SecuriLan network	VdS
SecuriFire 2000	FACP, ECP or FEP; SecuriLan network	VdS
SecuriFire 1000	FACP, Non-networked	VdS
SecuriFire 500	FACP, Non-networked	VdS

Table 13 Securiton Fire Alarm Systems (FAS)

Figure 18 illustrates the use of different SecuriFire modules to design a main FAS with multiple Sub FAS and mimic panel configurations which are commonly required for hospitals and large clinics.

This chapter describes the following key elements underpin the optimisation of SecuriSmoke ASD Early Warning Fire Detection for datacom facilities with Securiton 360 fire protection solutions:

- 1 Features and benefits
- 2 Integrated verify, control and respond
- 3 Detection and suppression actuation
- 4 Inspection, testing and maintenance (ITM)

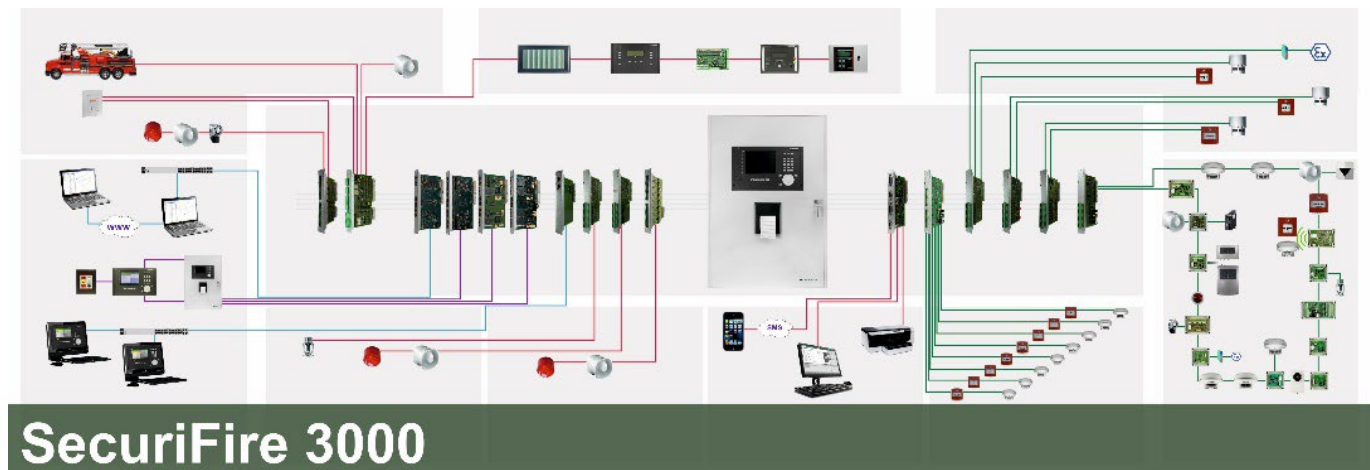


Figure 18 Securiton 360° Fire Protection Solution (FACP and Connections)

5.1 Features and benefits

Summary of benefits of SecuriSmoke ASD detection products are as follows.

Features	Benefits
Early and reliable smoke detection	Ensure safe egress for life safety, minimise operational interruptions and potential losses
ASD unit away from sampling pipes	Easy access for services while ensuring operation continuity
Automatic on-demand fault alarms	Minimal service required, hence low Total Cost of Ownership (TCO)
5-level of alerts and alarms	Enable fully integrated and orderly verify, control and response

²¹ FACP (Fire Alarm Control Panel); ECP (extinguishing system control panel); FEP (fire detector/extinguishing system control panel).

Features	Benefits
Optimal alarm settings supported with design tool for code compliance	Eliminate false alarms in challenging environments
Dynamic use of aspirating technology to address unique operating conditions	Consistent detection performance in areas with pressure difference (e.g., operating theatres), high or low temperature or humidity
Seamlessly integrated with fire alarm system (FAS) and building management system (BMS) components	SecuriSmoke ASD is designed as a key component of a total fire prevention and protection solution

5.2 Integrated verify, control and respond

Table 14 shows the typical use of SecuriSmoke ASD multilevel alarms, illustrating the advantages of using SecuriSmoke ASD detectors five levels of alerts ('Pre-signal1', 'Pre-signal2', 'Pre-signal3') and alarm signals ('Alarm', 'Alarm2').

Level	Signal	Typical use
1	Pre-signal1	Verify and control (manual extinguishing as needed)
2	Pre-signal2	Manual shutdown of HVAC and operation to affected areas if required; call emergency team
3	Pre-signal3	Auto shutdown of HVAC and related BMS; Initiate smoke and fire management and other related processes; evacuate the site
4	Alarm	Actuate clean agent suppression; initiate fire alarm; call fire brigade
5	Alarm2	Actuate pre-action sprinkler

Table 14 Alert and alarm levels and their typical use for SecuriSmoke ASD

There may be slightly different requirements on how smoke detection is used in the emergency response and automatic actuation of various suppression systems (see [Appendix A:](#)). SecuriSmoke ASD 'Pre-signal2' and 'Pre-signal3' alerts can be designed for manual HVAC or other BMS components power-down. SecuriSmoke 'Pre-signal3' alert and 'Alarm' can be used for automatic power-down.

Regardless of where and what type of suppression systems are installed, a suitable smoke detection system such as SecuriSmoke ASD is required to either actuate the related suppression zones or allow for a timely intervention to prevent the need for suppression. When configured for automatic actuation and release schemes, SecuriSmoke ASD 'Alarm' or 'Alarm2' alarm signals alone or together with alarms from other fire detectors can be applied.

Table 15 is a summary of typical detection and automatic power-down schemes using SecuriSmoke 'Pre-signal' alert or Alarm.

Suppression	Automatic power-down (SecuriSmoke 'Pre-signal3' or 'Alarm')
Clean agent only ²²	Initiation of a power-down sequence as planned, either automatic or automatic with time delay
Automatic sprinkler system only	Initiation of an automatic power-down sequence of related equipment as planned, from either detection alarm or water flow alarm from a pre-action type sprinkler system
Both clean agent and automatic sprinkler system	Initiation of an automatic or automatic with time delay power-down sequence at 'Pre-signal3', alert for discharge of the clean agent system; use the 'Alarm', signal with or without time delay for automatic sprinkler system related power-down sequence
Water mist system	Initiation of an automatic power-down sequence

Table 15 Typical detection and power down schemes

Other BMS components such as mechanical forced fans or large HVAC smoke control in hospitals and large clinics may be controlled through these SecuriSmoke alarm signals depending on the sequence and purpose of the

²² For discharge of clean agent suppression system, HVAC power-down will be subject to the system design for incoming air, which may dilute the concentration of extinguishing agent.

control. One practical example is upon detection of a fire incident at an early stage, to turn off the selected ventilation system so its operation does not impede the effectiveness of ceiling level sprinkler operation.

In addition, when incorporating SecuriSmoke 'Pre-signal2', 'Pre-signal3' alerts and 'Alarm' with the manual or automatic power-down procedure, consider the following:

- Work with EPO²³ switch/button, remote manual, ventilation switch/button, etc. for powering down in affected zone(s)
- Use a manual remote override to disconnect control for a pre-determined automatic power-down scheme
- When site security investigation is available upon SecuriSmoke 'Pre-signal1' and 'Pre-signal2' alerts, the manual control points should be located in such a way that an immediate action to effect or override power-down is possible
- For automatic power-down with time delay associated with clean agent systems, manual power-down will be completed in a maximum of 10 minutes as part of the orderly power switch-off process, at which time automatic power-down sequence is initiated.

5.3 Detection and suppression actuation

Table 16 illustrates various suppression actuation schemes with SecuriSmoke ASD or the combination of SecuriSmoke ASD with other Securiton detection systems such as Optical Smoke Switches ORS and SecuriHeat Line Type Heat Detection.

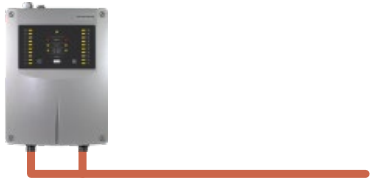
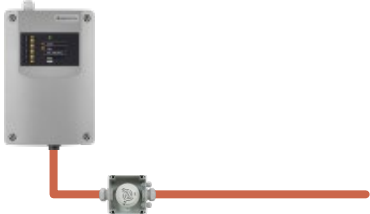
Scheme	Illustration	Remark
A		2 x SecuriSmoke ASD 531, 532, 533 for full redundancy or cross zone coincidence design
B		Single SecuriSmoke ASD 535-2/4 with one set of pipe network
C		Single SecuriSmoke ASD 535-2/4 with two independent pipe network
D		Use REK in place of 2nd ASD in Scheme A, or localised suppression
E	Scheme A, B or C plus 	Any of SecuriSmoke ASD with REK
F		Combination of Optical Smoke Switches ORS, localised suppression
G	Scheme A to F + SecuriHeat d-LIST	Combine with SecuriHeat Line Type Heat Detection

Table 16 SecuriSmoke ASD, REK and SecuriHeat for control and suppression actuation

²³ EPO: Emergency Power Off

5.4 Inspection, testing and maintenance

All hospitals and large clinics stakeholders and facility operators are committed to regular maintenance service on site. Examples of relevant codes and standards for fire detection and alarm systems Inspection, Testing and Maintenance (ITM) include ISO 7240-14 [27], NFPA 72 [15], BS 5839 [28] and AS1851 [29]. In general, codes and standards also make references to the manufacturer's design, installation, and operation manual listed with relevant product-type approvals such as UL, EN or FM Approval. Testing methods refer to FIA CoP, NFPA 76 or local applicable requirements.

Service Item	Fault/Alarm	Trimestrial	Yearly
Cleaning the detector housing exterior (air outlet)	(✓) ²⁴	?	✓
Cleaning of sampling pipe tube network, accessory parts, airflow sensors	(✓)	?	✓
Replacement of dust filters	(✓)	✓ ²⁵	✓
Cleaning of air flow sensor	(✓)	✓ ²⁵	✓
Check correct seating (no leakage)	(✓)	?	✓
Check of fault and alarm release	✓	?	✓
Update maintenance protocol	✓	?	✓
Analyse event memory	✓	?	✓
Analyse airflow issues (caused by operational changes)	✓	?	✓

Table 17 Typical Inspection, Testing and Maintenance (ITM) Schedule for SecuriSmoke ASD

An advantage of using SecuriSmoke ASD detectors is the non-intrusive access to the system. Non-intrusive access to the fire detection system while maintain business continuity is important design consideration for data centres as access to the server areas is generally deemed undesirable both from a security and a air cleanliness and HVAC efficiency point of view.

Table 17 above is a simplified ITM schedule for SecuriSmoke ASD product services. Refer to Securiton product manuals for more details.

6 Operation software & application support

This chapter describes briefly the software tools for design, configuration or remote monitoring and management of SecuriSmoke ASD and related products. Securiton's dedicated application support is ready to assist you with specific project needs.

6.1 Control room monitoring

SecuriSmoke ASD detectors are networked through RS485 or TCP/IP. The networked detectors from one or multiple sites can be centrally monitored and managed from a remote location, such as from an on-site control room, authorised off-site locations or through a certified remote monitoring centre.

²⁴ ✓ indicates 'shall do'; (✓) indicates 'as needed'; ? indicates 'only if required by local codes and standards'

²⁵ As per manufacturer recommendation for maintenance areas with high level of dust present or semi-enclosed areas subject to dusty air particulates.

6.1.1 Rack-mount standalone FidesNet RCU

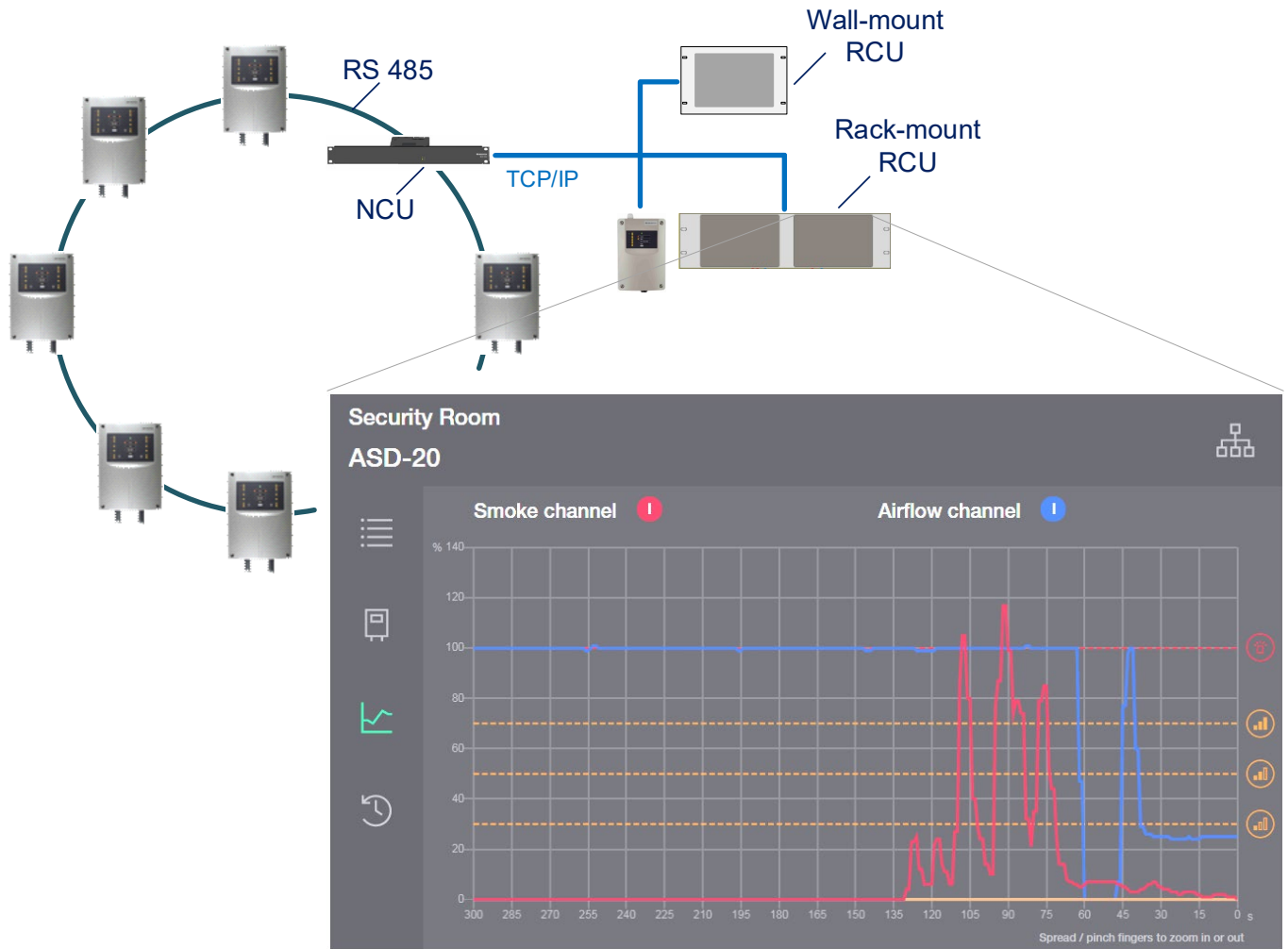


Figure 19 Standalone FidesNet RCU display and control

Using Securiton FidesNet, multiple ASDs are connected to each other via serial RS485 interface. The FidesPort NCU 900²⁶ acts also as a gateway for remote access, which supports standard interfaces (such as Modbus TCP or SNMP) to connect to a BMS. SecuriSmoke ASD systems support SNMP connectivity, allowing them to interface easily with the data centre operator's platform of choice.

FidesControl RCU 700²⁷ is a rack-mounted or wall mounted standalone networked SecuriSmoke ASD display, control and management console. It comes with 7" touch screen and offers access to all connected ASD for routine services and emergency response tasks. With the use of an RCU in most cases, it becomes obsolete to physically access the ASD devices themselves – often placed in highly secured areas – or bringing in personal laptop computers into such areas. Because the RCU device is designed for one-to-many or many-to-one topologies, more than one RCU to the same FidesNet networked SecuriSmoke ASD can be connected.

Figure 19 illustrates the RCU and NCU for display, control and management of networked SecuriSmoke ASD detectors remotely from the protected areas.

²⁶ NCU: Network Communication Unit

²⁷ RCU: Remote Control Unit

6.1.2 PC-based Universal Management System UMS

The UMS visualises live data from networked SecuriSmoke ASD. A comprehensive overview of the entire ASD population on one or more site(s) can be accessed from a central location, including the detectors current states. All data is visualised in form of lists, on a simple building layout plan or even a complex graphical view. UMS allows configuring and retrieving data from any of the detectors in the network through a user-friendly, intuitive graphical user interface.

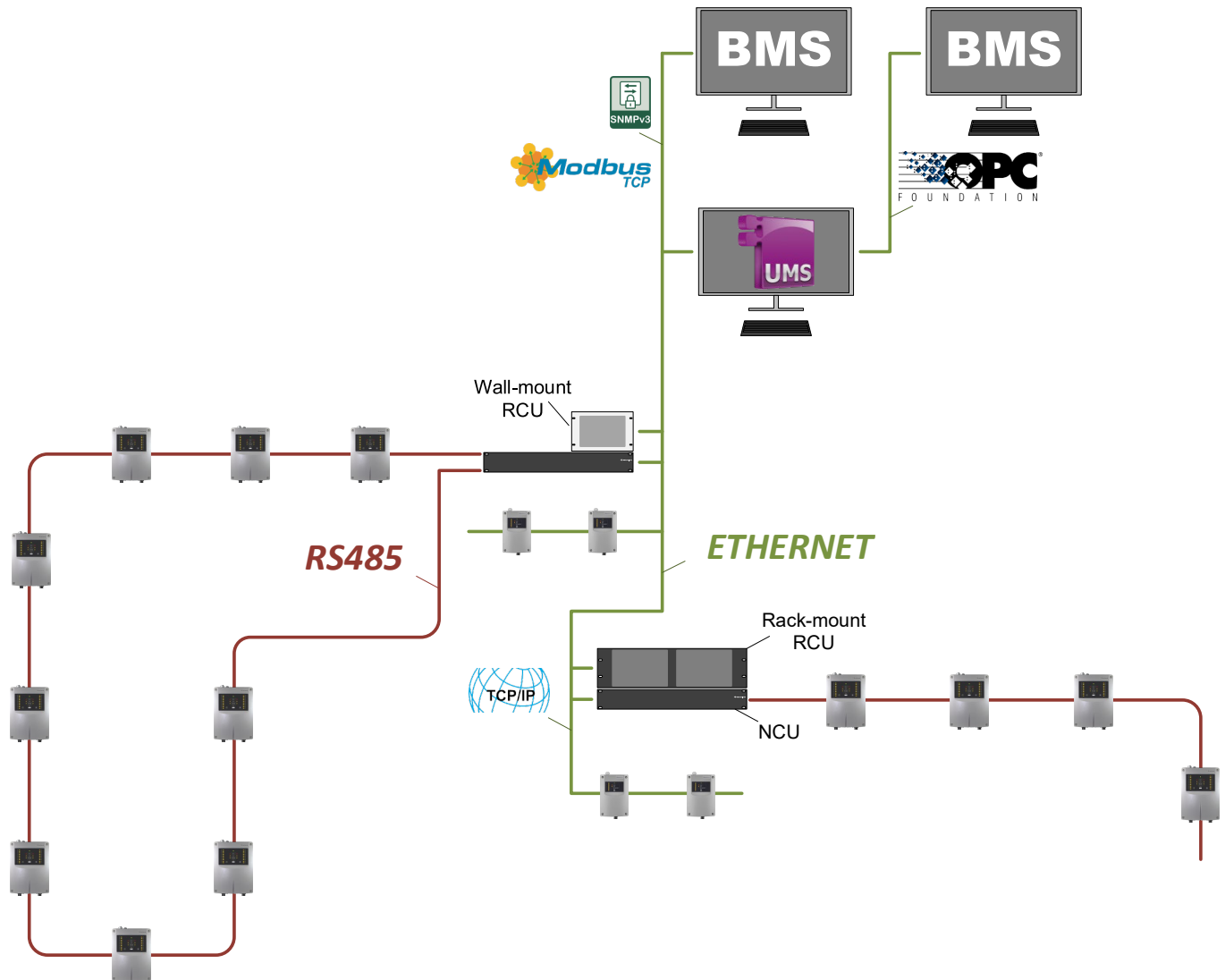


Figure 20 Networked SecuriSmoke ASD managed with UMS

Figure 20 illustrates two FidesNet networks of SecuriSmoke ASD devices, each connected to an RCU 700 for local display and control. Both networks are connected to a UMS for overall monitoring and control. The figure also illustrates the possible connection to a BMS.

6.2 Software tools and application support

Application support includes mainly:

- Software tools for design, configuration, commissioning and ongoing ITM
- Partner accreditation program
- Application and field engineering support

6.2.1 Software tools

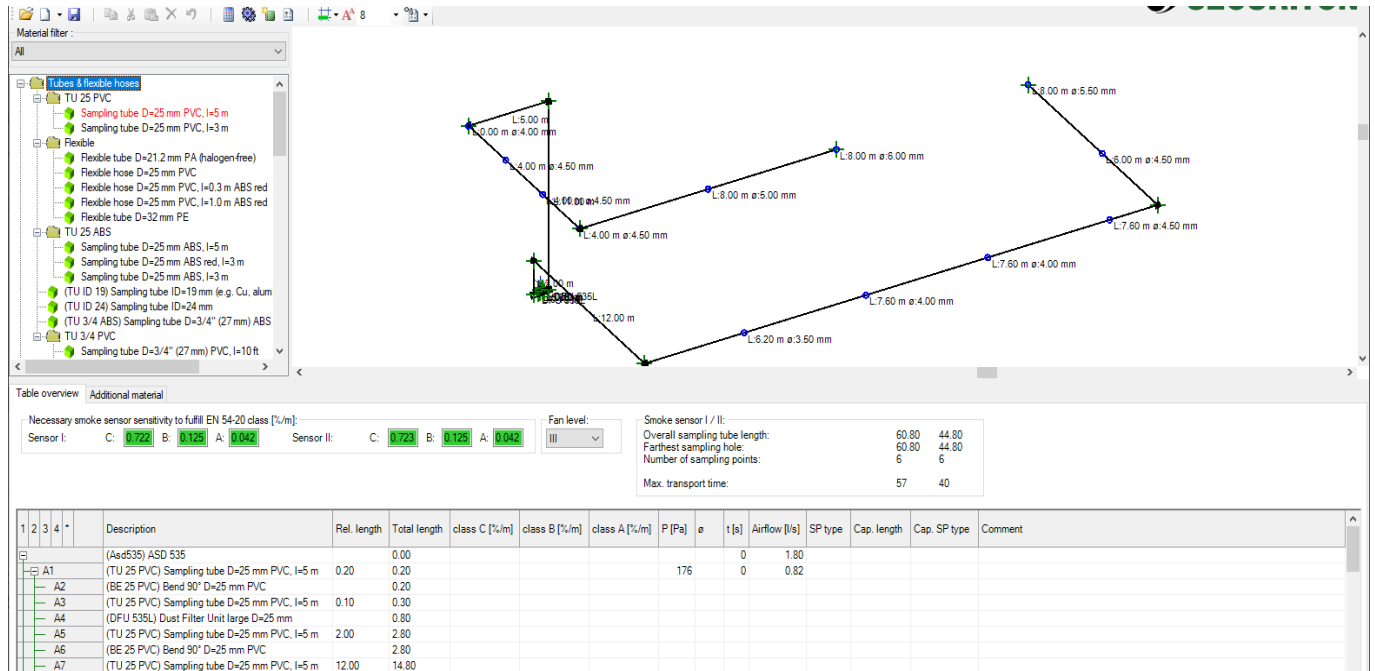


Figure 21 SecuriSmoke ASD design software: ASD PipeFlow

To design SecuriSmoke ASD detectors which meet the levels of protection required for an application (in terms of detection sensitivity, sampling hole placement/coverage, transport time limits, etc.), it is essential to use the SecuriSmoke ASD PipeFlow design software (Figure 21). This software helps in generating a design package, which is the basis of design, installation, commissioning and ongoing ITM throughout the product lifecycle.

The ASD PipeFlow software tool provides system designers the means and support to design a system in such a way, that SecuriSmoke ASDs are operating in accordance with either EN 54 or NFPA 72 provisions. It furthermore helps to optimise bills of material (BOM) supported with a 3D illustration of the entire pipe network.

During installation, commissioning and ongoing ITM on site, SecuriSmoke ASD Config (Figure 22) is used for quick and easy set-up of individual or networked detectors from a single location, thus significantly improving the efficiency of all required fieldwork. When necessary, Securiton support teams can also connect to the detector network from a remote location for troubleshooting.

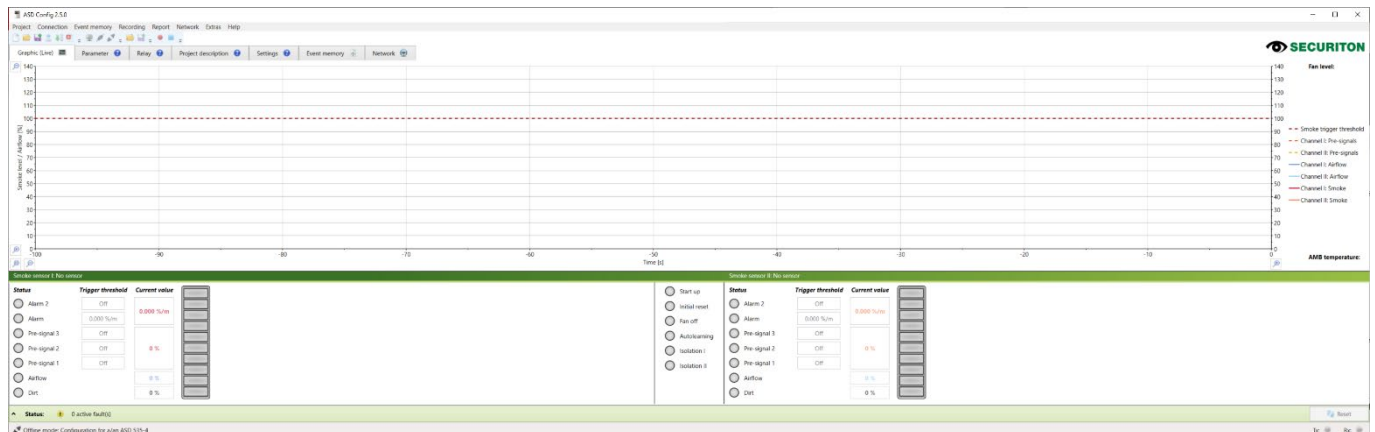


Figure 22 SecuriSmoke ASD configuration software: ASD Config

Securiton SecuriFire Studio (Figure 23) is a powerful and modern software tool supporting engineers during designing, installation, commissioning and ongoing ITM on site or remotely, of SecuriFire FAS installations. It allows

for planning, configuring and troubleshooting of an entire networked FAS installation from a single location, consequently reducing significantly both time and labour required for routine ITM tasks.

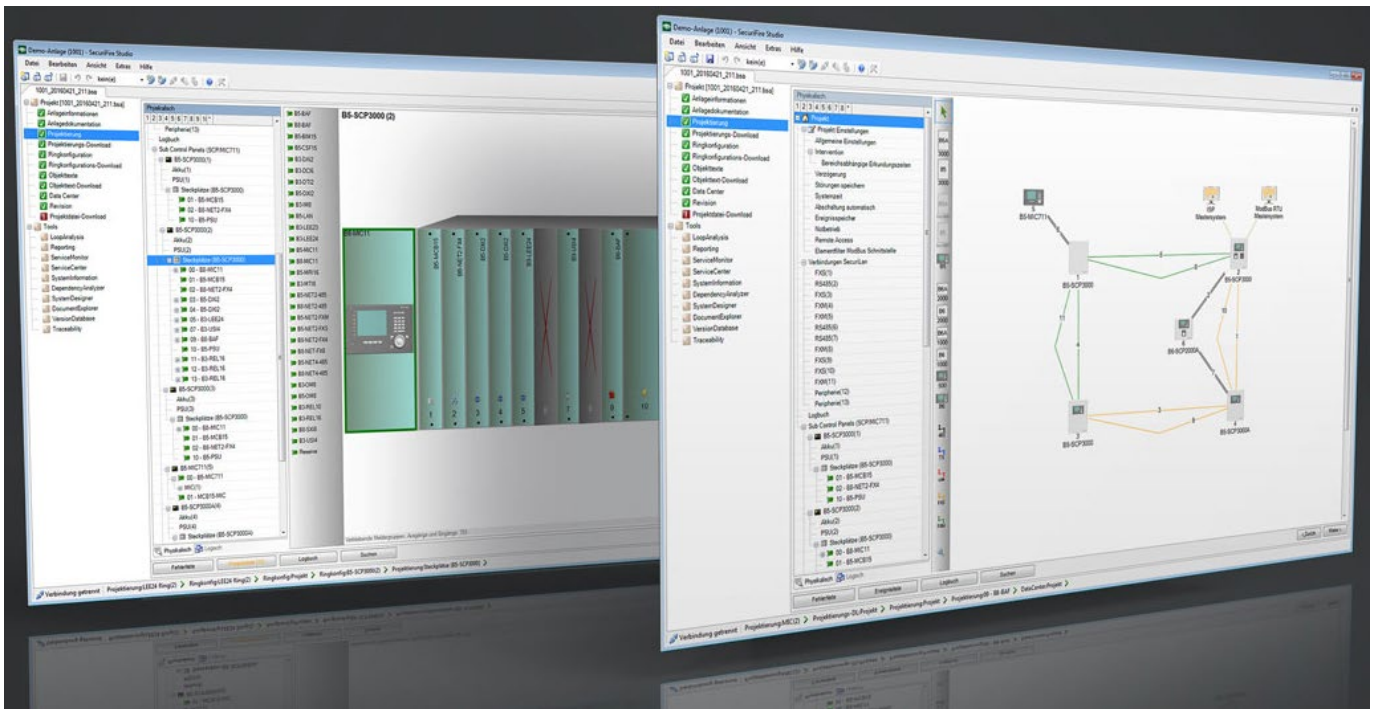


Figure 23 SecuriFire configuration software: SecuriFire Studio

6.2.2 Partner accreditation program

Securiton is committed to providing service excellence through its worldwide partner network. A key element of the partner accreditation program is the training of the partner's staff in sales, engineering, troubleshooting and maintenance of Securiton products.

For this purpose, Securiton is operating a comprehensive online training platform in combination with in-depth training courses, conducted either at Securiton headquarter or locally at the partner's premises.

Refresher courses are required for the partner to maintain or improve his accreditation level.

6.2.3 Application and field engineering support

Securiton application engineering support is always available to ensure a properly designed and implemented fire-engineered SecuriSmoke ASD Early Warning Fire Detection solution to protect mission critical infrastructure for life and building safety as well as maintain business operation continuity.

Field engineers and fully accredited product specialists from [Securiton regional offices](#) and its local distribution partners ensure a smooth installation and commission phase on site as well as supporting the client's maintenance force for ongoing ITM tasks.

Product support specialists and application engineers at Securiton European headquarter provide the next level of support to resort to. They in turn have access to the R&D department, thus ensuring adequate and effective support services on all levels.

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Appendix A: Highlight of fire detection codes

This Appendix provides information on related codes and standards for Early Warning Fire Detection systems as well as the typical site performance test methods for the purpose of commissioning and verification of system installation to the performance requirements of VEWFD and EWFD systems in datacom facilities.

A.1 Summary of Codes & Standards

Table 18 is a summary of relevant codes and standards for Early Warning Fire detection systems for the datacom industry (telecommunications and data centres).

Region	Product Approvals	Design for Use	Install/Commissioning, ITM ^{#1}
Global	UL 268; UL 268A	NFPA 75; NFPA 76, NFPA 72 FM 5-14, FM 5-32	NFPA 72 FM 5-14, FM 5-32
EU/UK, MENA, SEA, India	EN 54-20; EN 54-7	BS 6266; VdS 2095 Appendixes, R7 Rules, BS FIA CoP, VdS 2095, BS 5839-1 5839-1, etc.	
China	GB 50116-2013	GB 50016, etc.	GB 50166
ANZ, Pacific, SEA, India	AS 1603-8	AS 1670-1; AS 7240-20/AS 1603-8	AS 1851

Table 18: Summary of codes & standards (Early Warning Fire Detection)

Apart from these requirements from relevant codes and standards, you also need to refer to Securiton product manuals.

Table 19 is an example for how prescriptive codes are cross-referenced with PBD codes when designing Early Warning Fire Detection and the actuation of suppression (Clean Agent Gaseous) system by the detection systems for datacom facilities protection.

	NFPA 76	NFPA 75	BS 6266
Detection system	The confirmation of the presence of smoke can be accomplished by: (1) Cross-zoning; (2) Time/smoke density factors; (3) Activation of multiple detectors; (4) Manual pull station in combination with detection strategy; (5) Heat detection; (6) Automatic suppression system actuation.	The equipment used shall be a listed smoke detection-type system and shall be installed and maintained in accordance with NFPA 72. Automatic detection systems shall be installed: (a) At the ceiling level throughout the area; (b) Below the raised floor; (c) Above the suspended ceiling and below the raised floor.	Recommendations for electronic equipment areas protection are complementary to the BS 5839-1. Smoke detection is often the most appropriate form of detection for electronic equipment areas. Aspirating smoke detection systems are particularly suitable. Point type heat detectors are considered unsuitable as primary detectors.
Gaseous suppression system	Where provided, clean agent extinguishing systems should be designed, installed, and maintained in accordance with the requirements of NFPA 2001.	Where gaseous agent total flooding systems are used, they shall be designed, installed, and maintained in accordance with the requirements of codes such as NFPA 2001.	The vulnerability of electronic equipment rooms to fire damage, necessitates very early and effective action to suppress the fire.
Detection sensitivity	Application of VEWFD, EWFD and SFD.	See "Detection system" above.	The sensitivity of fire detection systems covers a wide range. A highly sensitive system can detect an incipient fire condition. Normal sensitivity systems are likely only to detect a fire when it has reached a sustained smouldering or flaming stage, when fire and smoke might already have caused some damage to sensitive equipment.
Gas release	Detection systems used to actuate clean agent suppression systems should be designed so that the selected EWFD and VEWFD smoke detection systems with spacing that is less than that normally required by NFPA 72.	Gaseous agent systems shall be automatically actuated by an approved method of detection meeting the requirements of NFPA 72, and a listed releasing device compatible with the system.	Detection systems can be used additionally for the following purposes: a) to isolate the power supply or initiate programmed shut-down of the electronic equipment; b) to shut down air-conditioning; c) to initiate the release of fire suppression media.
Double-interlock / coincidence scheme	Detection should be either cross-zoned or an equivalent method should be used to limit the possibilities of false discharges.	Not specified but made reference to NFPA 2001	Where any actions could result in disruption of operations or other serious inconvenience, careful consideration should be given to reduce the possibility of false operation. This might include the use of coincidence connection in accordance with BS 7273-1 and the initiation of different actions at different stages of alarm.

Table 19: Example of prescriptive and PBD code requirements (cross-referencing)

Note: Purpose of this Table is to show examples of how Early Warning Fire Detection and suppression (Clean Agent Gaseous) systems work together in the context of cross referencing between PBD and prescriptive codes for Datacom industry. The exact wordings should refer to the latest revision of respective codes.

A.2 Testing Methods: Early Warning Fire Detection

The most commonly used test methods for Early Warning Fire Detection systems are those described in FIA CoP and NFPA 76.

FIA CoP 2012 Appendix A – ASD System Performance Tests

NFPA 76 Annex B Performance Test Procedures for VEWFD and EWFD Systems

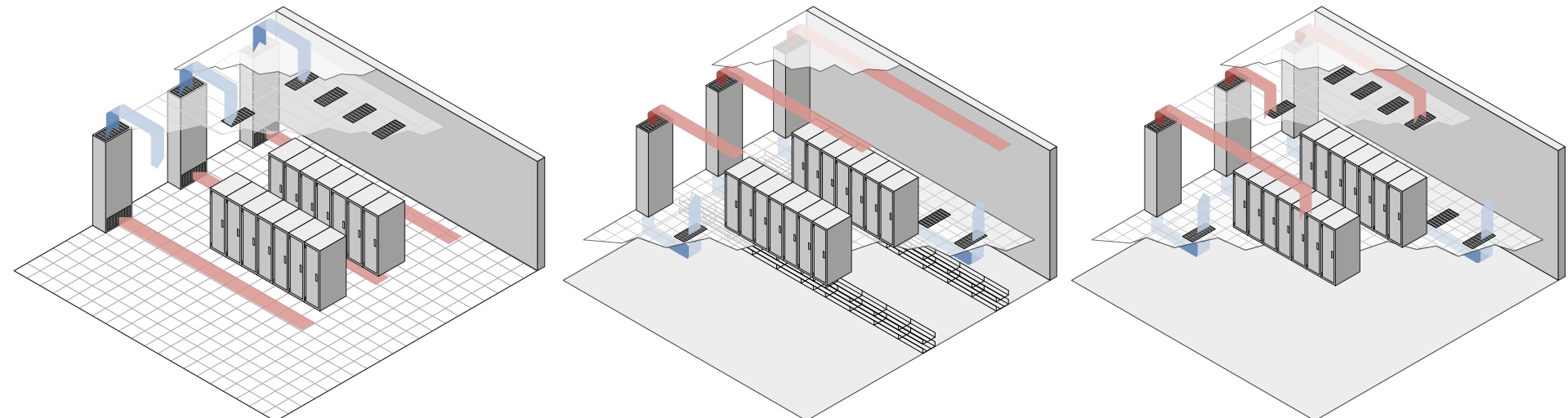
Type	Application	Response Class A	Response Class B	Response Class C
Primary	Clean room, Telco or computer facility (ceiling <3m)	2m PVC wire (E.2)	1m PVC wire (E.1)	7-9g pellet (B.1)
	Other (including open areas and high ceilings)	1m PVC wire (E.1)	7-9g pellet (B.1)	13-18g pellet (B.2)
Secondary	Low 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 >3m³	12 ohm for 70sec (F.2)	2x12ohm for 80sec (F.3)	2m PVC wire (E.2)
	Unvented <3m³	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)

Table 20: Typical Early Warning Fire Detection performance test methods

Table B.2.1 Heated Wire Test Parameters				
Parameter	BS 6266 Test (1992)		Modified BS 6266 Test: Two 1 m Wires in Parallel	North American Wire Test: North American Wire
	2 m Wire Test	1 m Wire Test		
Wire specs	10 strands of 0.1 mm diameter tinned copper wire.	Total cross-sectional area of conductor is 0.078 mm². Insulated with PVC to a radial thickness of 0.3 mm.	Wire is very flexible due to stranded construction and highly plasticized insulation.	A single strand of 22 AWG copper wire, insulated with PVC to a diameter of 1.1 mm (0.041 in.). This wire is stiffer than the BSI wire due to the single-strand construction and the minimally plasticized PVC insulation.
Smoke characterization	Smoke is very light (barely visible). HCl vapor is unlikely to be produced due to the low temperature achieved in the wire. The primary constituent of the smoke is plasticizer.	More visible smoke than the 2 m test, but still very light smoke. Due to the higher temperature in the wire, a very small amount of HCl vapor will be produced.	More visible smoke than the 2 m test or the single wire 1 m test but still very light smoke. Due to the higher temperature in the wires, a small amount of HCl vapor will be produced.	More visible smoke than the BSI wire tests but still very light. A minor amount of HCl is produced but for a shorter duration than the BSI wire tests.
Test period	180 seconds	60 seconds	60 seconds	30 seconds
Electrical load	Constant voltage — 6.0 volts dc, current varies from 0 to 15 A during the test due to changing resistance in the wire.	Constant voltage — 6.0 volts dc, current varies from 0 to 15 A during the test due to changing resistance in the wire.	Constant voltage — 6.0 volts dc, current varies from 0 to 30 A during the test due to changing resistance in the wire.	Constant current of 28 A. Voltage varies from 0 to 18 volts dc during test due to changing resistance in the wire.
Pass/fail criteria	Fire detection system should "respond" within 120 seconds of the end of the test period.		"Alert" or "pre-alarm" signal within 120 seconds of the end of the test period.	

Appendix B: With/Without Cold-aisle/hot-aisle Containment Illustrations

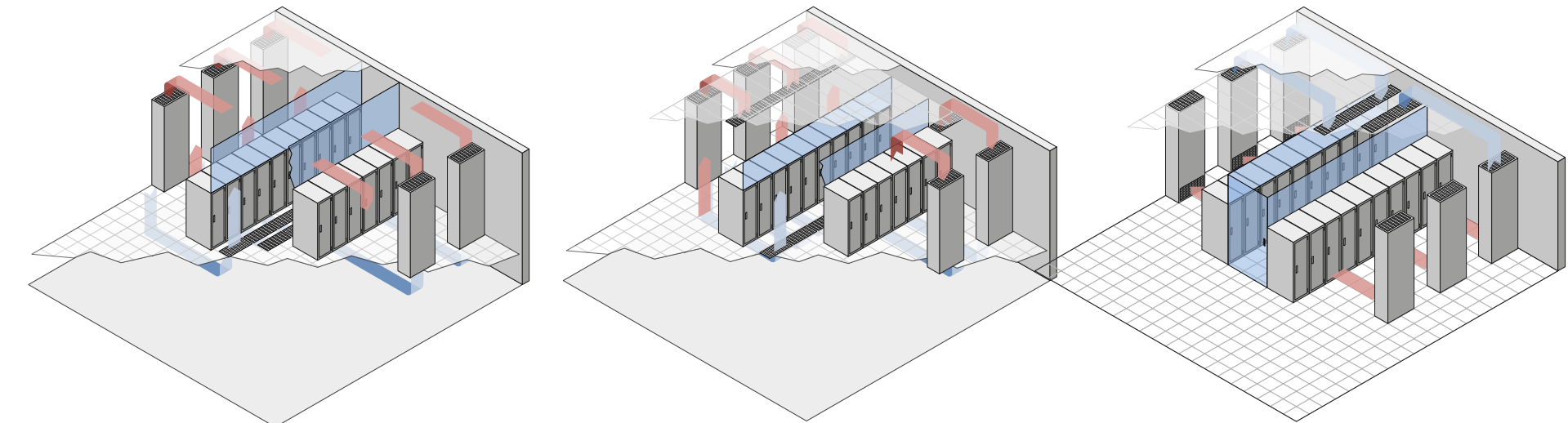
This Appendix provide additional illustrations of various HVAC airflow configurations for (1) no-containments (common in telecommunication facilities and small data centre or small server rooms) (see [Figure 24](#)); and (2) with cold-aisle/hot-aisle containments (common in large data centres), (see [Figure 25](#) and [Figure 26](#) below).



(a) Ceiling plenum (air supply)
Figure 24 Illustrations of no containment configuration

(b) Raised floor plenum (air supply)

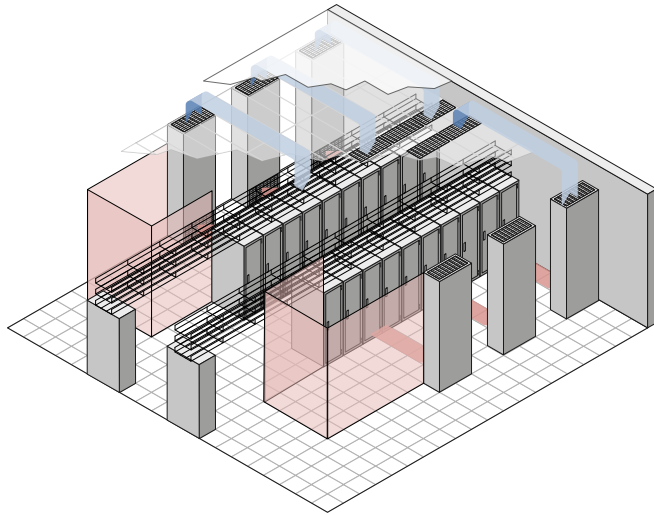
(c) Ceiling plenum (air return)



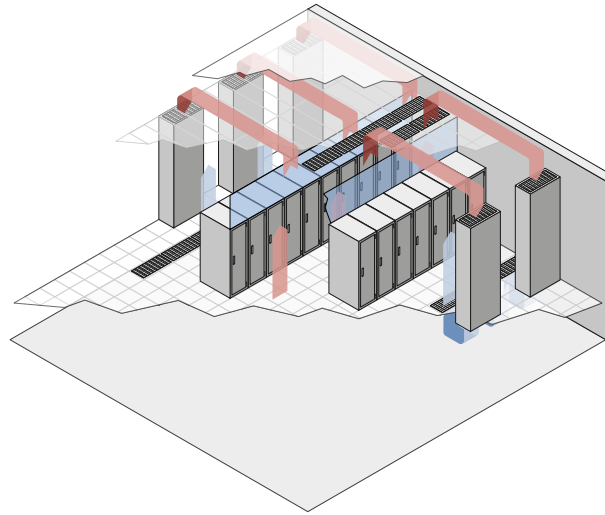
(a) Open space HVAC return
Figure 25 Illustrations of cold-aisle containment configuration

(b) Ceiling plenum hot air return

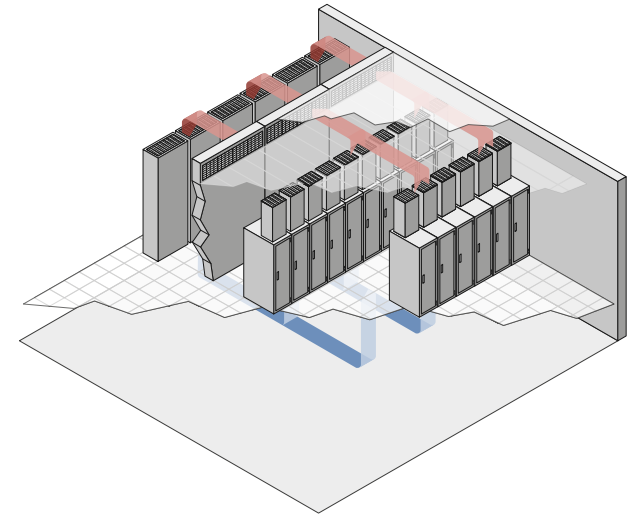
(c) Overhead cold-aisle containment



(a) HVAC hot air return compartment



(b) Hot-aisle (row) ceiling plenum return



(c) Raised floor to ceiling plenum direct

Figure 26 Illustration of hot-aisle containment configurations



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