Early Warning Fire Detection

DISTRIBUTION LOGIS-TICS & WAREHOUSING INDUSTRY

Design Guide

June 2020

SECURITON

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Executive Summary

Fast growing logistics & distribution, storage warehousing industry

Warehouses and storage facilities are historically one of the key built environments attracting significant new constructions to cater for increasing demands from urban population growth, consumers' change of behaviour and innovative goods and services fulfilments. A significant number of retrofits or expansions to older warehouses is driven by changing of occupancy, modernisation of warehousing operations and maintaining business footprints, often in prime real estate locations and close proximity to dense population and logistics & distribution hubs such as rail, roads and air transportation networks. With the rapidly growing e-commerce and digitisation of warehousing operations, the warehouse robotics market alone is projected to reach US$ 5.2 bn by 2023. The global cold storage market is also anticipated to reach US$ 212.54 bn by 2025, with a 43% increase in capacity in the USA alone since 2000, largely due to investments in larger scale facilities exceeding 70'800 m^3 (2.5 m ft^3) of space.

Larger, taller, flexible with dense and complex racking systems is a trend

Newly constructed warehouse footprint sizes have been growing because logistics distribution operation has moved towards fewer but larger regional distribution centres, a single national distribution centre or through specialist logistics warehousing service providers for businesses to reach a scale of global distribution with flexible ongoing OPEX, rather than upfront CAPEX investments. This results in typically 25'000-40'000 m^2 (269'100-430'600 ft^2) buildings or even larger ones, e.g. 80'000 m^2 (861'100 ft^2) or double of that. In large warehouses, including cold stores, goods can be routinely placed on racks 30.5-40 m (100-130 ft) high, with some going up to 60 m (200 ft) above the floor, where automatic storage and retrieval systems (AS-RS) are installed.

Racking systems (e.g. high-bay racking, block storage, bulk goods storage, liquid storage) are designed for maximum storage capacity per square meter/foot. As such, a higher roof and narrower aisle width are desirable from a business profitability perspective. As the level of warehousing automation increases, very high rack configuration and very narrow aisle become possible thus further maximising total storage volume on the same footprint, supported also with multi-tiered racking systems and multilevel mezzanine configurations within large warehouses.

Business continuity is vital and risk for loss due to fire damages increase

On the other hand, business continuity is paramount to deliver promised high levels of service for all logistics distribution centres, and for high-value manufacturing processes to ensure Just-in-Time (JIT) production and delivery.

Persistently, fire risks and a high percentage of total loss due to fires in industrial and warehouse/storage type of occupancies remain high. In the UK, trends in non-residential buildings showed a 20% increase in fires and a 16% increase in deaths, from 2008 to 2017. Storage fires in the USA in the 5-year period of 2013 to 2017 accounted for almost 30% of total fires reported (excluding residential and outside or special property class), 46% of total civilian deaths and almost 25% of total property loss. In Germany, the German Insurers' Association's (GDV) fire statistics from 2001 to 2016 show a total of over 76'000 risks and approximately 7'000 claims from warehouses during this period, with almost 60% of average claims for damages exceeding € 500'000. Historically, large damage claims of € 150 m from a car manufacturer in Germany or a US$ 100 m claim for a distribution centre of a retail chain in the USA harden the desire for businesses to adopt rigid risk management regimes and for the insurers to manage risks through the recommendation of best practices in fire safety and protection.

Challenges for fire safety systems

Fire hazards inside Logistics & Distribution, Storage Warehousing facilities are generally assessed in line with the classification of occupancy as well as commodities (for example NFPA 1 Fire Code and FM Global Data Sheet 8-1 Commodity Classification), where specific to storage fire safety, materials, wastes and hazard of contents are further divided into varieties of classes. Flammable and combustible liquids storage is addressed separately because relevant fire hazards in these storages require suitable fire protection measures.

The diverse nature of Logistics & Distribution, Storage Warehousing facilities require the design of a fire detection system to be simple and flexible to meet Deem-to-Satisfy (DtS) fire and building safety provisions. The design shall also be able to address risk-based detection needs, over and beyond prescriptive requirements to ensure business operations and asset protection.

Early warning is key to business continuity

Adequate fire detection system to automatically alarm local fire services can make a huge difference in minimising fire damage. However, the ability to detect and alert early allows warehouse operators and the occupants to control the initial outbreak or remove potential hazards that could lead to a real fire. Early Warning Fire Detection, based on Securiton SecuriSmoke Aspirating Smoke Detectors, is critical to many large Logistics & Distribution, Storage Warehousing facilities in order to avoid business interruption. When an advanced Early Warning Fire Detection system can be designed and installed at a low total cost of ownership (TCO), the same level of protection can be realised regardless of the size and use of the facility to achieve building and life safety objectives as well as protection of business assets.

Risk and Performance-based Design

Fire protection professionals work within the prescriptive constraints of the applicable building codes and standards while applying best engineering practices to address industry and building occupancy specific needs. In particular the risks for uninterrupted business operation requirements in Logistics & Distribution, Storage Warehousing facilities shall be adequately addressed. In this regard, a risk-based 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 (such as UK DCLG), (2006) Fire Safety Risk Assessment - Warehouses & Factories).

Performance-based Design (PBD) is typically implemented when elements of fire safety and protection system design are not covered in the prescriptive codes, due to unique building structure, environmental conditions, added detection for early warning or extended egress considerations, among others. While PBD may be required for some Logistics & Distribution, Storage Warehousing facilities, the majority of them can be designed to the prescriptive codes with added detection and protection based on a risk assessment, applying appropriate system design to these targeted risk areas and locations in addition to meeting the codes and standards for general building and life safety.

To further enhance risk management, fire prevention and protection, FM Global develops a comprehensive suite of property loss prevention data sheets for various warehouses and storage facilities, such as refrigerated storage and rubber tire storage. In addition, NFPA codes are also extended to include some unique storage facilities, such as archives and records centres and the production, storage and handling of Liquefied Natural Gas (LNG).

Design Guide objectives

Since its first edition more than a century ago, the NFPA Fire Protection Handbook (currently in its 20th edition) always highlights the challenge and uniqueness of fire risks in warehouse and storage facilities. While warehousing technologies and material handling evolved over the years, many aspects of fire safety concerns, such as a rapid growth of a fire and difficulties in manual firefighting, remain. Early Warning Fire Detection is a critical part of best practice of a fire engineering solution, although sprinklers proofed effective in potentially reducing the fire damage and time to recover. Only a well-designed Early Warning Fire Detection system provides risk mitigation to probably prevent a fire from happening or developing before the fire services arrive. A suitable fire detection system is also required for the actuation of pre-action and co-incidence (or interlock, double interlocked) suppression systems.

The objective of this Design Guide is to provide design recommendations for SecuriSmoke ASD and other related Securiton fire detection systems, to cover operation areas in typical Logistics & Distribution, Storage Warehousing facilities as well as industrial or manufacturing plants operating in a warehouse-like building structure. The specific areas covered include general admin or support areas

such as loading bays and critical operation and support areas, as well as areas with challenging environmental conditions or are deemed as hazardous areas. Included are the main large open warehouse or production areas, high-bay racking, Automatic Storage and Retrieval Systems (AS-RS), multi-tiered or multilevel mezzanines. Challenging environments range from dusty, extreme high or low temperature, high humidity to intrinsic safety or flameproof hazardous area protection. The design recommendations are generally in the context of key relevant international codes and practices on prescriptive (or Deem-to-Satisfy) fire detection requirements for warehouse-like building structure facilities housing general warehouses, storages and industrial workshops. Enhanced detection design is mainly covered with a risk-based approach, where extensions of a prescriptive design are provided to address the need for risk management or to prevent property loss and unacceptable business interruption.

Broad coverage of international and industry codes and standards

This Design Guide focuses on design recommendations for Securiton advanced Aspirating Smoke Detection (ASD) systems, related fire detectors and their integration with key control elements such as HVAC[1] and fire suppression systems. Although it is far from exhaustive in referencing codes and standards and relevant local/regional industry Codes of Practice, this Design Guide's recommendations cover major international and industry codes and practices related to fire detection for Logistics & Distribution, Storage Warehousing facilities. Among them NFPA 1, NFPA 72, FM Global DS 5-48/DS 8-1 or ISO/AS 7240-20 (from a DtS perspective) and NFPA 76, NFPA 232/232A, BS 6266, FM Global DS 5-14/DS 8-29 (from a risk-based protection perspective). Other codes covering Inspection, Test and Maintenance (ITM), such as EN 54-20, UK FIA Code of Practice, ISO 7240-14, BS 5839-1, AS 1851, VdS 2095 and FM Global DS 5-48 are also covered. Due to the extensive use of ceiling sprinkler and in-rack suppression systems in warehouses, codes such as NFPC 13, CEA 4001en and FM Global DS 2-0 are referred to in the context of the best placement of Securiton SecuriSmoke ASD products in line with sprinkler or suppression system design.

Ask Securiton

The Design Guide also provides an overview of how other Securiton products such as SecuriHeat Line Type Heat Detection and SecuriFire range of Fire Alarm Systems can be used as part of its comprehensive 360° Fire Protection Solution offerings. Securiton provides high quality technical expertise to support your projects in the Logistics & Distribution, Storage Warehousing industry through its extensive network of offices and distribution partners around the world. Please contact Securiton or any of the local offices in your region.

[1] HVAC: Heating, Ventilation and Air Conditioning

1 Introduction

Logistics & Distribution, warehousing industry outlook

Warehouses and storage facilities are historically one of the key infrastructure buildings that attract significant new constructions to cater for increasing demands from urban population growth, change in consumers' behaviour and innovative goods and service fulfilment. A significant number of retrofits or expansions to older warehouses is driven by changing of occupancy, modernisation of warehousing operations and maintaining business footprints often in prime real estate locations and close proximity to dense population and Logistics & Distribution hubs such as rail, roads and air transportation networks. With the rapidly growing e-commerce and digitisation of warehousing operations, the warehouse robotics market alone is projected to grow at a CAGR of 11.6% to reach US$ 5.2 bn by 2023 from a base year valued at US$ 2.4 bn in 2016 [1]. Emerging market demands also drive purpose-built warehouses, such as cold storages to cater for increasing preferences for fresh and frozen perishable goods, pre-packed or grocery shopping (current rate of online grocery shopping remains low at around 3% to reach 20% by 2025), pharmaceuticals, biologic components and high value electronic goods. The global cold storage market is anticipated to reach US$ 212.54 bn by 2025, growing at a CAGR of 12.4%. Since 2000, the U.S. cold storage warehouse industry has experienced a 43% increase in capacity, largely due to investment in larger scale facilities exceeding 70'800 m^3 (2.5 m ft^3) of space [2].

Bigger, taller warehouses with narrower aisles rely more on robotics and automation

Racking systems (e.g. high-bay racking, block storage, bulk goods storage, liquid storage) are designed for maximum storage capacity per square meter/foot. As such, a higher roof and narrower aisle width are desirable from a business profitability perspective. As the level of warehousing automation increases, very high rack configuration and very narrow aisles become possible to further maximise total storage volume on the same footprint. While older warehouses for general use have a roof height of 7-8 m only (23-26 ft), the roof height of a typical new built warehouse is 11.5-12 m (30-40 ft) to cater for various racking systems and movement of forklifts.

Newly constructed warehouse footprint sizes have been growing because Logistics & Distribution operation has moved towards fewer but larger regional distribution centres, a single national distribution centre or through specialist logistic warehousing service providers for businesses to reach a scale of global distribution with flexible ongoing OPEX[2], rather than upfront CAPEX investment. This results in typically 25'000-40'000 m^2 (269'100-430'600 ft^2) size buildings or even larger buildings of up to 80'000 m^2 (861'100 ft^2). In large warehouses, including cold stores, storage can be routinely placed on racks 30.5-40 m (100-130 ft) high, while some go up to 60 m (200 ft) above the floor where AS-RS[3] equipment is installed [3], [4], [5].

Risk management and business continuity is paramount to operation

Persistently, fire risks and a high percentage of total loss due to fires in industrial and warehouse/storage type occupancies remain high. While in the UK, trends in non-residential buildings (including industrial and storage properties) showed a 20% increase in fires and a 16% increase in deaths, from 2008 to 2017. Storage fires in the USA in the 5-year period of 2013 to 2017 accounted for almost 30% of total fires reported (excluding residential and outside or special property class), 46% of total civilian deaths and almost 25% of total property loss. In Germany, the German Insurers' Association's (GDV[4]) fire statistics from 2001 to 2016 show a total of over 76'000 risks and approximately 7'000 claims from warehouses during this period, with almost 60% of average claims for damages exceeding € 500'000 [6], [7], [8]. Historically, large damage claims of € 150 m from a car manufacturer in Germany or a US$ 100 m claim for a distribution centre of a retail

[2] OPEX: operating expenditure, CAPEX: capital expenditure
[3] AS-RS: Automatic Storage and Retrieval Systems
[4] GDV: Gesamtverband der Deutschen Versicherungswirtschaft e.V.

chain in the USA, harden the desire for businesses to adopt rigid risk management regimes and for the insurers to manage risks through the recommendation of best practices in fire safety and protection.

Electrical equipment is the prime cause for fires

Over 25% of fires in storage warehousing facilities originated from electrical distribution, lighting equipment or heating equipment. While sprinklers are deemed as standard fire protection for storages, only about 30% in reported fires from warehouses were equipped with sprinklers in the USA. Of these, 12% were deemed as failure to operate or to operate ineffectively [9], [10]. Even in warehouses with installed fire detection systems, some of these did not activate alarms as expected in the event of a fire.

High ceiling, dense racking configuration and occupancy challenge fire safety system design

Coupled with fire protection system design efficacy and fit-for-purpose system performance, the building height, large open spaces, block storage, complex rack and mezzanine structures, all present challenges to the design of fire detection and suppression systems. For facilities with high roofs, smoke dilution and stratification in non-ambient controlled environments are key considerations when choosing suitable fire/smoke detection systems. When there are multilayer structures, the type of detection and placement of detection points have an impact on the cost of total ownership from first installation to ongoing service and maintenance. Various occupancy classifications, found in warehouse-like buildings, may require a different type of detection systems (e.g. smoke or heat or a combination of both point type or line type) for either open space or in-rack detection, or in different hazard classification areas [11].

Flexible and reliable early detection is critical

The diverse nature of Logistics & Distribution, Storage Warehousing facilities requires the design of a fire detection system to be simple and flexible to meet Deem-to-Satisfy (DtS) fire and building safety provisions. The design shall also be able to address risk-based detection needs, over and beyond prescriptive requirements, to ensure business operations and asset protection.

Adequate fire detection system to automatically alarm local fire services can make a huge difference in minimising the fire damage. However, the ability to detect and alert early allows warehouse operators and the occupants to control the initial outbreak or to remove potential hazards that could lead to a real fire. Early and reliable fire detection is critical to many large storage warehousing and distribution facilities to avoid business interruption. When an advanced Early Warning Fire Detection system can be designed and installed at a low TCO[5], the same level of protection can be realised to achieve building and life safety objectives as well as protection of business assets, regardless of the size and use of the warehouse.

Why a Design Guide?

Since its first edition more than a century ago, the NFPA Fire Protection Handbook (currently in its 20th edition [12]) always highlighted the challenge and uniqueness of fire risks in storage warehousing facilities. While warehousing technologies and material handling evolved over the years, many aspects of fire safety concerns remain, such as a rapid growth of a fire and difficulties in manual firefighting. Early Warning Fire Detection is a critical part of best practice of a fire engineering solution, although sprinklers proofed effective in potentially reducing the fire damage and time to recover. Only a well-designed Early Warning Fire Detection system provides risk mitigation to potentially prevent a fire from happening or developing out of control before the fire services arrive. A suitable fire detection system is also required for the actuation of pre-action and co-incidence (or interlock, double interlock) suppression systems.

This Design Guide provides design recommendations for Securiton SecuriSmoke Aspirating Smoke Detectors (ASD) and REK aspirating in-line high sensitivity intelligent point type smoke detectors for pinpoint addressability. Where applicable, Securiton SecuriHeat Line Type Heat Detectors will be included, particularly when heat detection is required for the purpose of fire detection in hazadous areas or in-rack detection with in-rack pre-action sprinkler systems.

[5] TCO: Total Cost of Ownership (of an Early Warning Fire Detection system)

The design recommendations focus on aspects of prescriptive (Deem-to-Satisfy) code requirements, risk-based detection point placements and industry practices to address the key issues of best prevention practices. The Design Guide encompasses SecuriSmoke Early Warning Fire Detection systems for risk-based protection methods, for optimising the level of detection sensitivity and allowing for reliable staged responses, manual and automatic suppression actuation as well as control of other BMS[6] components (e.g. procedures of power-down forced ventilation fans or power-on smoke extraction systems).

1.1 Purpose

Who is it for?

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 Logistics & Distribution, Storage Warehousing facilities, including

1. Heated or unheated general warehouses and storages with simple large open spaces or with varieties of rack configurations, two-tier/multi-tier and multilevel mezzanine structures
2. Ambient-controlled, humidity-controlled or refrigerated storages where environmental conditions having an impact on the fire detection system design
3. Facilities with warehouse-like building structures for industrial processes, material handling and workshop environments, where potential false or nuisance alarms for a fire detection system need to be taken into account

It is also suitable for facility management and end-customers alike to gain a high-level insight to cost-effective, fit-for-purpose and fire-engineered fire detection and protection solutions to meet prescriptive (Deem-to-Satisfy) fire detection and protection compliance as well as enhanced fire detection methods to avoid business interruption and mitigate risks through the best fire prevention practices.

1.2 Scope

What does it cover?

The scope of this Design Guide covers detailed recommendations, design considerations and practices for Securiton Early Warning Fire Detection system (SecuriSmoke ASD 531, 532, 533, 535 and 535 HD[7] Aspirating Smoke Detectors and REK 511) for Logistics & Distribution, Storage Warehousing facilities. Depending on the actual building occupancy and business use, facilities with warehouse-like building structures may be classified [13], [14] as industrial occupancy, storage occupancy/multi-storage building, business occupancy or any combination of various occupancy classifications when the business type and operation within the same facility are taken into account. To simplify the scope, general fire detection system design recommendations in this Design Guide are applicable to:

1. Heated or unheated general warehouses and storages
2. Ambient-controlled, humidity-controlled or refrigerated storage[8]
3. Industrial processes, material handling or workshops housed in a warehouse-like building structure

[6] BMS: Building Management System
[7] HD: Heavy Duty
[8] Also commonly known as Cold Stores

Other considerations that can change the design approaches include:

1. A mix of or changed building use (for instance a new flex style warehouse to cater for multi-use tenants in the same premises, future altered use of it or the expansion of the protected areas)
2. Business activities (for instance wet or high humidity, dust or high ambient pollutants level)

Hazardous areas and considerations

Warehouse-like building structures and storage facilities meeting strict requirements are often used for heavy industrial operations, ranging from steel mills and chemical plants to corrosive, combustible, potentially toxic gas leak or explosive ambient environments. Purpose-built storages can provide liquid storage (fuel and non-propellant), flammable and combustible storage, radioactive material storage, hazardous chemical storage and ammunition storage.

This Design Guide does not cover the detailed design of fire detection systems in these hazardous areas with the exception when the areas are classified in according to the following:

1. Per NFPA 1 Chapter 34.2 Classification of Commodities and Chapter 60.3 Classification of Materials, Wastes, and Hazard of Contents [13] with a UL-listed smoke detector use per NFPA 72 [15]
2. Hazardous areas of use per FM Global-listed Smoke Detectors
3. Hazardous areas where Securiton SecuriHeat Line Type Heat Detection (LTHD) may be used or the use of SecuriSmoke products together with recommended special hazardous rating accessories (see Appendix C: SecuriSmoke ASD Accessories).

Covering all areas

For warehouses and storage facilities within the scope of this Design Guide, the fire detection design recommendations cover large open spaces for business operation as well as other related areas for general operation/administration, high sensitivity areas such as on-premise server rooms and record storages as well as mechanical rooms and power distribution rooms. The design recommendations are generally in the context of key relevant international codes and practices on prescriptive (or Deem-to-Satisfy) fire detection requirements for warehouse-like building structure facilities housing general warehouses, storages and industrial workshops. Enhanced detection design is covered mainly based on risk-based approaches where extensions of a prescriptive design are provided to address the need for risk management or to prevent business losses and unacceptable interruption.

The reference codes and industry practices are mainly based on NFPA, ISO/EN/AS/BS, VdS and FM Global (see Appendix A.1 Summary of Codes and Standards).

To facilitate the best risk management practices and reliable emergency response procedures through early intervention and elimination of potential fire incidents, the Securiton Early Warning Fire Detection product portfolio is also designed to be a flexible yet integral part of a fire safety solution. This Design Guide touches on:

- Use of Early Warning Fire Detection for suppression (mainly sprinklers, pre-action sprinklers, water mist or expansion foam suppression) actuation
- Securiton 360° Fire Protection Solution (FACP and ECP[9])
- Securiton Software for local and remote monitoring

Inspection, Testing and Maintenance

The Design Guide also provides key requirements on Inspection, Testing and Maintenance (ITM) of SecuriSmoke Early Warning Fire Detection system as well as world-class technical and application support offered by Securiton through its

[9] 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.

headquarters teams in Europe and its vast global network of regional offices and distribution partners.

Covering variety of layout and operations

Design recommendations for Logistics & Distribution, Storage Warehousing facilities are applicable to all warehouses and storages because internal layouts such as high-bay racking, AS-RS equipment, two-tier/multi-tier and multilevel mezzanine storage, robot controlled warehousing automation, with or without physical separation (compartmentation) can affect how a fire detection system is designed. In addition, areas with controlled or uncontrolled ambient air or fully enclosed or potentially connected to external outdoor areas, can also have an impact on the fire detection design. Other relevant support areas such as power supply and distribution, HVAC and mechanical rooms are also covered.

The Design Guide recommendations cover only the key design attributes without reference to all relevant details in national/local standards or industry code of practices. Even when the latest revision of code is referenced, e.g. NFPA 72 (2019), some AHJs[10] still enforce compliance to NFPA 72 (2016) or older revisions. It is therefore important to verify the actual design per project site location with the local AHJ or even municipal/city level fire ordinances requirements.

For simplicity, only the term 'Early Warning Fire Detection' is used in the Design Guide, it refers to both fire and/or smoke detection capable of detection sensitivity of VEWFD (Very Early Warning Fire Detection) similar to EN 54-20 [16] Class A or EWFD (Early Warning Fire Detection) similar to EN 54-20 Class B. However, for some general warehouses protection, a simple Standard Fire Detection (SFD) similar to EN-54-20 Class C are applied to meet prescriptive (deem-to-satisfy) fire detection compliance.

1.3 Overview

Table 1 below is an overview of this Design Guide.

Table 1 Logistics & Distribution, Storage Warehousing Design Guide overview

Chapter	Overview
1	Introduction and scope of this Design Guide
2	Logistics and Warehousing, environment and protection needs
3	Securiton Early Warning Detection and prevention methods
4	Detection design for level of protection optimisation
5	Securiton 360° Fire Protection Solution outline
6	Inspection, Testing and Maintenance
7	Software and Application support from Securiton
8	List of references and literature
Appendices	Additional details on codes; illustrations of design and related accessories

Keywords: Warehousing, Storage, automation, Refrigerated Storage, Record Storage, High-bay, high airflow, freezer, extreme high or low temperature, dusty, hazardous, sprinkler system, ASD (Aspirating Smoke Detector), Early Warning Fire Detection, detection design, detection installation, incipient fires, FACP, ECP, suppression actuation, risk management, fire prevention.

[10] AHJ: Authority Having Jurisdiction.

2 Aspects of Fire Safety and Prevention

Fire safety challenges

Logistics & Distribution, Storage Warehousing facilities store a wide range of materials and products in mostly high-density bulk storage, block stack-up storage or high-bay racking storage. Tall building structures and multilevel mezzanine structures, coupled with narrow aisle width present a challenge for detecting a fire at its incipient or early development stage. Stratification in many warehouses utilising natural ventilation can further impede the smoke detection, when conventional point type smoke or heat detectors are installed close to the roofline. Additional challenges to the Line Type Smoke Detectors or flame detectors installed below the roofline include the obstruction of racks or operation of warehouse machinery such as forklifts.

Sprinklers in combination with adequate fire detection is desirable

A relatively high percentage of warehouses have sprinklers installed. Although ceiling-level sprinklers are installed under ceilings as high as 13.8 m (45 ft) [17], [18], many high-bay warehouses also have an in-rack sprinkler system installed [11]. This is due to the ineffectiveness of ceiling level sprinklers to control a fire with a significant fuel load, rapid vertical fire propagation and fire spread from one aisle to another. As such, multilayer fire detection or ceiling level fire detection combined with risk-based local detection is desirable for early detection of a fire incident regardless of where it originated.

Challenging environments

Control of mechanical ventilation (such as the use of big fans in non-ambient-controlled warehouses) may be important for the ceiling level sprinklers to be effective. For other challenging environments such as deep freezers in refrigerated storage, extremely low temperatures paired with condensation issues also present unique challenges to the proper use of Early Warning Fire Detection systems.

Fire damages cause unacceptable loss and downtimes

On the other hand, business continuity is paramount to deliver high levels of service for all large distribution centres and for high-value manufacturing processes to ensure Just-in-Time (JIT) production and delivery. A fire in 2019 destroyed one of the robot-controlled distribution warehouses of a UK retailer resulting in over £ 6 m direct stock loss, company shares dropping by 10% in a day, with the fire burning for days affecting neighbouring businesses due to the risk of a toxic release or a large cylinder explosion [19]. Any operation interruption due to a fire event similar to this could lead to an unacceptable extended service downtime to customers.

A central element of best fire safety practices is the use of Early Warning Fire Detection. This chapter highlights the following key aspects of fire safety and fire prevention in Logistics & Distribution, Storage Warehousing facilities:

- Hazard profile and risk management
- Warehousing and operation characteristics
- Challenges to Early Warning Fire Detection
- Risk and Performance-based Design (PBD) with Securiton Early Warning Fire Detection

2.1 Hazard Profile and Risk Management

Electrical equipment is a major cause for fire

Excluding intentionally lit fires, electrical distribution, lighting and heating equipment are by far the major causes of fire in the warehouses and storage facilities [20]. A high sensitivity smoke detection system is ideal for large open spaces. While good housekeeping may reduce the likelihood of a fire from happening, the vast size of the facility and significant amounts of stored goods in high density, present challenges to risk mitigation and risk management under some unique hazardous conditions.

Fire hazards, commodity classifications

Fire hazards inside Logistics & Distribution, Storage Warehousing facilities are generally assessed in line with the classification of occupancy as well as commodities (for example NFPA 1 [13] and FM Global DS 8-1 [21]). Where specific to storage fire safety, material, waste and hazard of contents are further divided into varieties of classes (e.g. FM Global DS 8-9 [11] Storage of Class 1, 2, 3, 4 and Plastic Commodities). Flammable and combustible liquids storage is addressed separately because relevant fire hazards in these storages require suitable fire protection measures.

Extended codes and standards

To enhance risk management, fire prevention and fire protection further, FM Global develops a comprehensive suite of property loss prevention Data Sheets for various warehouses and storage facilities. They cover Refrigerated Storage [22], Rubber Tire Storage, Baled Fiber Storage, Coal and Charcoal Storage, Storage of Hanging Garments, Roll Paper Storage, Storage of Baled Waste Paper, Rolled Nonwoven Fabric Storage, Idle Pallet Storage, Storage of Wood Chips, Storage of Carpets and Carousel Storage and Retrieval Systems. In addition to these covered by FM Global, NFPA codes are also extended to include some other unique storage facilities, such as Guide for Fire Protection for Archives and Records Centers [23] and Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG) [24].

Fire incidents affect operation and services

Most, if not all Logistics & Distribution, Storage Warehousing facilities are designed for processing and distribution of goods either for their own businesses or as a service hub connecting businesses to their customers. Business continuity and avoiding any loss due to fire are paramount. Regardless of storage occupancy or type of commodities handled, Early Warning Fire Detection is a key to risk management of these storage facilities to ensure a high level of service availability and reliability. Naturally, any fire or non-fire incident, such as a false fire alarm can result in significant downtime of the facility's operation and services.

Business Continuity benefits from Early Warning Fire Detection

Figure 1 illustrates how business interruptions and potential losses due to fire damage may be avoided by installing a fire detection system. A reliable Early Warning Fire Detection system further increases the benefit by issuing the call to the fire service a lot earlier (a) as opposed to a standard fire detection system (b). Without a fire detection system, business continuity will rely only on the sprinkler suppression and delayed fire services arrival for manual firefighting. With an Early Warning Fire Detection system, fire incidents or small fire situation can be managed during its incipient stage to avoid business interruption and damages, or at least keep them minimal. Even as the fire situation progresses, fire services can be notified automatically and arrive at the scene much earlier before the fire spreads. With pre-action suppression systems installed in the facilities and ensuring the effectiveness of ceiling level sprinkler operation, staged detection system alarms can control mechanical ventilation as needed and actuate the pre-action suppression. A reliable Early Warning Fire Detection system provides pre-signal alerts so potential fire incidents are dealt with well before any interruption to the service occurs, resulting in minimal interruption to the business and loss in stored goods.

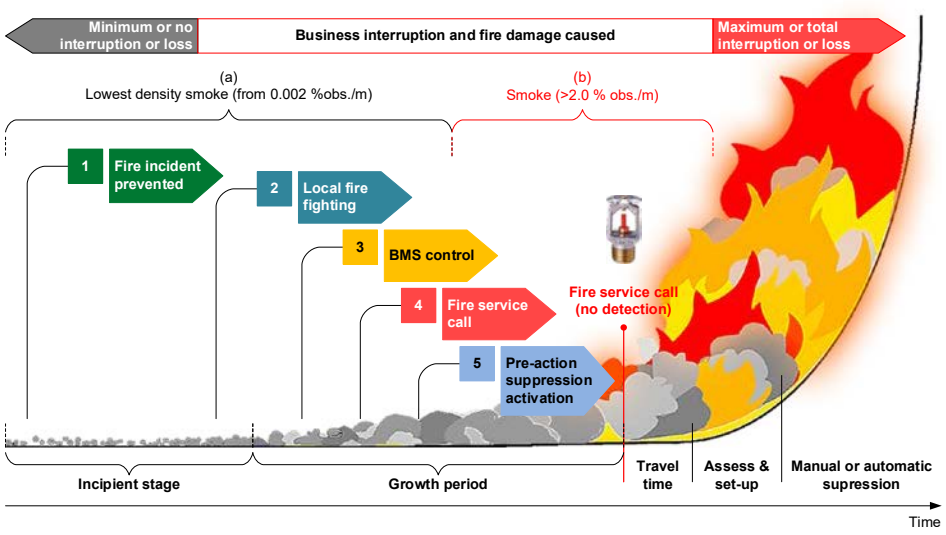


Figure 1 Impact of detection system on business continuity and loss due to fire damages

2.2 Warehousing and Operation Characteristics

Warehouse design and operation considerations

While warehouse design and construction are done to meet requirements of the facility owners or operators, common design considerations include facility parameters/dimensions, available local utility for firefighting (e.g. water supply), storage commodity (for occupancy), stock handling, construction methods (wall, floor and roof). To cater for warehousing operation, considerations are given to types of storage spaces; space configurations, durable and functional requirements, energy-efficiency, safety and security of people and goods, health and comfort level, as well as emerging issues throughout the life of the building such as change of occupancy or expanded use of AS-RS equipment as a retrofit [25].

Assessing fire system design

Fire system design includes the assessment of potential ignition sources, the suppression methods and agents, detection and/or suppression release, the presence of AS-RS equipment and local suppression, the probability for failure of detection and suppression system and last but not least, local fire services response as well as its firefighting priority.

Specially designed warehouses meeting strict requirements can also provide liquid storage (fuel and non-propellant), flammable and combustible storage, radioactive material storage, hazardous chemical storage, and ammunition storage.

Common features in modern warehouse design

Features already common in modern warehouse designs are higher bays, sophisticated material handling equipment, broadband connectivity access and more distribution networks. A wide range of storage alternatives, picking alternatives, material handling equipment and software exist, in order to meet the physical and operational requirements of the warehouses. Warehouse spaces shall also be flexible to accommodate future operations and storage needs as well as operation mission changes.

Other custom designed storages for defence or government use may also have to follow the detailed guidelines from the respective agencies (e.g. USA DoD Unified Facilities Criteria (UFC) for Warehouses and Storage Facilities).

Although warehouse-like buildings come in different shapes for different purposes, the design of an Early Warning Fire Detection system can follow certain

simple rules. For the purpose of fire detection system design, the following 5 categories of warehouse facilities are the focus of this Design Guide:

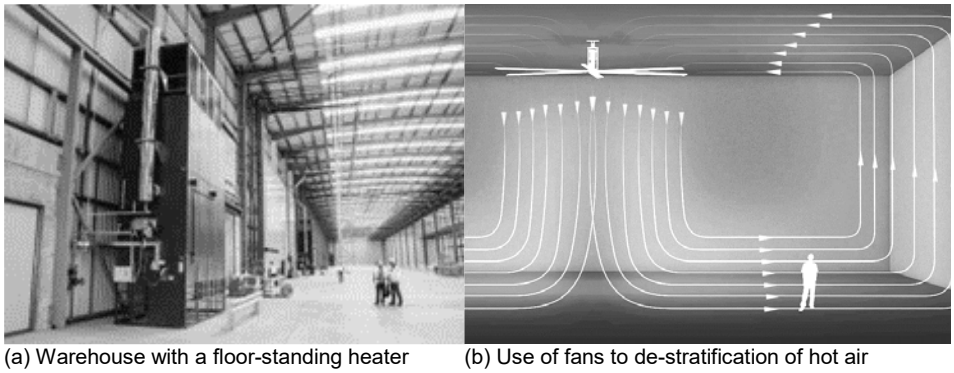
1. Heated, unheated and ambient-controlled warehouses
2. High-bay/AS-RS warehouses
3. Tiered racking/multilevel mezzanine warehouses
4. Refrigerated (deep freezer) warehouses
5. Warehouse-like facilities with challenging environments

2.2.1 Heated, Unheated and Ambient-Controlled Warehouses

Heated and unheated warehouses

The building structure of heated and unheated warehouses can be the same. Unheated warehouses commonly rely on natural ventilation while heated warehouses (through warm or radiant air) require good airtightness during the heating seasons. Warm air rises to the ceiling and causes hot air stratification. To avoid this issue, big fans (mounted below the ceiling level) force the air to circulate. The impact of the higher airflow resulting from the fans must be taken into account when designing the fire detection system.

Figure 2 illustrates a typical large warehousing facility with a floor-standing heating system (a), while in some heated warehouses, large fans may be installed to force air circulation when warmer air tends to congregate around the ceiling (b).



(a) Warehouse with a floor-standing heater (b) Use of fans to de-stratification of hot air

Figure 2 Heated warehouses and hot air distribution

Goods sensitive to ambient conditions need to be stored and handled in an ambient-controlled environment. For example, European Good Distribution Practice Guidelines [26] and WHO generally require pharmaceutical products kept in dry, well ventilated conditions and at a temperature range of 15°C to 25°C (59°F to 77°F). Vaccines must typically be stored and handled in a range of 2°C to 8°C (35.6°F to 46.4°F).

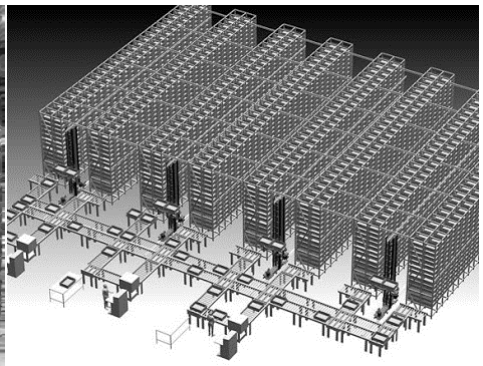
2.2.2 High-bay/AS-RS Warehouses

Rack heights are growing while aisle widths are narrowing

High-bay warehouses are popular due to their high-density storage capacity on a given floor footprint. With the use of robots or varieties of Automatic Storage and Retrieval Systems (AS-RS), the rack height is pushed further while the width of the aisle becomes narrower, typically 1.2 m (4 ft) or less. With the use of in-rack sprinklers and the possible use of AS-RS with built-in integrated detection and suppression modules, the design of Early Warning Fire Detection system needs to take these factors into account.

Figure 3 illustrates a typical high-bay storage and a AS-RS automatic operated warehouse and distribution centre.

(a) Typical high-bay warehouse



(b) AS-RS warehouse with narrow aisles

Figure 3 High-bay and AS-RS automated warehouses

AS-RS play an important role in modern day warehouse automation. With unit-load and mini-load type, they can run operations such as order picking and packing, staging orders for shipping automatically. While reducing people present in the storage area and significantly increasing the racking density and height, the probability of a fire incident being detected by a human in an early stage and the ability to deal with the situation quickly is significantly reduced. But this challenge presents an opportunity to apply Early Warning Fire Detection at the locations where the risks are highest, in addition to the ceiling level detection.

2.2.3 Tiered Racking/Multilevel Mezzanine Warehouses

Consider future installations and expansions

Figure 4 illustrates typical tiered racking system and racks on multilevel mezzanines. One key design consideration for an Early Warning Fire Detection system is the need for detection in compartments and allowing detectors to cover possible future installation of tiered racking or mezzanine levels in a warehouse. Due to the changes of stored commodities or business growth, which demands additional storage space or layout, this is often best served with such racking configurations.

(a) Multi-tiered racking systems

(b) Multilevel mezzanine warehouse

Figure 4 Tiered racking and multilevel mezzanine warehouses

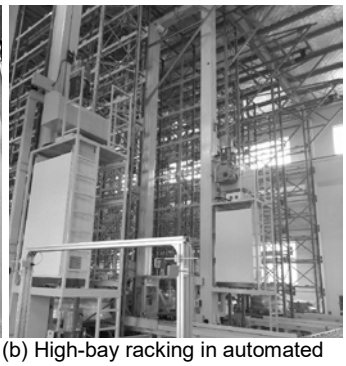
2.2.4 Refrigerated (Deep Freezer) Warehouses

Unique fire hazard characteristics and challenging conditions

Refrigerated storage facilities usually consist of deep freezers with operating temperature typically in the range of -30°C to -15°C (-22°F to 5°F), chillers from -9°C to 2°C (16°F to 36°F) and coolers and loading bays at 0°C to 18°C (32°F to 65°F). Special design considerations shall be given due to their unique fire hazard characteristics, extreme challenging conditions to the fire detection systems, condensation, and often change of temperature range to suit for operational needs or for the purpose of energy efficiency, which can all affect detection and operation performance if inappropriate detection products are selected.

Figure 5 illustrates refrigerated storage rooms with high airflow blast and open/close automatic roller doors. As online shopping for grocery and other perishable merchants becomes more popular, AS-RS equipment is also used in cold stores with high-bay configuration.

(a) Deep freezer with high airflow blast and roller doors



(b) High-bay racking in automated cold store

Figure 5 Typical refrigerated storage with high airflow blast and AS-RS equipment

2.2.5 Warehouse-like Facilities with Challenging Environment

Other challenging environments

Apart from the deep freezers in refrigerated storage warehouses as described in chapter 2.2.4, other challenging environmental conditions to the design and use of Early Warning Fire Detection System include dusty, high humidity, high air temperature or potentially corrosive or explosive ambient conditions. Although this Design Guide is not dedicated to hazardous areas protection, some industrial or manufacturing processes are commonly located in a warehouse-like building structure where fire detection systems are routinely installed to provide early warning.

Figure 6 illustrates typical dusty environment found in waste recycling plant or a chemical plant with hazardous classification.

(a) Dusty (Waste Recycling Plant)

(b) Corrosive (chemical processing)

Figure 6 Warehouse-like facilities with challenging environment

2.3 Challenges to Early Warning Fire Detection

Fit-for-purpose fire protection faces many challenges

Statistically – among the non-residential building occupancies – the percentage of business interruption, property and life loss due to fire remains high in storage warehousing facilities. Manifold commodities and versatile storage structures, manufacturing processes and different hazard classifications in various warehouse-like building structures are common nowadays. Fire detection and protection solutions need to be effective and fit-for-purpose to manage these and other emerging challenges, like taller buildings and racking systems, much narrower aisle widths (due to the use of AS-RS) and the demand of highly flexible use of warehouse space.

Early Warning Fire Detection ensures business continuity

The use of an Early Warning Fire Detection system poses significant advantages over other conventional detection methods. Proper design of an Early Warning Fire Detection system for specific fire risk mitigation is of fundamental importance to ensure business continuity and prevent property loss, paired with enhanced life safety for people working in the storage facilities. While there are practical difficulties in choosing suitable detection products, SecuriSmoke ASD and REK Early Warning Fire Detection systems address all the key challenges in order to deliver early and reliable fire detection in Logistics & Distribution, Storage Warehousing facilities (see Table 2). For the purpose of completeness, SecuriHeat Line Type Heat Detection systems and SecuriBeam Linear Type Smoke Detectors are also included where applicable.

Table 2 Challenges and solutions (Early Warning Fire Detection)

Challenge	SecuriSmoke ASD, REK and SecuriHeat
Large Open Space	Active aspirating sampling with powerful fans and approval listings
Natural or forced ventilation	Flexible placement of sampling points and spacing between them
Diluted smoke and stratification	Very high, consistent detection sensitivity for incipient fires; position of sampling holes at a lower level
Extreme high or low temperature	Practically no limitation to detector installation location (SecuriSmoke ASD operating temperature range is -30°C to 60°C (-22°F to 140°F), SecuriHeat controller temperature range is -30°C to 70°C (-22°F to 158°F), sensing tube temperature range is -40°C to 300°C (-40°F to 572°F))
Complex design considerations	Unique features such as option of dual detection chambers, maximum number of sampling holes for all levels of sensitivity, add-on intelligent pinpoint detection REK for better addressability and control
Risk-based detection	Flexible sampling pipe and sampling hole placement for detection at multilevel, compartments, in-rack/above-rack, vertical riser type
Obstructed or difficult access	Active sampling technology with detectors and testing points often located in areas easy to access or outside the protected areas, or positioned at locations away from AS-RS in warehouses or machine and equipment in processing plants
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)
Hazardous and challenging environment	With certified accessories and with consideration of overall system design, SecuriSmoke, SecuriHeat and SecuriBeam products can effectively protect these challenging areas
Flexible design caters for change of storage use	Use of Securiton design tools for large scale projects design, give provisions of coverage expansion if needed

2.4 Risk and Performance-based Design

Risk and Performance-based Design are key to mitigate issues affecting uninterrupted business operation

Fire protection professionals work within the prescriptive constraints of the applicable building codes and standards such as NFPA 101 [14] and The International Building Code [27] while applying the best engineering practices to address industry and building occupancy specific needs[11]. In particular, the risks and uninterrupted business operation requirements in Logistics & Distribution, Storage Warehousing facilities shall be adequately addressed. In this regard, a risk-based 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 [28].

Performance-based Design (PBD) is typically implemented when elements of fire safety and protection system design are not covered in the prescriptive codes among others due to unique building structure, environmental conditions, added detection for early warning or extended egress considerations [29]. A PBD approach is commonly adopted for either of the following:

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

While PBD may be required for large distribution hubs or storage warehousing facilities for mixed and flexible occupancies, the majority of them and these warehouse-like structure buildings can be designed to the prescriptive codes meeting the codes and standards for general building and life safety with added detection and protection based on a risk assessment and in addition applying appropriate system design to these targeted risk areas and locations.

Table 3 illustrates how Early Warning Fire Detection system performance, as well as the fire safety goals and objectives are defined.

Table 3 Similarity in Early Warning Fire Detection definitions

VEWFD/EWFD

Sensitivity	BS/EN 54-20 [16] #1	NFPA 76 [30]
Class A or VEWFD	Very high sensitivity: An ASD system is capable of providing very early warning of a potential fire condition, particularly in high-risk areas with the benefits of staged responses.	Systems that detect low-energy fires, before the fire conditions threaten mission critical service, benefits of staged responses with a sampling hole sensitivity alert of 0.66% obs/m (0.2% obs/ft).
Class B or EWFD	Enhanced sensitivity: An ASD system is for applications where an additional degree of confidence is required for the protection of a particular risk such as with unusually high airflow.	Systems that use smoke, heat, or flame detectors to detect fires before high heat conditions threaten human life or cause significant damage to mission critical service.
Class C or SFD	Normal sensitivity: An ASD system designed to give equivalent performance to standard point detection systems meeting the requirements of EN 54-7 [31].	Systems that use fire detection-initiating devices to achieve certain life safety and property protection, in accordance with applicable standards such as NFPA 72 [15].

#1: ISO 7240-20 [32] and AS 7240-20 [33] are derived from BS/EN 54-20.

Differences in prescriptive provisions from country to country

Although there might be marginal differences from one country to another in DtS prescriptive building and fire code requirements on fire detection, a combination of DtS prescriptive and risk-based design approach is the best engineering practice to meet prescriptive requirements as well as to satisfy facility operators' need for business continuity and property protection.

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

Differences exist for example between NFPA 72 [15], BS 5839-1 [34] or VdS 2095 [35] for Aspirating Smoke Detectors (ASD) as the equivalency to point type smoke detectors in normal built environments (e.g. air change rate of up to 60 ACH[12]), coupled with other risk-orientated codes of practices (e.g. FIA Code of Practice [36], BS 6266 [37]) and risk management orientated FM Global Data Sheets related to specific types of storage such as DS 8-3 [38] or DS 8-29 [22].

3 Early Warning Fire Detection Design

A wide product range is advantageous

When combining the prescriptive and risk-based approaches to design a fit-for-purpose fire detection system for Logistics & Distribution, Storage Warehousing facilities, it is important to select advanced SecuriSmoke ASD detection products. SecuriSmoke ASD products allow for a fully 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 REK in-line intelligent smoke detectors.

SecuriHeat LTHD products may be used together with the SecuriSmoke product portfolio where heat detection is suitable.

This chapter outlines design recommendations and methods using SecuriSmoke ASD and REK products to protect Logistics & Distribution, Storage Warehousing facilities in the following application scenarios:

- General large open space and high ceiling
- Multi-tiered racking and multilevel mezzanine
- Risk-based protection and detection methods in extreme or otherwise challenging environments

3.1 Securiton Detection Product Portfolio

SecuriSmoke Early Warning Fire Detection

This Design Guide focuses on Securiton Early Warning Fire Detection (SecuriSmoke ASD and REK portfolio) systems, mainly for storage and warehousing distribution areas, as shown in Table 4 below.

Table 4 SecuriSmoke ASD and REK products

Model	**Key performance parameters** [#1]					
EN 54-20 sensitivity	Total # of holes (Class)			Aggregated pipe length (m)		
	A	B	C	A	B	C
SecuriSmoke ASD 531	6	8	12	75		
SecuriSmoke ASD 532	8	12	16	120		
SecuriSmoke ASD 533	16	50	50	200		
SecuriSmoke ASD 535-1/3	18	56	120	300		
SecuriSmoke ASD 535-2/4	36	112	240	2 x 300		
SecuriSmoke 535 HD (Heavy Duty) [#2]	36	112	240	2 x 300		
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)					
Rating	IP54 (IP66 for SecuriSmoke ASD 535 HD (Heavy Duty))					

[12] ACH: Air Change per Hour

Operational	Temperature	Built-in Relay (Expand)
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 (10-2xRIM35)
REK	0 to +50°C (32 to 122°F)	1 (NA)

#1: Highlight performance parameters as per EN54-20 Approvals
#2: SecuriSmoke ASD 535 HD (Heavy Duty) is to be released in Q2/2020

Additional fire detection products

However, inside some hazardous areas or as part of detection-suppression integration, heat-based detection and control may be desirable for certain fire hazards, for instance the use of Securiton SecuriHeat Line Type Heat Detection as in-rack detection to work with in-rack pre-action suppression systems. In addition, Logistics & Distribution, Storage Warehousing facilities also require other form of detection for general areas. Securiton's other related detection portfolio is listed in Table 5 for reference.

Table 5 Securiton detection portfolio (point type, line type smoke and heat)

Model	Type	Function [#1]
SecuriBeam	Linear Type Smoke Detector (LTSD)	Detect and Control
SecuriHeat	Line Type Heat Detector (LTHD)	Detect and Control
Smoke Switch LRS	Duct Type (Smoke)	Detect and Control
Fire Door Control	Open/Close	Control
Multi-criteria point type	Smoke with Temperature and/or CO	Detect
Smoke Detectors	Point type (Smoke)	Detect
Temperature Detectors	Point type (Heat)	Detect

#1: Products listed with 'Detect' only function are connected to building FACPs such as Securiton SecuriFire Fire Alarm Systems described in chapter 5, Table 17.

3.2 Design Criteria and Remarks

Key terminologies

Airflow and detection sensitivity are two main factors that require a change of SecuriSmoke ASD sampling hole spacing. Table 6 summarises a number of key design criteria for the deployment of Early Warning Fire Detection for the Logistics & Distribution, Storage Warehousing facilities.

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. EOT condition) and the notification of their presence at the ASD detector

Key design criteria

Table 6 Key design criteria (SecuriSmoke ASD)

Model	Key design criteria		
NFPA/FM Global	VEWFD	EWFD	SFD[#1]
Hole sensitivity	3.28% obs/m (1.0% obs/ft)	4.92% obs/m (1.5% obs/ft)	Point type over number of holes

Model	Key design criteria		
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
EN/AS/ISO/BS	Class A	Class B	Class C[#1]
Hole sensitivity[#2]	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[#3]	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[#4]	<60 sec	<90 sec	<120 sec
Reaction time[#5]	<60 sec	<60 sec	<60 sec

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

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

#3: 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.

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

#5: Reaction Time of 60 sec after EOT refers to EN54-20 test requirements for relevant tests to Class A, B or C sensitivity.

ASD PipeFlow design tool

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 (see chapter 7.2.1). PipeFlow offers to calculate a pipe layout in two modes:

1. EN 54-20: 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 [16] 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 6 above for target Class A (VEWFD), Class B (EWFD) or Class C (SFD) design.

Table 7 Sensitivity requirements vs. detection requirements (FIA Code of Practice [36])

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[13]	Smoke is visible but insufficient to be detected by point or beam technologies (per [31] or [39])	Smoke visible and sufficient to be detected by point or beam technologies (per [31] or [39])
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

[13] LOS: Large Open Space

Parameters	Key design considerations		
EN 54-20 Class	Class A	Class B	Class C
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 8 Recommended ceiling heights

Recommended ceiling height limits for ASD[#1]			
ASD Type[#2] **1**	**ASD Type 2**	**ASD Type 3**	**ASD Type 4**
10.5-18.0 m (34.4-60.0 ft)	15.0-26.0 m (49.2–85.0 ft)	25.0-43.0 m (82.0-141.0 ft)	40.0-43.0 m (131.3-141.0 ft)

#1: Recommended ceiling height for ASD varies from generally applicable (Low Limit) to ceiling with design for property protection with rapid fire service attendance time of 5 min. Include sloped ceiling no greater than 10% of ceiling height (High Limit).

#2: 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
Type 4: ASD system with: at least 15 Class B holes

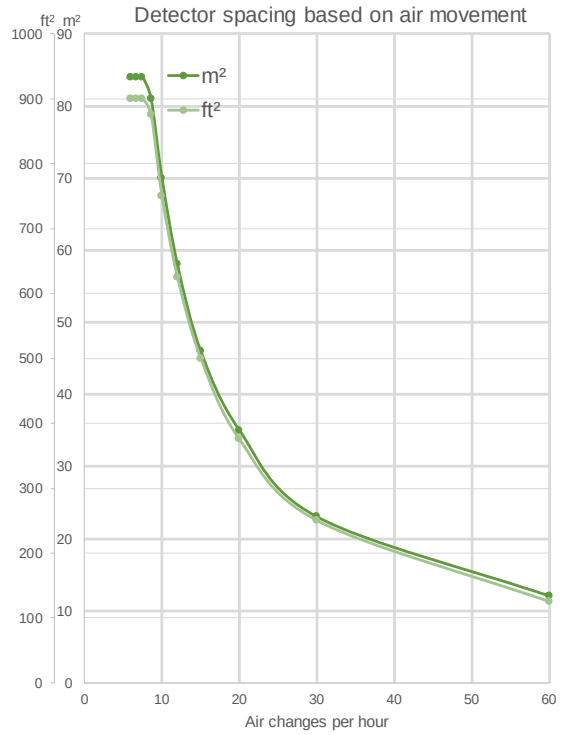
In general, simply follow relevant codes and standards for the design of smoke detection system to meet prescriptive requirements. Two key considerations in design are (a) sensitivity requirements versus detection requirements in relation to the height of the ceiling and (b) the smoke detector spacing (or ASD sampling hole spacing as equivalent) in relation to the airflow.

Table 7 and Table 8 above as well as Table 9 below illustrate the design parameters commonly referred to when designing Early Warning Fire Detection with SecuriFire ASD in accordance with the codes NFPA 72 [15] and FIA Code of Practice [36].

However, individual countries may have different provisions regarding height limits or multilayer detection prescribed as Deem-to-Satify (DtS). Examples of maximum height for the use of ASD in Germany is 20 m (65.5 ft) (DIN VDE 0833-2), in the Netherland it is 45 m (147.6 ft) (NEN2525-C1) and in France it is 12 m (39.4°ft) (R7) [40]. 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.

Table 9 Smoke detector spacing based on air changes (NFPA 72[15]/FM DS 5-48 [41])

ACH	Spacing [m^2 (ft^2)]
60.0	12 (125)
30.0	23 (250)
20.0	35 (375)
15.0	46 (500)
12.0	58 (625)
10.0	69 (750)
8.6	81 (875)
7.5	84 (900)
6.7	84 (900)
6.0	84 (900)



Key design variables

Because each ASD sampling hole in effect represents a single point type smoke 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 general perpendicular downwards to the floor unless mentioned otherwise)

3.3 Detection Design: General Open Space

Design for open areas

For large open spaces such as production and storage processing areas in a Logistics & Distribution, Storage Warehousing facility, a SecuriSmoke ASD Early Warning Fire Detection system is used for ceiling level detection to meet prescriptive code requirements as well as enhanced detection performance design to meet risk-based fire safety objectives and to avoid loss due to fire damages and ensure business continuity.

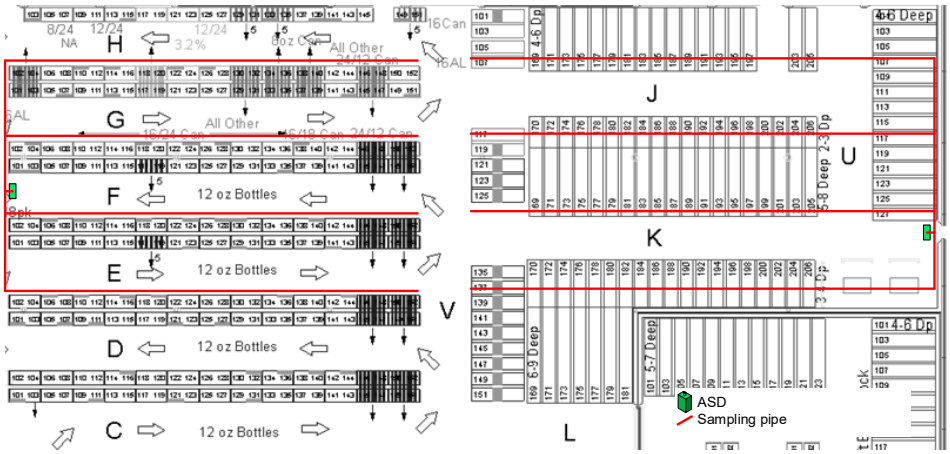
This chapter describes the following three detection methods:

1. Underside Roof (Pitched, Sloped or Flat)
2. Underside Roof with Beam/Joist
3. High-bay Racking and In-Rack Detection

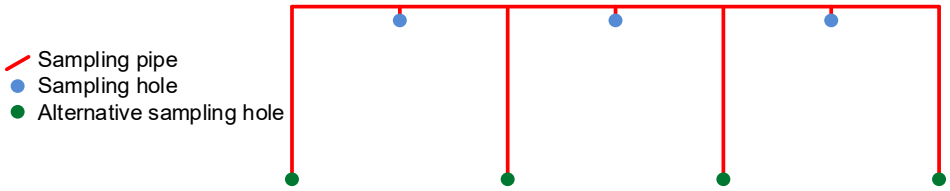
In the context of this document the terms 'roof' and 'ceiling' are use synonymously. Both refer to the upper limit of the structure.

3.3.1 *Underside Roof (Pitched, Sloped or Flat)*

Figure 7 illustrates how SecuriSmoke ASD sampling holes are located underside a flat ceiling.

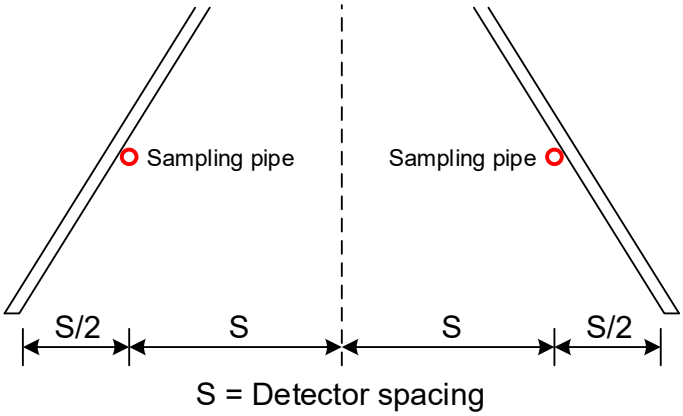


(a) Plan view ADS pipe layout at ceiling level

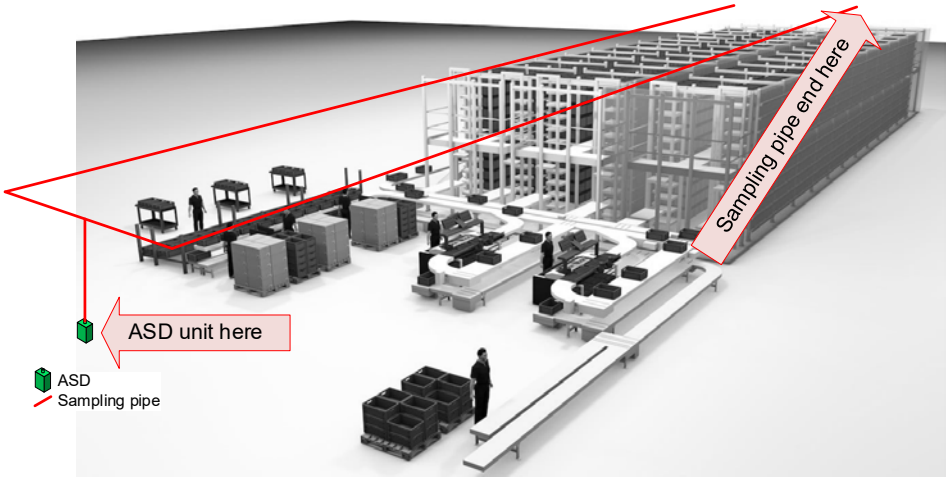


(b) Elevation view of 2-layer or alternate sampling (only when needed)

Figure 7 Fire detection placement (underside ceiling – pitched, sloped or flat)



(c) Pitched ceiling with additional sampling points located inside



(d) Example of ASD Detector Unit location and sampling pipe run away from operation area

Figure 7 Cont'd: Fire detection placement (underside ceiling – pitched, sloped or flat)

Sampling holes

Variable	Design recommendation
Spacing	For general design with regard to sensitivity class and ceiling height, refer to Table 7 and Table 8. For airflow < 60 ACH: From 84 m^2 (900 ft^2) @6 ACH down to 12 m^2 (125 ft^2) @60 ACH, refer to Table 9. If a higher detection sensitivity is required, refer to Table 6 for recommendations for Class A (VEWFD) and Class B (EWFD). Reducing the hole spacing along the pipe can be considered to cater for high ceilings when Class C or Class B sensitivity is used.
Placement	(i) Underside the ceiling; Additional sampling hole(s) may be considered on the vertical pipe run from the detector to the ceiling if local codes require or to enhance detection coverage (ii) Place the pipe in each aisle closer to the top of the rack (Figure 7 (a)) for wider aisles. Research supports that smoke spread inside the rack and exits at the top of the rack. (iii) Always consider a blind end-cap to be located at a lower level, away from all the warehouse handling or processing equipment. It serves as a commissioning and maintenance test point for easy access[#1] (iv) In automated warehouses, always take into account AS-RS equipment and their operating spaces and position the ASD detector unit and the run of the pipes away from these areas. Example is shown in Figure 7 (d)
Orientation	Perpendicular downwards (ceiling level), outwards (vertical)

2-Level detection or alternate level sampling holes	When 2-level detection is required by code or to address the concern of stratification, one way to achieve that is to apply alternate sampling at two different levels by extend every second sampling hole down from the ceiling (Figure 7 (b)), the other way is to incorporate the second layer with in-rack detection (Section 3.3.3). Take into account the minimum clearance between top of the storage to ceiling sprinkler deflectors plus the top tier maximum storage height recommended come to approximately 1.5 m (5 ft) [13] when designing alternate level sampling holes positions, always keep the sampling pipes within warehouse operation safety clearance area.
Sloped roofs	Generally, sloped roofs with a slope no greater than 10% of the roof height are treated as flat ceilings. Large warehouses typically feature a flat roof.
Pitched roofs	Pitched roofs are very rare in large Logistics & Distribution, Storage Warehousing facilities. If the width at the a bottom of the pitched roof is wider than the sampling hole spacing, then additional sampling holes are to be placed inside the pitched area [15] (Figure 7 (c)).

#1: For the initial commissioning and ongoing ITM[14], 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 [36].

3.3.2 Underside Roof with Beam/Joist

Figure 8 illustrates how SecuriSmoke ASD sampling holes are located underside the beams/joist or inside deep beam pockets.

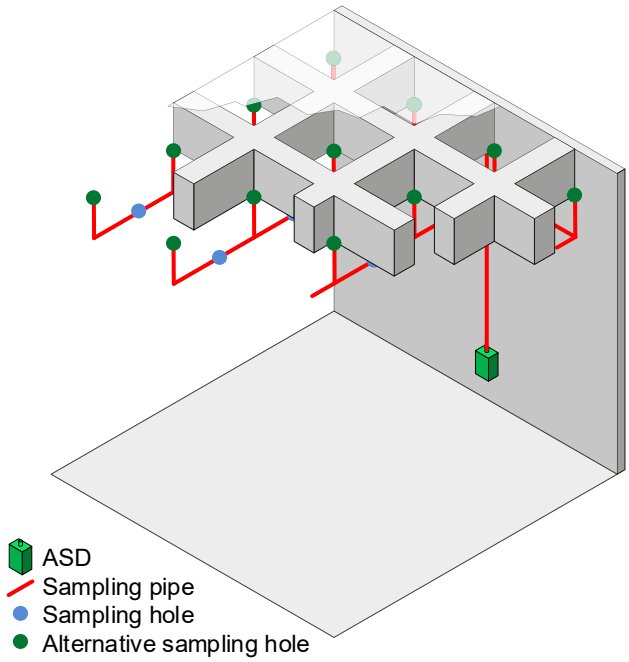


Figure 8 Fire detection placement (underside ceiling – deep beam/joist)

The airflow speed shall 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 fitting the provisions of chapters 3.3.1 and 3.3.2 closest.

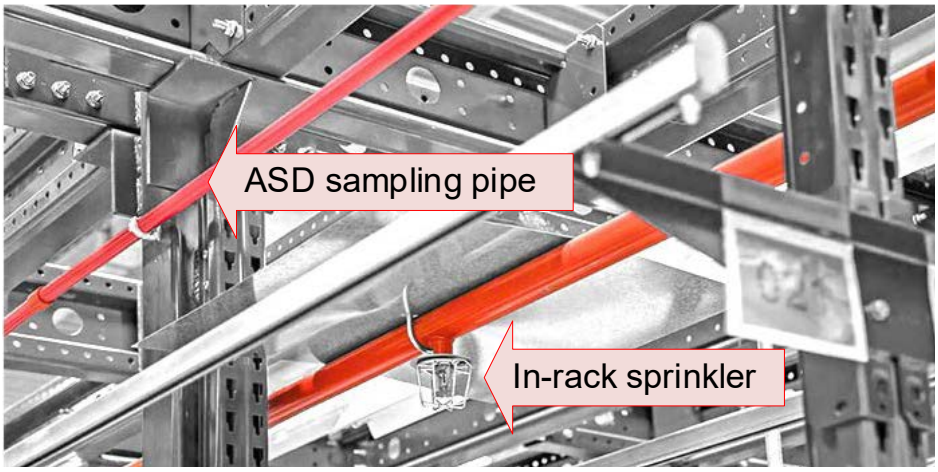
[14] ITM: Inspection, Testing and Maintenance

Sampling holes

Variable	Design recommendation
Spacing	In relation to airflow, refer to chapter 3.3.1 above. Many warehouses have a beamed structure to support the roof, ASD sampling pipes are generally installed under the beams according to the following: 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: (i) 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) (ii) Beam spacing ≥ 40% of ceiling height: a sampling hole shall be placed on the ceiling within each beam pocket (see alternative sampling holes in green). Note that more than one sampling hole may be required to cover a given beam pocket
Placement	Refer to PBD design approach per [42] or prescriptive codes such as NFPA 72 [15], summarised above
Orientation	Perpendicular downwards

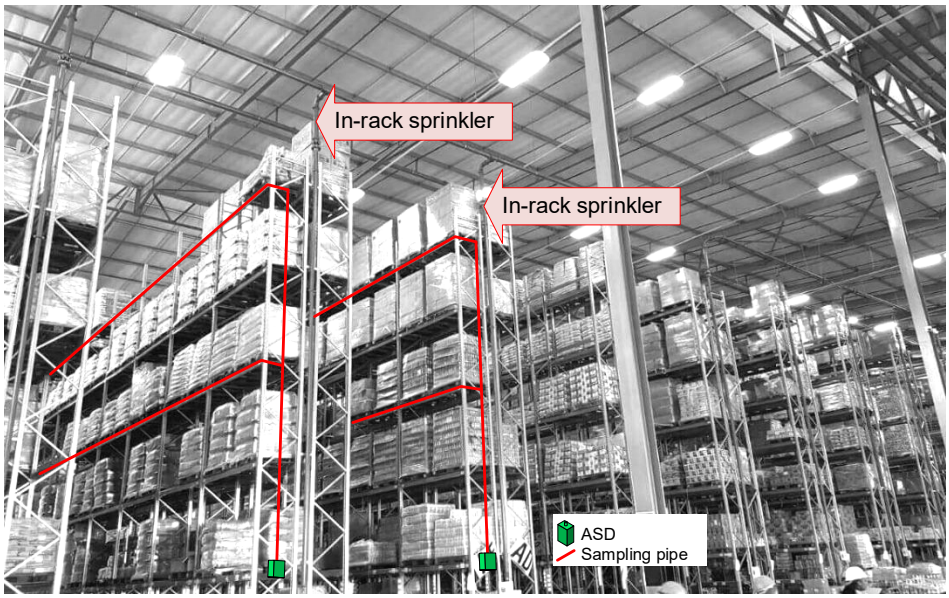
3.3.3 High-bay Racking and In-Rack Detection

Figure 9 and Figure 10 illustrate how SecuriSmoke ASD sampling pipes are positioned for high-bay racking and in-rack detection, in reference to where in-rack sprinkler system are commonly deployed.

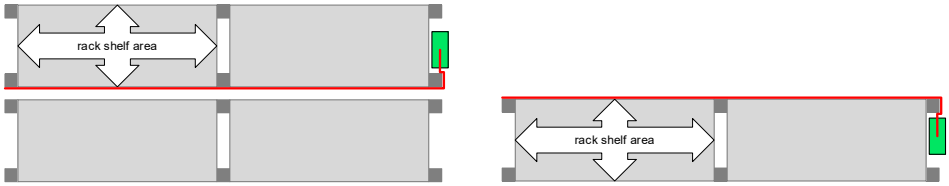


(a) In-rack ASD sampling pipes installed on the side of in-rack sprinkler pipes

Figure 9 Fire detection placement (high-bay in-rack detection)



(b) In-rack ASD sampling pipe spaced at every second in-rack sprinkler pipe



(c) Position of ASD sampling pipe (single and double row rack)

Figure 10 Cont'd: Fire detection placement (high-bay in-rack detection)

Variable	Design recommendation
Spacing	Vertical sampling pipe spacing: (i) Take into account in-rack sprinkler vertical spacing, space the sampling pipes from 4.5 m (15 ft) to 12.0 m (40 ft) (Figure 10 (b)). Exception for reduced spacing may be given in case of solid shelf storing high value or storing sensitive commodities[#1] (ii) The very top of ASD sampling pipe may be aligned with top of the in-rack sprinkler pipe, or at a height that meets local code requirement for 2-level smoke detector installation when ceiling height exceeds prescriptive code provisions Horizontal (transverse) sampling hole spacing: (i) It is recommended to design SecuriSmoke ASD for VEWFD (Class A) or EWFD (Class B) (ii) Sampling hole spacing should not be greater than 4.5 m (15 ft); spacing may be reduced if sampling pipe vertical spacing is wider; for example, if vertical spacing is the maximum of 12 m (40 ft), the sampling hole spacing could be reduced to 3.0 m (10 ft) for better coverage
Placement	Only a single sampling pipe is needed at each level for double-row or single-row rack configuration (Figure 10 (c)). When placing the sampling pipe for a double-row rack, consideration shall be given for possible access to the pipes or sampling holes for ITM purposes
Orientation	Facing to the aisle with the sampling hole angle slightly offset downwards (e.g. 15° to 30°).

#1: Per FM Global DS 8-9 [11] and NFPA 13 [17], max. 9.0 m (30 ft) for cartoned expanded plastics/non-cartoned plastics; max. 12 m (40 ft) for Class 1 through 4 and cartoned unexpanded plastics

Sampling holes

3.4 Detection Design: Multi-tiered and Mezzanine

Warehouse design with mezzanine floors or compartmentation

Many warehouses, such as record storages and big box home centres, use multi-tiered racking systems or construct multilevel mezzanines within the warehouse building structure. This allows for maximum storage volume and for easy access to stored goods (usually smaller in size and lighter in weight compared to bulk or cartoned commodities), without the need of high-bay racking that requires AS-RS equipment or forklifts to transport the goods.

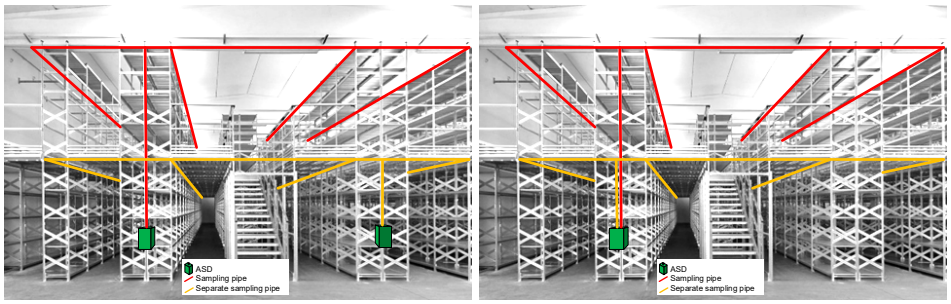
This chapter describes the design of SecuriSmoke Early Warning Fire Detection systems to address the needs for:

1. Separate detection coverage for lower level mezzanines and compartmentation created due to multi-tiered rack configuration
2. Redundant detection capacity to cater for future needs for lower level mezzanines or compartmentation protection as the warehouse layout is evolving

3.4.1 Mezzanine Areas and Compartmentation

Figure 11 illustrates how SecuriSmoke ASD sampling holes are positioned at the lower level of a multi-tiered racking or multilevel mezzanine structure within a warehouse.

(a) Multi-tiered racking with mesh floor where one detector provides multilevel sampling



(b) Separate detector or detector with dual detection chambers cover low level mezzanine

Figure 11 Fire detection placement (Multi-tiered and multilevel mezzanine coverage)

Variable	Design recommendation (lower level detection)
Spacing	(i) It is recommended to design SecuriSmoke ASD for VEWFD (Class A) or EWFD (Class B) (ii) When designed as underside lower level ceiling detection, refer to chapter 3.3.1. (iii) When designed using vertical sampling for lower level(s), spacing the vertical pipes where the pipes can be installed securely, preferably not exceeding 9.0 m (30 ft). (iv) When there are compartmentations to be considered, provide at least two sampling holes inside each compartment or to use REK detectors for location addressability.
Placement	Cover each aisle when designed as lower level underside ceiling detection. Otherwise refer to above 'vertical sampling' Figure 11 for vertical sampling pipe placement.
Orientation	Perpendicular downwards (ceiling level), outwards (vertical).

Sampling holes

For warehouse ceiling level detection related to this chapter, refer to chapter 3.3 above.

3.4.2 Redundant System Capacity for Future Expansion

Warehouse design follows business needs; fire protection must follow any changes

In some new or retrofit warehouses, the rack or storage layouts may be determined in advance but the actual construction of multi-tiered racking or mezzanine levels are done in phases to meet immediate and future business needs. Other demands for flex warehouses also raise the question about how fire detection systems may be designed, so that a change of the overall system will have minimal or no effect when the racking layout configurations are altered in the future.

To ensure a cost-effective solution that can last the expected life time operation, certain redundant performance capacity can be incorporated during the initial design of an advanced Early Warning Fire Detection system with SecuriSmoke ASD to meet both immediate or future expansion requirements.

Designing for future needs

Figure 12 illustrates how SecuriSmoke ASD design could be done to cover both immediate (red solid line sampling pipes) and future (yellow line sampling pipes) installations. The pipe work is designed in such a way that when the new multi-tiered racking or mezzanine floors are constructed in the currently open space, the pipe network can be enhanced from the original design option with minimal effort and without the need to replace the actual ASD detectors.

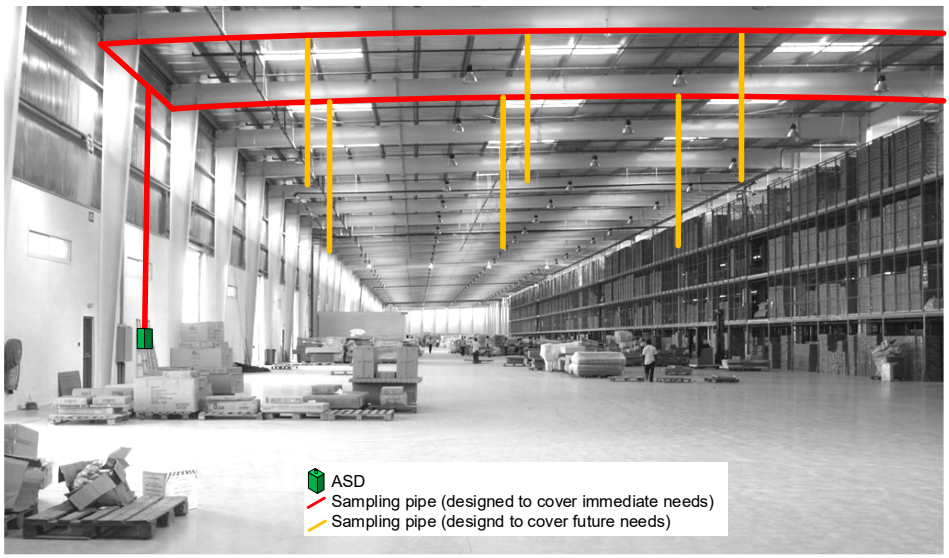


Figure 12 Fire detection redundant system capacity design for future use

Sampling holes

Variable	Design recommendation
Spacing	See chapter 3.3 and chapter 3.4.1
Placement	See chapter 3.3 and chapter 3.4.1
Orientation	See chapter 3.3 and chapter 3.4.1

Use the Securiton ASD PipeFlow design software (chapter 7.2.1) to design two sets of pipe and sampling hole configurations. Ensure that both design parameters meet the detection objectives. Detailed pipe network changes and expected future racking or mezzanine floor layout are clearly documented.

3.5 Detection Design: Risk-Based

Risk-based detection

Apart from warehouse open space protection, other risk-based detection methods may be relevant depending on the site. The concept of the risk-based protection method is to detect smoke where smoke originates and propagates or where the protected areas pose very challenging environmental or hazardous conditions.

This chapter describes the following detection methods that are relevant to some of the warehouse-like structure buildings, namely:

1. Return air grills
2. Localised protection for power cabinets, sensitive rooms or special compartments within a large warehouse
3. Duct detection
4. Detection in challenging environment
5. Special considerations for refrigerated storage
6. Object Protection: Automated Storage and Retrieval Systems

3.5.1 Return Air Grills

Figure 13 illustrates how SecuriSmoke ASD sampling points are positioned in front of return air grills.

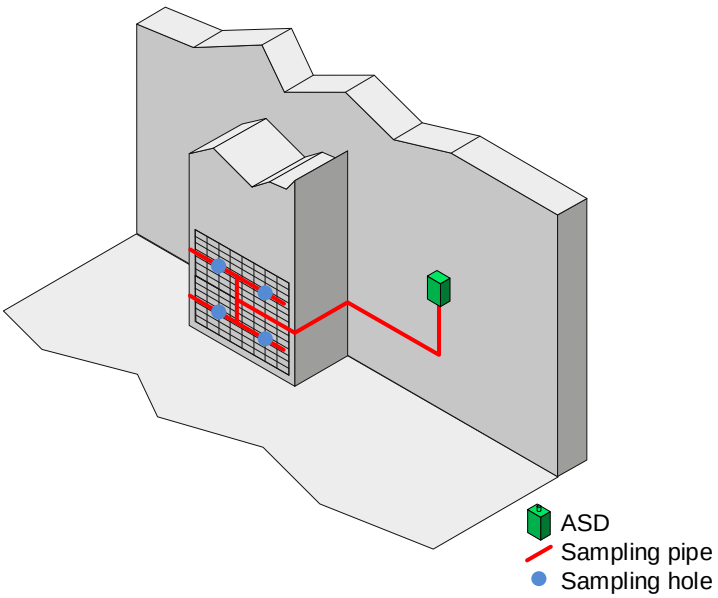


Figure 13 Fire detection placement (return air grills)

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 [36]. 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

Sampling holes

3.5.2 Localised Protection: Plant Rooms and Sensitive Areas

Localised detection

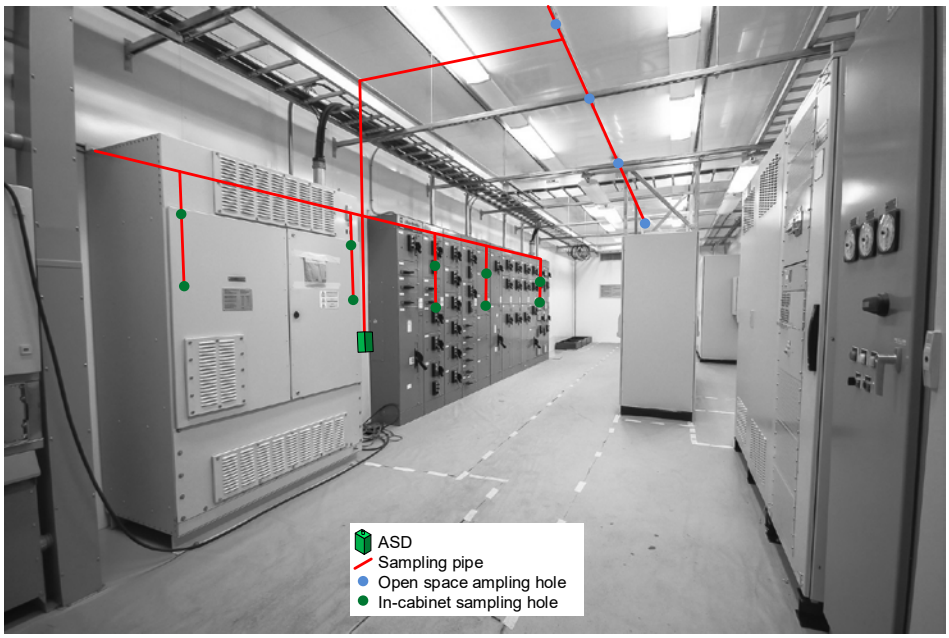
Within a large warehouse, there are plant rooms and other sensitive areas that require Early Warning Fire Detection to ensure continuous operation or protecting sensitive areas in an otherwise standard warehousing structure. Examples are power and mechanical rooms, a modular cooler/freezer or clean room, a small record storage, computer server room or a plant control centre.

Figure 15 and Figure 15 illustrate how SecuriSmoke ASD sampling points are positioned for both room open space and in-cabinet (electrical) detection (Figure 15 (a)) or simple room protection for a standalone structure or inside a plant room (Figure 15 (b)).

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

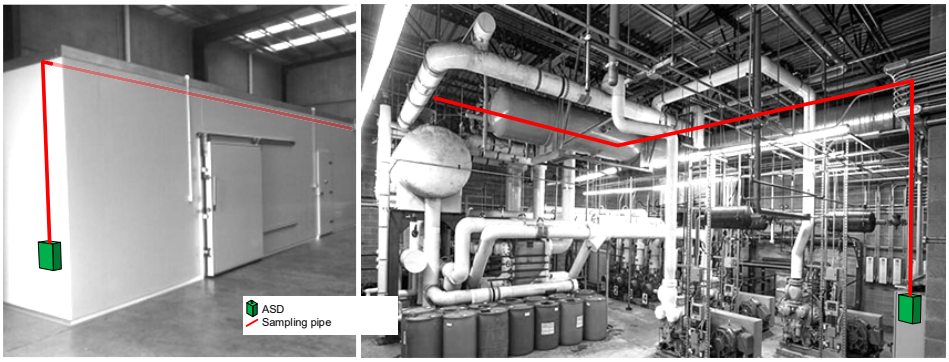
Protecting cable trays

Cable trays are best 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.



(a) Example of one ASD for combined room and in-cabinet sampling

Figure 14 Fire detection placement (localised protection)



(b) Examples of one ASD protecting sensitive area within a warehouse or plant

Figure 15 Cont'd: Fire detection placement (localised protection)

Sampling Holes

Variable	Design recommendation
Spacing	(i) Refer to chapter 3.3 above for general open space (ii) In-cabinet: Nominal 100 cm (40 in), 2 or more sampling holes per inside cabinet
Placement	(i) Ceiling level, Refer to chapter 3.3.1 above for placement (ii) Inside at the rear of cabinet where applicable (iii) Additional sampling holes in or near the hazardous area within the room as needed
Orientation	Perpendicular to the run of the sampling pipes

3.5.3 Duct Detection

Challenges in high-airflow conditions

NFPA 72 [15] 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 [37] 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.

Use SecuriSmoke ASD for in-duct smoke detection

SecuriSmoke ASD can be used for high airflow duct detection (approved to UL268A [43] with maximum airflow of up to 20.3 m/s (4'000 ft/min). Figure 16 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.

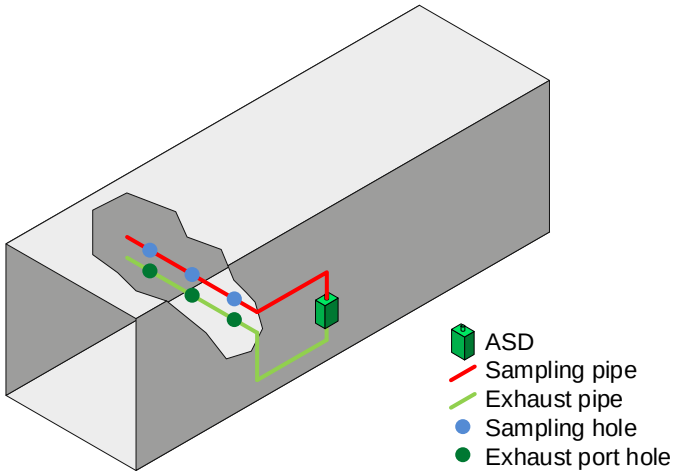


Figure 16 Fire detection placement (duct detection)

Sampling holes (sampling pipe)

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

Pressure balance holes (exhaust port pipe)

Variable	Design recommendation (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

Refer to selected Securiton Aspirating Smoke Detector Technical Description manual for design details. As an example, SecuriSmoke 532 model Technical Description is shown in [44].

It is recommended per NFPA 72 [15] 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).

3.5.4 *Detection in Challenging Environments*

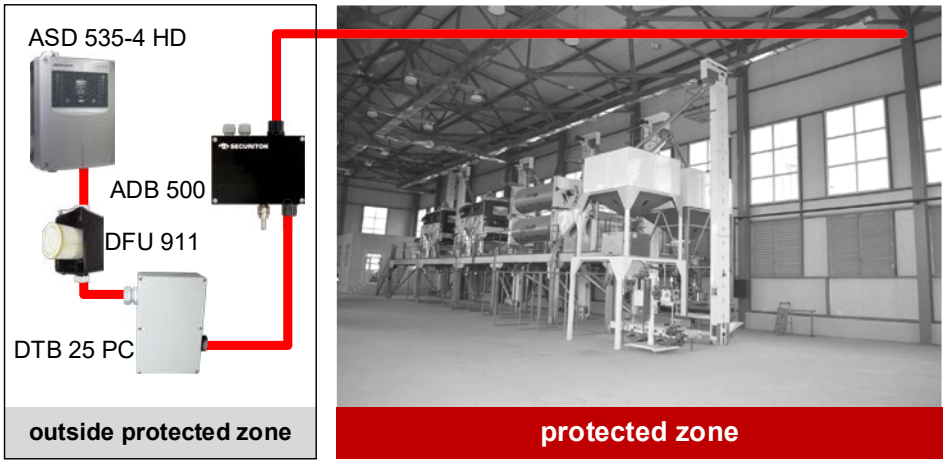
Detection in hazardous areas

Although Securiton SecuriSmoke products currently do not have flameproof or explosion-proof or intrinsic safety certificates for the products to be installed in these hazardous areas, all products do come with FM Global approvals which allow for the products to be installed inside the protected areas with certain hazardous classifications [45]. Due to the differences in classifying hazardous areas between IEC[15] [46] (Zone), NFPA 70 [47] and FM Global (Class/Division or Zone where IEC standards are adopted), the actual hazardous conditions and requirements for detection equipment can vary from project to project. The assessment of suitability of SecuriSmoke Early Warning Fire Detection system shall take into account respective site conditions.

Detection in challenging and harsh conditions

Apart from sites that are deemed as high hazardous areas, many low-level hazardous areas may actually present very challenging environmental conditions to fire or smoke detection, such as very high or turbulent airflow, dust, extremely hot or cold temperatures and high humidity. The SecuriSmoke ASD 535 HD (Heavy Duty), for example, is IP66 rated and can be installed in a location where high enclosure IP rating is required. While many conventional fire or smoke detectors fail in these environments, SecuriSmoke ASD detectors are proven as fit-for-purpose in early and reliable fire detection due to their unique air sampling technology, high quality components and Securiton's application know-how.

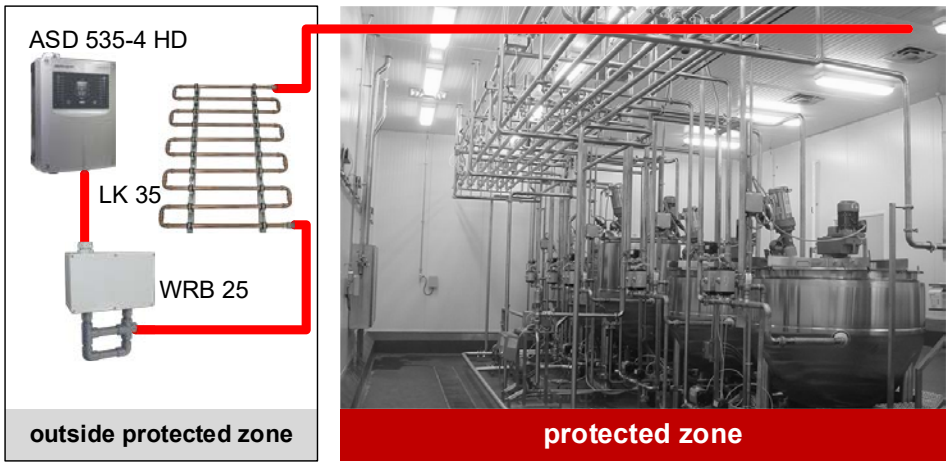
Figure 17 and Figure 18 illustrate examples of SecuriSmoke ASD detector use in some challenging environments and how to select Securiton approved accessories to ensure a reliable installation and performance.



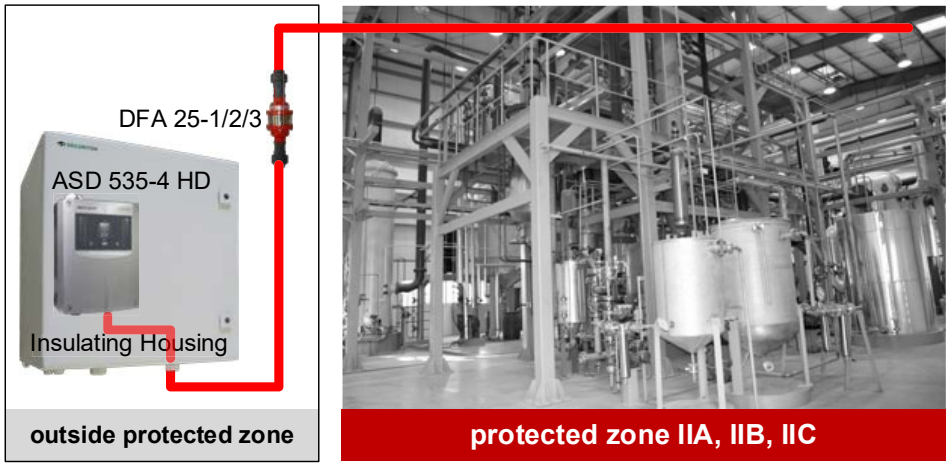
(a) High IP rating enclosure and very dusty environment (e.g. grain storage)

Figure 17 Fire detection placement (example use for harsh environment protection)

[15] IEC: International Electrotechnical Commission



(b) Extremely high temperature and/or humidity



(c) Work with certified flame arrestors

Figure 18 Cont'd: Fire detection placement (example use for harsh environment protection)

Sampling holes

Variable	**Design recommendation (SecuriSmoke)**
Spacing Placement Orientation	Refer to chapter 3.3 and chapter 0 for SecuriSmoke products design recommendations in terms of detector sampling pipe layout and sampling hole locations.

Use of SecuriSmoke accessories

Accessory	**Description** (see Appendix C: for more details)
DTB 25 PC	Dirt trap box
ADB 500	Automatic blow-out device
WRB 25 PVC/ABS	Water retaining box
LK 35 PVC/ABS	High temperature air cooler
DFA 25 1/2/3	Flame arresters
ASD Housing Ex	IP54 steel enclosure

Refer to selected Securiton Aspirating Smoke Detector Technical Description manual for accessory selection and application design details [44].

3.5.5 Special Considerations for Refrigerated Storages

Ensuring detection performance in icy conditions

Refrigerated storage fire protection poses unique challenges, including the reliability of Early Warning Fire Detection system in freezers where temperatures can be as low as -30°C (-22°F) (see also chapter 2.2.4), and change of storage temperature for different storage rooms to meet changing demands. Due to significant difference in temperature, condensation and its subsequent ice build-up, particularly in the proximity to automatic roller doors, can result in blocking the ASD sampling holes in these areas. It is therefore important that the detection systems are suitable for an installation inside the freezer and that there is way to manage blocked sampling holes to ensure detection performance.

Figure 19 illustrates how SecuriSmoke ASD can be installed inside a deep freezer with option of using heated sampling points.

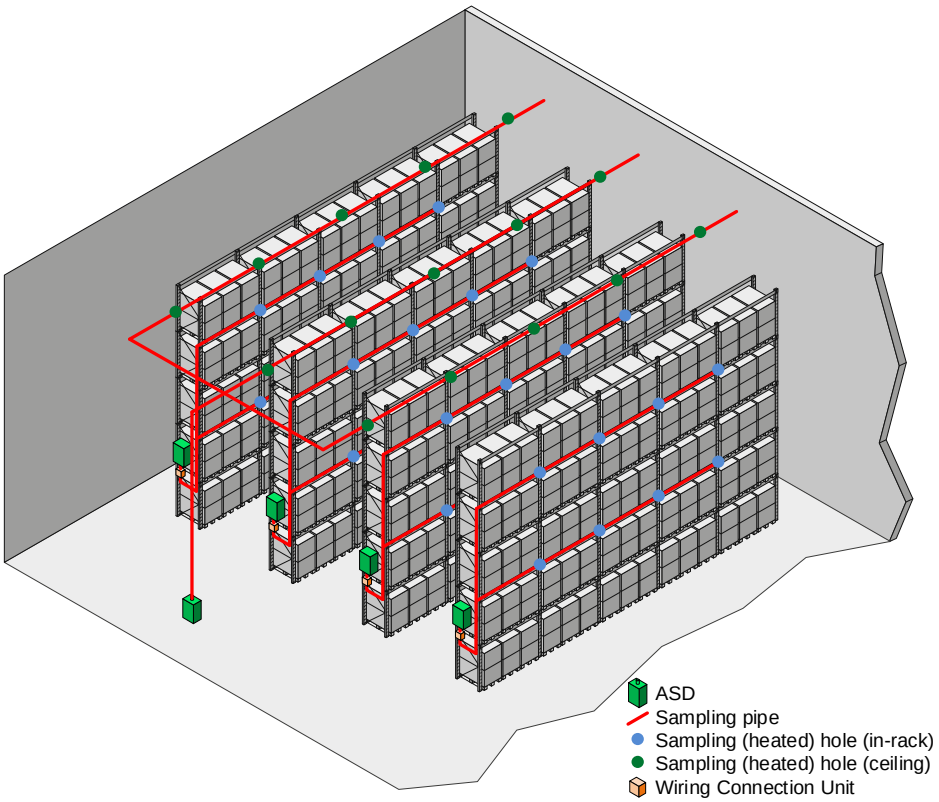


Figure 19 Fire detection placement (deep freezers)

Sampling holes

Variable	**Design recommendation (SecuriSmoke)**
Spacing Placement Orientation	Refer to chapter 3.3 and chapter 3.4 for SecuriSmoke products design recommendations in terms of detector sampling pipe layout and sampling hole locations.

Use of SecuriSmoke accessories

Accessory	**Description** (see Appendix C: for more details)
HEAT PVC/ABS	Sampling point with heating in various sampling hole sizes (3.0, 3.5, 4.0, 4.5 and 5.0 mm) to prevent build-up of ice (thus blocking the sampling hole) caused by condensation
WCU 535	Wiring connection unit

Refer to selected Securiton Aspirating Smoke Detector Application guidelines for deep-freeze warehouses[48].

4 Optimising Level of Protection

Fit-for-Purpose

Optimising the level of protection for Logistics & Distribution, Storage Warehousing facilities, when using advanced SecuriSmoke ASD-based Early Warning Fire Detection 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 large ceiling fans and high airflow heating device), power-down processes and suppression actuation

4.1 General Areas

Detection products for general areas

A summary of Securiton detection products for general areas in or around Logistics & Distribution, Storage Warehousing facilities, is shown in Table 10 below.

Table 10 Detection design considerations (general areas)

General Area	Design considerations
Administration (offices and hallways) Loading docks General operation support rooms	• SecuriStar point type multi-criteria detectors for other areas and high nuisance or false alarm areas such as kitchen areas • SecuriBeam projected-beam detectors for high ceiling areas • SecuriSens Line-Type Heat Detection for loading docks and underground parking lots

4.2 Storage and Challenging Environments

Detection products for critical operation areas

Table 11 is a summary of Securiton detection products for critical operation areas within Logistics & Distribution, Storage Warehousing facilities.

Table 11 Detection design considerations (critical areas)

Critical Area	Design considerations
Main storage and warehouses Distribution and processing Sensitive operation support rooms Areas with challenging environmental conditions Hazardous areas #1 Mobile facilities	• Mainly use SecuriSmoke ASD Early Warning Fire Detection system • SecuriHeat Line Type Heat Detection (LTHD) systems considered for in-rack detection, cable trays, loading docks, hazardous areas and where heat detection is required • May be installed where coincidence/cross-zone[16] smoke detection is required for suppression systems (pre-actuation sprinkler, water mist or clean agent gaseous suppression) • For high-sensitive areas (e.g. plant rooms, on-site records storage and computer server rooms) • 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 for early warning and property protection

#1: Examples of challenging environments and hazardous areas include deep freezers, furmigation (e.g. tobacco storages), wet/washing-down (e.g. food processing), dusty (e.g. waste recycling plant), heavy industries (e.g. steel mills, furnance), frequent gas discharge (e.g. hot works, fertiliser processing and storage), high hazard classification (e.g. chemical, Oil & Gas).

[16] A.k.a. 'double knock' or interlock or double-interlocked

4.3 Controls and Integration

SecuriSmoke ASD offers five alarm levels

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 overheating incident provide the early warning needed to prevent the situation from developing into a real fire event. Table 12 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.

Table 12 Typical use of SecuriSmoke ASD multilevel alarms

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

The main objective: gain time

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 (see Appendix A:).

4.3.1 Early Warning Incident Response

Staged response plans for incidents and emergencies

SecuriSmoke Early Warning 'Pre-signal1' and 'Pre-signal2' signals can be used in a logistics warehousing facility's Incident and 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

Power-down schemes

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 13 is a summary of typical detection and automatic power-down schemes using SecuriSmoke 'Pre-signal3' alert or 'Alarm'.

Table 13 Typical detection and power down schemes

Suppression	Automatic power-down (SecuriSmoke 'Pre-signal3' or 'Alarm')
Clean agent only	Initiation of a power-down sequence of AS-RS equipment, either automatic or automatic with time delay
Automatic sprinkler system only	Initiation of an automatic power-down sequence of AS-RS equipment, 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

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.

Examples for controlling other BMS components

Other BMS components, for instance mechanical forced fans or large ceiling fans used in warehouses, may be controlled through these SecuriSmoke alarm signals depending on the sequence and purpose of the control. One practical example is upon detection of a fire incident in an early stage, to turn off the large ceiling fans so their operation does not impede the effectiveness of ceiling level sprinkler operation. Another example is when in-rack SecuriSmoke ASD alerts are signalled, to control the surrounding or building HVAC to reduce or stop the air flow in order to ensure effective suppression system operation and to avoid or delay fire spread before the fire incident can be brought under control.

Good practice

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 EPO[17] switch/button, remote manual, ventilation switch/button, etc. for powering down in affected zone(s)
- Use manual remote override to disconnect control for 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.

4.3.3 Detection and Suppression Actuation

Clean agent suppression systems

While sprinkler and pre-action sprinkler systems are common to protect Logistics & Distribution, Storage Warehousing facilities, a clean agent suppression system may be used in some areas or warehouse-like structures as an addition to achieve full protection in order to accomplish both building safety objectives and protection of critical equipment for business continuity. Minimising the possibility of a full sprinkler discharge can also avoid water damage, thus minimising cost of interruption and recovery.

Water mist systems

Water mist systems are also considered in locations with confined space for installation. Protection against additional hazards inherent in fire-propagating cables, the use of water mist to control or suppress such a fire is accepted as a good practice due to much less water usage. However, the effectiveness of water mist relies on a timely reduction of airflow in the protected space. This can be

[17] EPO: Emergency Power Off

achieved with a SecuriSmoke early warning alert or alarm signal to turn down or turn off the HVAC before the water mist system is activated.

Suppression and Detection

Regardless where and what type of suppression systems are installed, a suitable (and recommended per relevant codes and standards such as [36]) 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 [49], SecuriSmoke ASD is an ideal solution.

Table 14 is a summary of typical detection and suppression actuation schemes using either SecuriSmoke 'Alarm' or 'Alarm2' alarm signals.

Table 14 Typical detection and suppression actuation schemes

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 AS-RS equipment.
Automatic pre-action sprinkler only	Activate pre-action valve with smoke detectors and control panel in accordance with FM Global DS 5-48 [41]. 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 zones, use of REK 511 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.

Detection actuation with sprinkler system refers to the initiation of interlocked pre-action sprinkler system or stage one on a double-interlock system.

4.4 Summary: Use of Securiton Fire Detection

Table 15 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.

Table 15 Summary (use of SecuriSmoke Early Warning Fire Detection)

	Detection design considerations		
Detection location	*Ceiling*	*In-rack*	*Localised*
General areas			
Admin (offices and hallways)	Point / LTSD	NA	NA
Loading docks	Point / LTHD	NA	NA
General operation support rooms	Point	NA	NA
Critical operation areas			
Main storage and warehouses	ASD	ASD / LTHD	ASD
Distribution and processing	ASD / Point	ASD / LTHD	ASD
Sensitive operation support rooms	ASD / Point	NA	ASD
Areas with challenging environmental conditions	ASD / Point / LTHD	NA	ASD / LTHD

	Detection design considerations		
Detection location	*Ceiling*	*In-rack*	*Localised*
Hazardous areas	ASD / Point / LTHD	NA	ASD
Mobile facilities	ASD + Point	NA	NA

Point/LTSD (Linear Type Smoke Detector) (subject to ceiling height); ASD/Point (subject to hazard or sensitivity classification); ASD + Point (additional point type smoke or heat detectors subject to DtS code and suppression activation); NA (generally not required or not applicable); ASD (Early Warning Fire Detection is the best option where smoke detection is required).

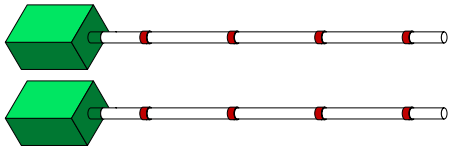
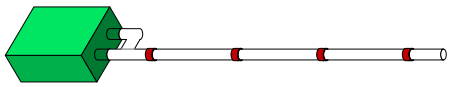
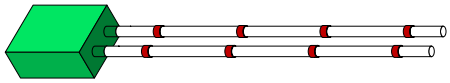
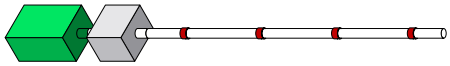
SecuriSmoke ASD, REK and SecuriHeat Line Type Heat Detection (LTHD) are the optimal combination for fire detection design in Logistics & Distribution, Storage Warehousing facilities.

Suppression Schemes

Table 16 is a summary of the use of SecuriSmoke ASD and REK for the purpose of control, power-down and actuation of suppression systems. Some of the suppression actuation schemes are referenced in FIA Code of Practices [36].

Table 16 SecuriSmoke ASD and REK for control and suppression actuation

Suppression actuation schemes for pre-action sprinklers (interlocked, double-interlock), water mist and clean agent gaseous systems

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 + 	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

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.

SecuriFire Fire Alarm Systems (FAS)

Table 17 is a list of Securiton Fire Alarm Systems (FAS) with its baseline approvals. With any of these FASs, all detection portfolios of products listed in Table 5 can be used together with SecuriSmoke (Table 4) Early Warning ASD and REK detectors for Logistics & Distribution, Storage Warehousing facility protection.

Table 17 Securiton Fire Alarm Systems (FAS)

Model	Key performance parameters	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

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

Use of different SecuriFire models can design a main FAS with multiple Sub FAS and Mimic panel configuration which are commonly required for large Logistics & Distribution, Storage Warehousing facilities (see Figure 20 below). For small sites such as power and plant rooms or storage or vault with high valuables, SecuriFire 500 would be a good fit.

Key attributes for total fire protection

SecuriFire centric total fire protection solution emcompasses the three key attributes below:

- Intelligence: Lightning-fast detection of incipient fires; fully redundant hardware and software design; modular and decentralised architecture; Up to 14 addressable loops with 3’500 elements per control unit; highest security standards
- Redundancy: 100% hot standby secondary system; maximum fail-safe design at all levels; secure data transmission via a redundant SecuriLan; tightly meshed diagonal SpiderNet networking technology; constant automatic system checks and remote diagnostics; device bus for external display and control devices connection
- Unique SpiderNet Technology: Up to 16 control units with maximum of 250 loops; can be combined and networked between each other; cover over a maximum distance of 3’500 m (~2.17 mi)

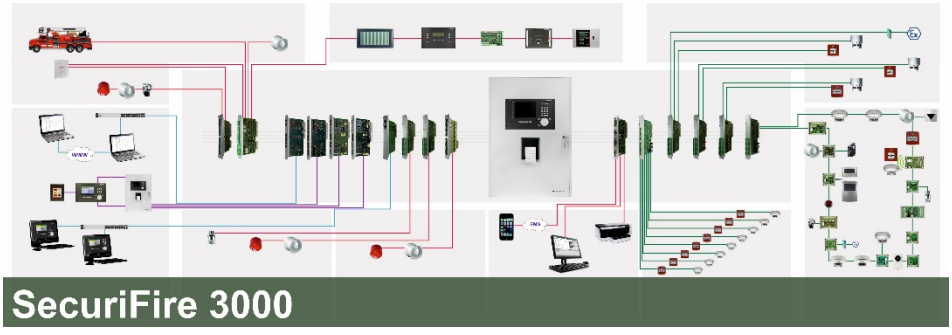


Figure 20 Securiton 360° Fire Protection Solution (FACP and Connections)

6 Inspection, Testing and Maintenance

Testing and services

Most, if not all Logistics & Distribution, Storage Warehousing 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 [50], BS 5839 [34], AS1851 [51] and NFPA 72 [15]. 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.

Table 18 below is a simplified ITM schedule for SecuriSmoke ASD product services. Refer to Securiton product manuals for more details.

Table 18 Summary of Inspection, Testing and Maintenance (ITM) scheme

Service Item	Fault/ Alarm	Trimestrial	Yearly
Cleaning the detector housing exterior (air outlet)	(✓)	?	✓
Cleaning of sampling pipe tube network, accessory parts, airflow sensors	(✓)	?	✓
Replacement of dust filters	(✓)	✓#1	✓
Cleaning of air flow sensor	(✓)	✓#1	✓
Check correct seating (no leakage)	(✓)	?	✓
Check of fault and alarm release	✓	?	✓
Update maintenance protocol	✓	?	✓
Analyse event memory	✓	?	✓
Analyse airflow issues (caused by operational changes)	✓	?	✓

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

#1: As per manufacturer recommendation for production, recycling plants, carpentry workshops and wood processing [52]

Testing methods refer to FIA CoP [36], NFPA 76 [30] (similar to these described in FM Global DS 5-14 [53]) and any local applicable requirements. Refer to Appendix A.2 for test method extracts from FIA Code of Practices (suitable as reference for large open spaces such as these warehouse areas) and NFPA 76 (suitable as reference for smaller rooms, confined spaces or compartments).

7 Operation Software & Application Support

Supporting design, configuration and remote monitoring

This chapter provides related software tools for design, configuration or remote monitoring and managing of SecuriSmoke ASD and related products. Securiton dedicated application support is ready to assist you with specific project needs.

7.1 Monitoring Software (Control Room)

Remote or local 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 an on-site control room or any authorised off-site location or a certified remote monitoring centre.

Manage with Securiton UMS

In general, one way to monitor and manage SecuriSmoke ASD detectors is to use Securiton UMS[18] software. In this scenario the SecuriSmoke ASD detectors are either

- independently networked and connected to the UMS, with simple alarm relays integration to the on-site FAS for alarm and fault notification, or
- are connected via SecuriLine to a FAS of the SecuriFire family, which offers both notification and full control capabilities; the SecuriFire FAS in turn is connected to the UMS.

Manage with a BMS

Another way is to manage SecuriSmoke ASD detectors through an enterprise BMS software. In this scenario the ASD detectors are independently networked and connected to the BMS with help of a gateway. In this scenario, both alarm/fault notification and control are possible.

7.1.1 Rack-mount Standalone FidesNet RCU

Display and Control

Using Securiton FidesNet, multiple ASDs are connected to each other via serial RS485 interface. The FidesPort NCU 900[19] acts also as a gateway for remote access, which supports standard interfaces (such as Modbus TCP or SNMP) to connect to a BMS.

No physical access required

FidesControl RCU 700[20] is a rack-mount, standalone networked SecuriSmoke ASD detectors 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 brining in personal laptop computers into such areas. This drastically improves the controlled access and contractors’ activity tracking for the purpose of site security. 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.

[18] UMS: Universal Management System
[19] NCU: Network Communication Unit
[20] RCU: Remote Control Unit

Figure 21 illustrates the RCU and NCU for display, control and management of networked SecuriSmoke ASD detectors remotely from the protected areas. Key features include:

- Device list: display all or a selection of the devices and the colour-coded status information of the individual networked devices
- Dashboard: display individual channels of a selected ASD with current measurement values (smoke and airflow), and current smoke value in relation to pre-determined alert and alarm thresholds
- Trending: display the measurement values of the airflow and smoke value in graphic charts with both real-time values and recorded values[21], against the pre-determined alerts and alarm thresholds (see Figure 21)
- Other views currently include an event memory and system settings

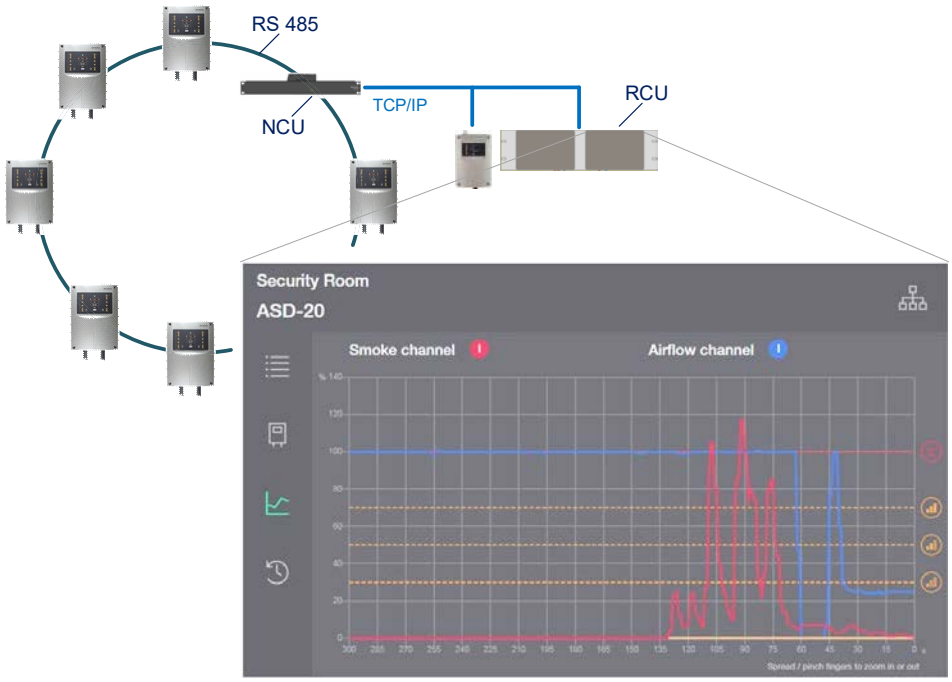


Figure 21 Rack-mount standalone FidesNet RCU display and control

[21] up to maximum of 300 seconds of recorded values

7.1.2 PC-based Universal Management System UMS

Managing all network devices

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 22 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 as mentioned in chapter 7.1.

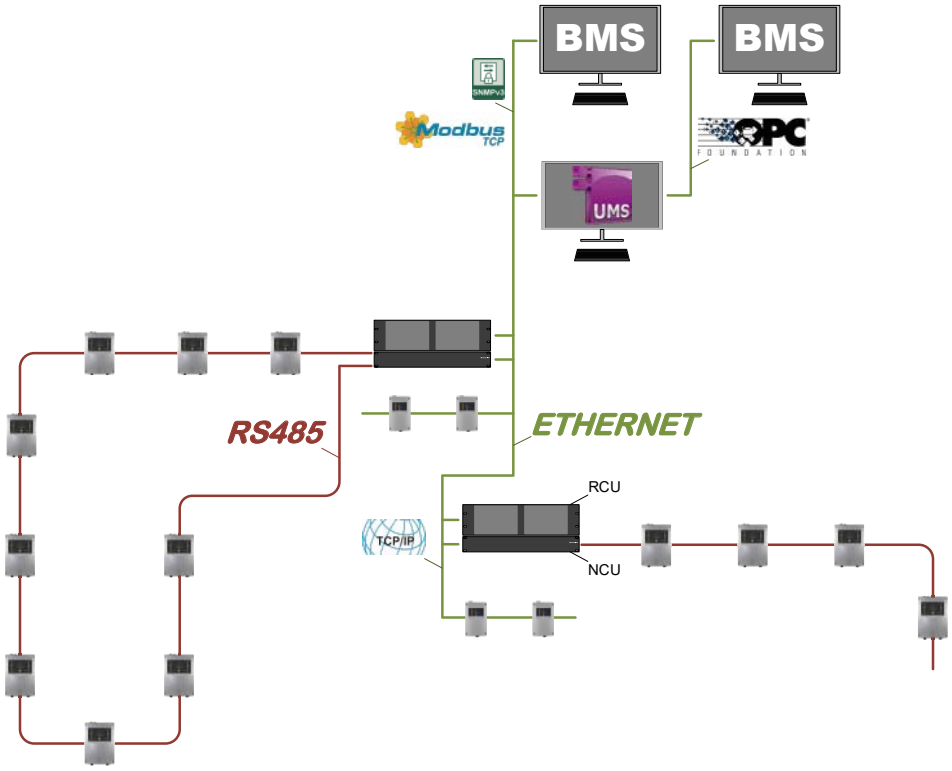


Figure 22 Networked SecuriSmoke ASD managed with UMS

7.2 Application Support

Application support includes mainly:

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

7.2.1 Software Tools

Designing pipe networks with 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 23). 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.

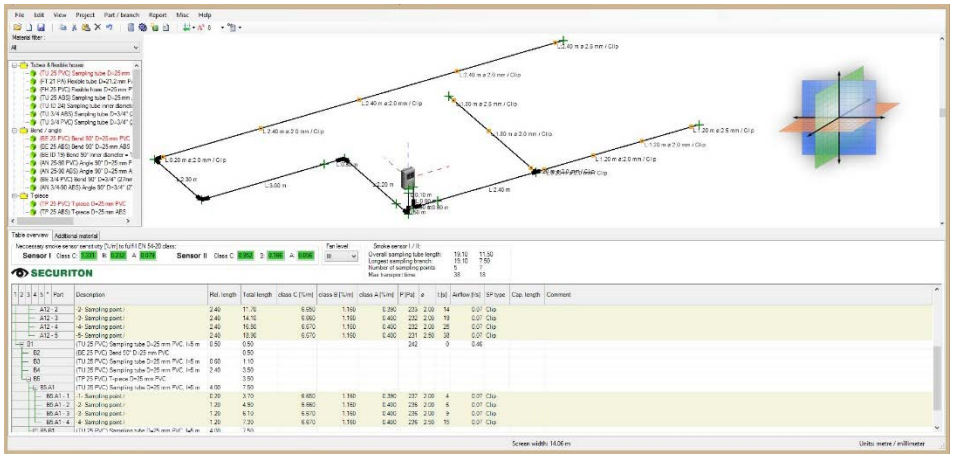


Figure 23 SecuriSmoke ASD design software: ASD PipeFlow

Configuration, commissioning and ongoing ITM for ASD with ASD Config

During installation, commissioning and ongoing ITM on site, SecuriSmoke ASD Config (Figure 24) 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.

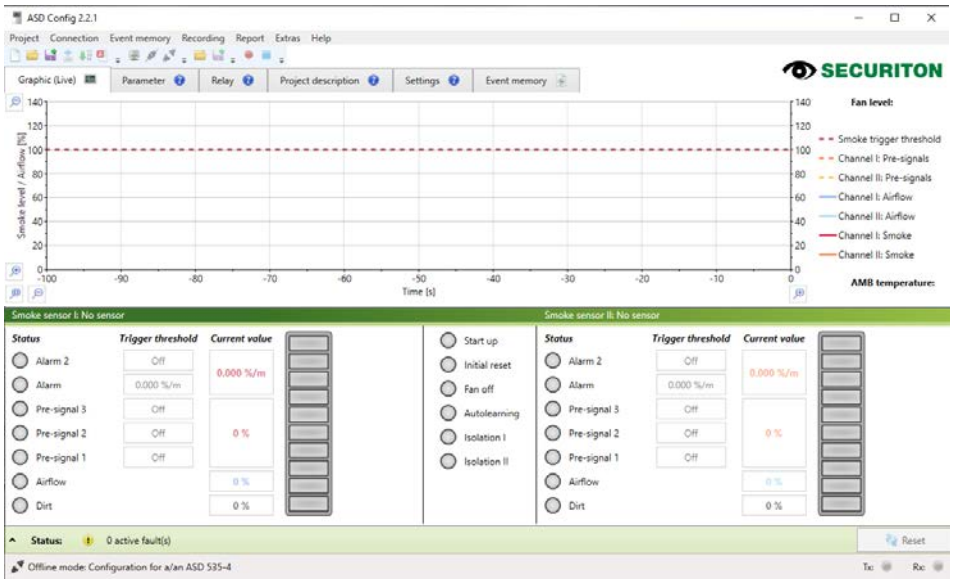


Figure 24 SecuriSmoke ASD configuration software: ASD Config

Configuration, commissioning and ongoing ITM for FAS with SecuriFire Studio

Securiton SecuriFire Studio (Figure 25) is a powerful and modern software tool supporting the design and field engineers during design, 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 manpower required for routine ITM tasks.

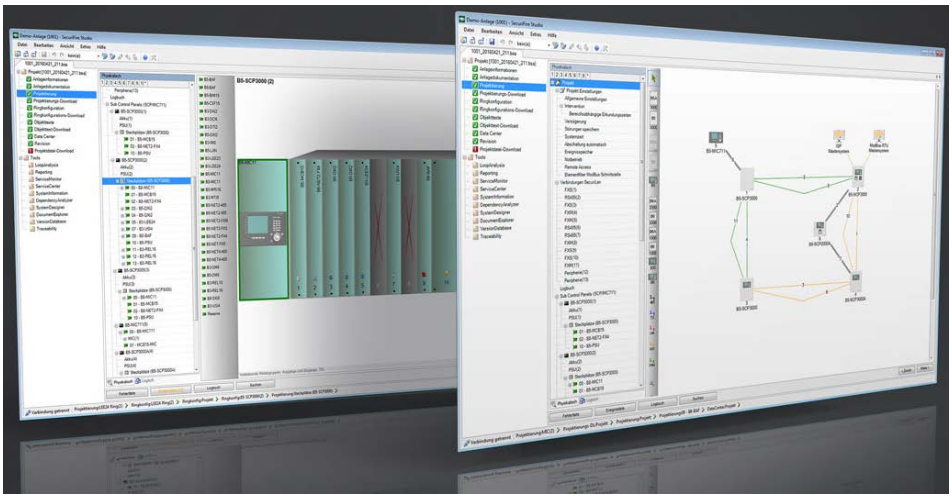


Figure 25 SecuriFire configuration software: SecuriFire Studio

7.2.2 Partner Accreditation Program

Training is a key element

Securiton is committed to provide 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.

Online training platform and training courses

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.

7.2.3 Application and Field Engineering Support

Application 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 support

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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7. FM Global Data Sheet 8-34 (2020) Protection for Automatic Storage and Retrieval Systems, Norwood, MA, USA.
8. FM Global Data Sheet 2-0 (2011), Installation Guidelines for Automatic Sprinklers, Norwood, MA, USA.
9. NFPA, (2018) NFPA 5000 Building Construction and Safety Code®, Quincy, MA, USA.
10. VdS Schadenverhütung GmbH, (2018) CEA 4001en - Sprinkler Systems, Planning and Installation, Pasteurstr, Germany

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 Logistics & Distribution, Storage Warehousing facilities.

A.1 Summary of Codes and Standards

Table 19 is a summary of relevant codes and standards for Early Warning Fire detection system design and applications in the Logistics & Distribution, Storage Warehousing facilities.

Table 19 Summary of codes and standards (Early Warning Fire Detection)

Region	Product Approvals	Design for Use	Install/Commissioning, ITM[#1]
Global	UL 268; UL 268A	NFPA 1; NFPA 101, NFPA 70, NFPA 72, NFPA 76, NFPA 232/232A FM Global DS 5-1, DS 5-14, DS 5-48, DS 8-1, DS 8-9, DS 8-29 ISO 7204-20	NFPA 72 FM Global DS 5-14 ISO 7240-14
EU/UK, MENA, SEA, India	EN 54-20; EN 54-7	BS 6266; VdS 2095 Appendixes, R7 Rules, BS 5839-1, (UK) Fire Industry Association Code of Practice, etc.	FIA CoP, VdS 2095, BS 5839-1
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

#1: ITM (Inspection, Testing and Maintenance) involves

(a) Install and commissioning

(b) System fault report and handling

(c) Periodic services and maintenance

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

A.2 Testing Methods: Early Warning Fire Detection

Most commonly used test methods for Early Warning Fire Detection systems are these described in FIA CoP and NFPA 76 (see Table 20).

Table 20 Typical Early Warning Fire Detection performance test methods

FIA CoP 2012 Appendix A – ASD System Performance Tests

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)

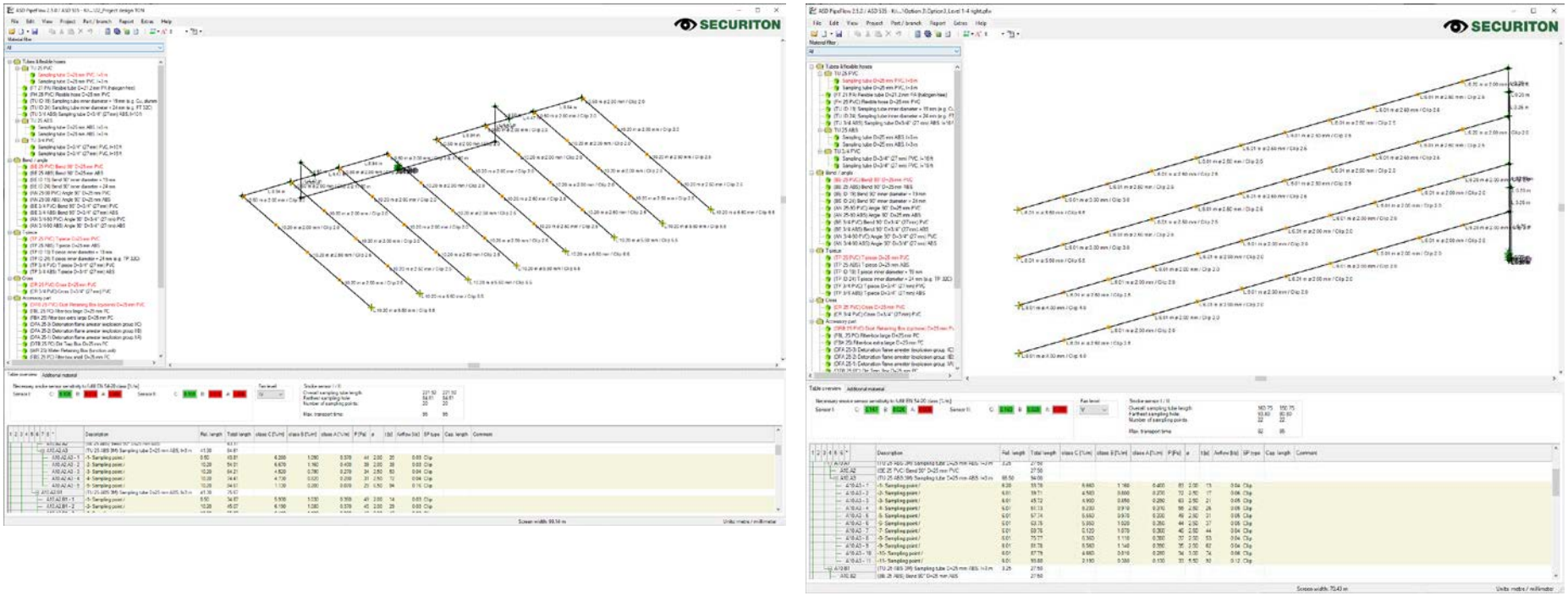
NFPA 76 Annex B Performance Test Procedures for VEWFD and EWFD Systems

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: Illustrations of Securiton ASD PipeFlow Design

This Appendix provide illustration of typical SecuriFire ASD pipe network design using Securiton ASD PipeFlow software tool (see Figure 26 below).



(a) Warehouse (general open space)

(b) Warehouse (4-level detection)

Figure 26 Illustration of Securiton ASD PipeFlow software tool (warehouse applications)

Appendix C: SecuriSmoke ASD Accessories

This Appendix provides a summary of SecuriSmoke ASD accessories (see Table 21) for challenging environments:

1. Dusty
2. High humidity or high air temperature
3. Intrinsic safety or potentially explosive
4. Deep Freezers

Table 21 Summary of SecuriSmoke ASD accessories for challenging environments

Challenging Environment	Illustration	Description
Dusty		**DFU 911** (large volume) or **FBS 25 PC (small volume)** dust filter unit increases the service life of the smoke sensors used in the ASD and greatly reduces the likelihood of false alarms
		**DTB 25 PC** Dirt trap box used in very dusty rooms. Inserted into the sampling pipe before dust filter
		**ADB 500** automatic blow-out device 1 sampling pipe is automatically blown out and cleaned, to prevent fault messages caused by clogged aspiration points and also to avoid false alarms.
		**MV 25 PVC or MV 25 ABS** Manual ball valve for revision and cleaning works with compressed air
High Humidity or High Air Temperature		**WRB 25 PVC or WRB 25 ABS** Water retaining box Used in rooms with high humidity
		**LK 35 – PVC or LK 35 – ABS** used as an air cooler when the sampling pipe is in a room >60°C. Can also be used as a water separator in rooms with high amount of air humidity and / or condensing water because of temperature differences
Potentially Explosive		**DFA 25-3 (**Equipment category IIC) or **DFA 25-2 (**Equipment category IIB) or **DFA 25-1 (**Equipment category IIA) Detonation flame arrester for explosion zones
		**ASD Housing Ex** IP54 Steel used as additional personal protection in explosive areas or serve as a mechanical protection measure
		**GC 25 Ex** Grounding Clamp for 25mm ASD pipes with ATEX certification. Copper or stainless-steel piping
Inside Deep Freezers		**HEAT 3.0/3.5/4.0/4.5/5.0 PVC HEAT 3.0/3.5/4.0/4.5/5.0 ABS** in deep-freeze rooms to prevent the freezing of the aspirating holes
		**WCU 535** Wiring connection unit introduction of the supply of the sampling point with heating into the aspirating tube, with internal clamps

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