Airport Facilities

Application Guide

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VESDA®

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Convention	Description
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Convention	Description
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Preface

This Application Guide provides guidelines for the design and deployment of VESDA smoke detection systems in Airport Facilities. Key environments and functions of airports addressed in this document include the following:

- Terminals: air passenger enplaning or deplaning, including baggage handling area
- Aircraft hangars
- Air traffic control centre and tower
- Cable and service tunnels
- Lift shafts
- Power supply and other essential services, i.e. charging locations and switch gear.

In the remainder of this Application Guide, the above environments will be referred to as **"Airport Facilities"**.

> **Note!**
>
> The information contained in this Application Guide should be used in conjunction with specific local fire codes and standards as well as the guidelines provided in the VESDA System Design Manual (Doc No. 10270). Where applicable, other regional industry practices and end user practices should also be adhered to.

Contents

1 Background

1.1 Airport Facilities

Airport Facilities consist of a number of key buildings, functional and service areas:

Airport terminal buildings contain areas of ticket sales, flight information, baggage handling (to be addressed separately in this Guide), retail spaces and other necessary functions for air transport operations. Besides life safety, fire protection objectives for terminals include maintaining continuity of airport operation (avoiding downtime), preventing public panic, and avoidance of unnecessary mass evacuation of occupants.

An **aircraft hangar** is a structure in which aircrafts are housed for service and maintenance. Aircraft hangars are high fire risk environments due to large quantities of stored flammable materials, electrical and mechanical equipment, and processes such as painting and maintenance.

Baggage handling systems consist of multiple functions like baggage check-in, collection, loading/unloading, screening, sorting, storage, and transportation. With a high density of combustibles and connections to multiple parts of terminals vertically and horizontally, fires started in this normally unattended area may develop quickly and spread to adjacent building areas.

The **air traffic control centre and tower** plays a key role in managing the operation of the airport in addition to controlling air traffic handling. This area typically contains mission-critical telecommunications, air traffic monitoring, and facilities control systems. Any fire incident or panic or unnecessary evacuation in air traffic control centre and tower may result in delay or cancellation of flights.

Lifts or elevators are widely utilized in airports, particularly in Terminals, providing a safe and fast mode for people transportation. However, in the event of a fire, the use of lifts/elevators presents special risk, such as trapping occupants inside if the fire in the shaft the outcome might be more detrimental to occupants being trapped inside.

Airport facilities can have considerable lengths of underground cabling in **tunnels**/vaults and electrical equipment in cable chambers. These cables and equipment are vital to maintaining power supply and data communication to various areas, which are essential to airport functions.

There are other functional and supporting services in airport facilities, like **charging locations** and **switch gear**. Charging locations provide charging services to various equipment powered by batteries, like electric vehicles (handicapped and trolley cars), or energy storage including UPS (uninterruptible power supplies). A switch room can contain a high density of electronic equipment housed in cabinets and automated switch-gear. These rooms maintain the primary communications and signalling functions of airports, and form the principal switching interface between the control room and the field equipment.

1.2 Fire Safety Considerations in Airports

Major fire risks within Airport Facilities include

- Electrical equipment and component failures, including overheating of electrical cabling/relays and arcing of transformers in data communications and processing areas, cable / service tunnels, substations, power supply (generator), and switch rooms.
- Electrical/lighting failures in commercial kitchens and seating areas.
- Mechanical equipment failure, i.e. moving parts in baggage handling systems (BHS) and lifts. Fire and its products — heat, smoke, and toxic gases — can spread to other areas of airports through the lifts / elevators shafts.
- Hot work and/or radiant heating in aircraft hangars and maintenance stations.
- Improper house-keeping or lack of maintenance, i.e. failure to dispose of packaging materials, lubrication of moving parts, etc.
- Densely-stored fuels, packed goods, and crowded arrangement of equipment will assist with the spread of fire.
- Ventilation ductwork can circulate smoke and gases to other compartments.
- Risk of explosion from flammable liquids and gases in battery rooms, aircraft hangars, fuel storage, fuelling depots, and cable tunnels/vaults.
- Arson or unintentional ignition of luggage, including battery failures.

1.3 Performance-Based Design

The design of most VESDA systems in airport facilities is prescriptive in nature. Alternative approaches like performance-based design (PBD) can be used to supplement these practices, especially in cases where the building shape/size is not addressed in codes or where an improved design with greater sensitivity, coverage and/or flexibility is deemed necessary in areas with critical mission equipment.

Examples of prescriptive and PBD approaches and risk management concepts relevant to airports are listed below:

- NFPA 415 Standard on Airport Terminal Buildings, Fuelling Ramp Drainage, and Loading Walkways.
- NFPA 409 Standard on Aircraft Hangars.
- FM Global FMDS0793 Aircraft Hangars, manufacturing and assembly facilities.
- NFPA 72 National Fire Alarm and Signal Code.
- NFPA 75 Standard for the Fire Protection of Information Technology Equipment.
- NFPA 76 Recommended Practice for the Fire Protection of Telecommunications Facilities.
- ISO 31000 Risk Management – Principles and Guidelines.
- SFPE Handbook of Fire Protection Engineering.

Performance-based fire protection solutions can be made to comply with the performance objectives of local and national codes and standards for building and life safety. Assessment of the environmental risks and performance requirements, specific to the airport facility, are conducted as part of the design process.

1.4 Key Design Considerations

The following should be considered when specifying and designing a VESDA smoke detection system in airport facilities:

1. What prescriptive codes / standards and industry practices are recommended?
2. What PBD codes are recommended for airport facilities?
3. What level of protection is required, and how will fire safety be managed?
4. What are the consequences of fire (e.g. interruption to air traffic, bad customer experience, and financial loss as result of down time)?
5. Which method(s) of protection are required (ceiling, raised floor, ceiling void, return air vent, cabinet, cable tunnels/vaults, fresh air intake, etc.)?
6. Is there a need to integrate suppression with a coincidence / cross zoning detection scheme?
7. Accessibility for maintenance, test and inspection in high ceiling areas, raised floor, ceiling void, within fully or partially enclosed equipment cabinets, restricted areas, etc.

1.5 Why Use VESDA Smoke Detection?

Fire events in airport facilities must be detected as early as possible to ensure personnel safety, asset protection, and continuous airport operation. VESDA is uniquely capable of mitigating the risk of fire ensuring business continuity in the following ways:

- A VESDA system can reliably detect diluted smoke, due to its very sensitive sensing chamber and cumulative sampling (smoke drawn through multiple sampling holes).
- VESDA detectors can be mounted in easily accessible locations. This allows for easy and safe system maintenance when sampling in awkward locations such as large open spaces (LOS), raised floors, ceiling voids, underground cable tunnels/vaults, and lift/elevator shafts. Having to access only the detector unit will not disrupt operations, will not cause breach of secure spaces, and will save operating and maintenance costs.
- VESDA detectors can monitor all fire stages from incipient to fully developed, providing multiple alarms for staged response. Detection at the incipient stage allows early intervention for investigation and action, before smoke and corrosive gases affect equipment and personnel. Early intervention can potentially eliminate the need for suppressants release, occupant evacuation or fire brigade call-out.
- A VESDA system actively draws air through the sampling holes which provides consistent detection performance, regardless of airflow conditions.
- VESDA detectors provide absolute smoke detection which generates reliable and predictable performance to meet performance requirements for both prescriptive codes and PBD.
- VESDA detectors have fixed calibration which ensures no need for recalibration during whole product life reducing operational cost.
- A VESDA pipe network design can be tailored to the building and environmental characteristics to address special concerns like high ceilings, thermal stratification and cross flows, whilst at the same time satisfying architectural and aesthetic objectives.
- There is a comparatively low incidence of false alarms with a VESDA system due to filtration, dust discrimination, programmable fire alarm thresholds, and alarm verification delays.
- Where a gaseous or sprinkler fire suppression system forms part of the overall fire protection solution, the VESDA system can be designed to actuate the release mechanisms through coincidence detection schemes.

2 Designed for Effective Protection

2.1 Areas Protected

This Application Guide provides application guidelines in following major areas of airport facilities.

- Terminals
- Aircraft Hangar
- Baggage Handling System (BHS)
- Air Traffic Control Centre and Tower
- Lift/Elevator Shaft
- Cable and Service Tunnels
- Charging Locations
- Switch Gear

VESDA systems may be applied in other areas of airport facilities to achieve comprehensive and reliable early warning fire detection.

The following sections of this Application Guide, outline the design guidelines for VESDA systems. This Application Guide should be used in conjunction with regional fire codes and national standards. Performance requirements and industry/end user practices and guidelines should be considered in the determination of sampling locations and sensitivity settings. Where there may be areas not covered by existing fire codes and standards, or noncompliance to prescriptive code requirements, or there is a requirement to use new building materials and technologies, a PBD approach should be followed to achieve overall protection objectives. Xtralis experts can assist in the PBD practice by optimising system designs, delivering CFD (Computational Fluid Dynamics) modelling assessment, designing and conducting in-situ performance validation tests.

2.2 Terminals

Challenges to fire/smoke detection systems in airport terminals include:

1. Smoke may not reach the ceiling due to thermal stratification, or disturbance of the rising smoke plume from ventilation
2. Dilution of smoke concentration of the rising smoke plume in the terminal's large open and/or high ceiling space, or from the action of ventilation systems
3. Nuisance alarms from cooking sources and external pollutants

Another challenge relating to the deployment of smoke detection systems involves maintaining an inconspicuous profile for aesthetic reasons.

The following VESDA protection options are recommended in Terminals to overcome the above challenges to deliver early detection.

- Ceiling detection – local code requirements should be followed on distance of the sampling holes under the ceiling, sampling hole spacing and detector sensitivity. Detector units can be mounted at floor level or catwalk in ceiling void for easy access and maintenance.
- Vertical detection – for high ceilings and/or where there is possibility of stratification, VESDA sampling pipes can be installed along vertical structures (posts, columns, etc.) to detect stratified smoke. Refer to local codes on the requirements of sampling height and spacing.
- Return air detection – detection at return air path is an effective solution for quick response to smoke driven by strong air movement. Smoke detection can be deployed across return air grilles or inside return air ducts. VESDA Pipe Network Installation Guide (Doc No. 10255) and VESDA Ducts Application Note (Doc No. 10760) should be followed respectively.
- Escalator or lift shaft detection – local detection of fires caused by moving machinery inside escalators and lift shafts. Consult the VESDA Lift Shaft Application Note (Doc No. 19109) for lift shaft protection.

2.3 Aircraft Hangars

The challenges to fire/smoke detection systems in aircraft hangars stem from the enormous large open space of these structures in conjunction with being open the outdoors. These include:

1. High ceilings in hangars present difficulties for heat detection devices (including sprinklers) because of cooling of the rising smoke plume. A fire would need to be reasonably large to generate enough heat to activate ceiling mounted heat detection devices
2. Smoke not reaching the ceiling due to thermal stratification and/or the action of cross flows
3. Dilution of smoke concentration as smoke plume rises and/or action of crossflows
4. The presence of large aircraft makes video fire detection (including video flame and smoke detection) difficult, since line of sight to a fire and smoke plume may be blocked. Video smoke detector's performance will degrade under poor lighting conditions and is not listed as a primary fire reporting device
5. Conventional detectors mounted at the ceiling are difficult to access and maintain without interruption on the normal operation of hangar

The following VESDA protection options are recommended in aircraft hangars:

- Ceiling detection – VESDA detection has sampling pipes under the ceiling with the detector units mounted at floor level or catwalk for easy access and maintenance.
- High-Low alternating ceiling detection – similar to ceiling detection except that every alternating sampling hole is extended below the ceiling by a drop-down pipe. This option is to overcome low vertical temperature gradients (slight stratification).
- Multilevel detection – VESDA detection has two horizontal levels of sampling pipe layouts, one at the ceiling and the other underneath beams with identical but horizontally off-set pipe networks. This option is to overcome high vertical temperature gradients (significant degree of stratification).

More detailed guidelines can be found from VESDA Design Guidelines for Aircraft Hangars Application Note (Doc No. 13305). An illustration of VESDA high-low alternating ceiling detection is shown in Figure 1.

Figure 1: VESDA high-low alternating ceiling detection in Aircraft Hangar

2.4 Baggage Handling Systems

Challenges to fire/smoke detection systems in baggage handling systems (BHS) include:

1. Smoke may not reach ceiling due to thermal stratification, obstruction from conveyers, ductwork and mezzanine, and lateral air movement caused by conveyers
2. Dilution of smoke from air movement
3. Nuisance alarms from internal and external pollutants

The following VESDA protection options are recommended for Baggage Handling area.

- Ceiling detection – VESDA detection has sampling pipes under the ceiling with the detector units mounted at easy to access locations for maintenance and service.
- High-Low detection – similar as Ceiling detection plus additional sampling holes extending below the ceiling level along vertical posts/columns.
- Intermediate level detection – VESDA detection with sampling pipes at intermediate heights of the Baggage Handling area. This option is recommended for high ceiling spaces, multi levels of conveyers, mezzanines with low perforation rate, or when there is a need for localized protection of equipment.

2.5 Air Traffic Control Centre and Tower

Challenges to fire/smoke detection systems in airport control centers and towers include:

1. Incipient/smouldering and low energy flaming fires with minimal smoke output – especially challenging for conventional detection systems
2. Fires most likely start inside equipment and concealed spaces, i.e. cabinets, floor voids, ceiling voids. This creates challenges for open area smoke detection because smoke cannot naturally migrate to the open area
3. Typically these areas are exposed to high airflow conditions for the cooling of electronics data processing equipment which dilute and affect the trajectory of smoke plume in the space

The following VESDA protection options are recommended for airport control centers and towers.

- Ceiling detection – VESDA detection has sampling pipes under the ceiling. Local codes should be followed for the spacing of sampling holes.
- Raised floor and ceiling void detection – VESDA system has sampling pipes inside raised floor and ceiling void where combustibles are present. VESDA detectors can be positioned outside the protected area for easy access for service and maintenance.
- Return air detection – when strong air movement is present, smoke will follow the air streams and not reach ceiling sampling holes. Under such situation, detection across return grilles or inside return air duct is an effective option. VESDA Pipe Network Installation Guide (Doc No. 10255) and VESDA Ducts Application Note (Doc No. 10760) should be followed for the return air grill detection and the duct detection respectively.
- Cabinet detection – In/On cabinet detection provides sampling within or around high-risk equipment to enable earliest possible smoke detection. Where detection addressability is desired, the following VESDA detectors should be considered:
  - VESDA-E VEA for addressability of individual cabinet,
  - VESDA-E VES for addressability of row of cabinets, and
  - small area VESDA detectors for addressability of small number of cabinets.

  More details of the design guidelines for the cabinet detection can be found from VESDA Pipe Network Installation Guide (Doc No. 10255).

An illustration of VESDA ceiling and cabinet detections in Airport Traffic Control Center and Tower is shown in Figure 2.

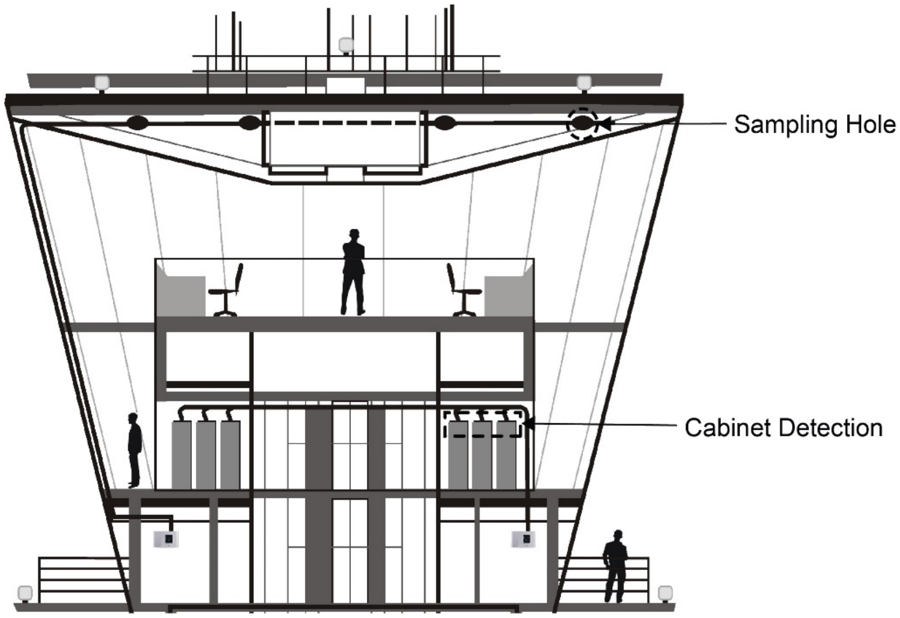

Figure 2: VESDA protections for Control Center and Tower.

2.6 Lifts/Elevators Shafts

Challenges to fire/smoke detection systems in lifts/elevators shaft structures include:

1. Rapid air movement caused by lift car (piston-effect) leads to smoke dispersion and dilution, and transient pressure changes inside the shaft poses difficulties to smoke sampling
2. Nuisance alarms
3. Difficult access to protected areas for maintenance and testing

The following VESDA protection options are recommended for airport lifts/elevators and shaft structures:

- Combination of ceiling and vertical detection – VESDA sampling pipes can be installed at the ceiling and along the shaft vertically.
- Damper or vent detection – where dampers and vents are used to relieve shaft pressure or remove smoke, VESDA sampling holes can be placed upstream the damper or vent.
- Machine room detection – where the machine room is separated from the lift/elevator shaft, VESDA sampling holes can be placed in the machine room and the shaft. VESDA-E VES with addressable fire reporting can be used to protect both the shaft and the machine room.

The exhaust air of VESDA detector should be returned back to the shaft to alleviate transient pressures. The maintenance test hole (MTH) located outside the shaft space will enable easy service and test without interruption to the lift operation. More details of VESDA design, commissioning and maintenance can be found in the VESDA Lift Shaft Application Note (Doc No. 19109). An illustration of VESDA protection of Lift Shaft is given in Figure 3.

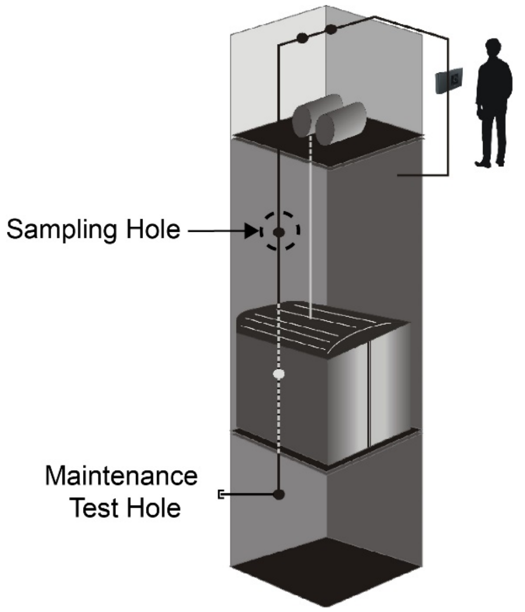

Figure 3: VESDA protection of Lift Shaft and Machine Room

2.7 Cable and Service Tunnels

Challenges to fire/smoke detection systems in cable and service tunnels include:

1. Nuisance alarms
2. High humidity

The following VESDA protection option is recommended for cable and service tunnels.

- Ceiling detection – VESDA branched sampling pipes can be installed along the centre of line of the tunnel ceiling, or above the cable trays.

VESDA ECO and VESDA Sensepoint XCL gas detectors are recommended for cable tunnels/vaults for detecting flammable, toxic and oxygen gas hazards. These aspirating gas detectors can be mounted outside the cable/service tunnels for easy service and maintenance.

An illustration of VESDA protection of Cable and Service Tunnels with detector installed outside, is given in Figure 4.

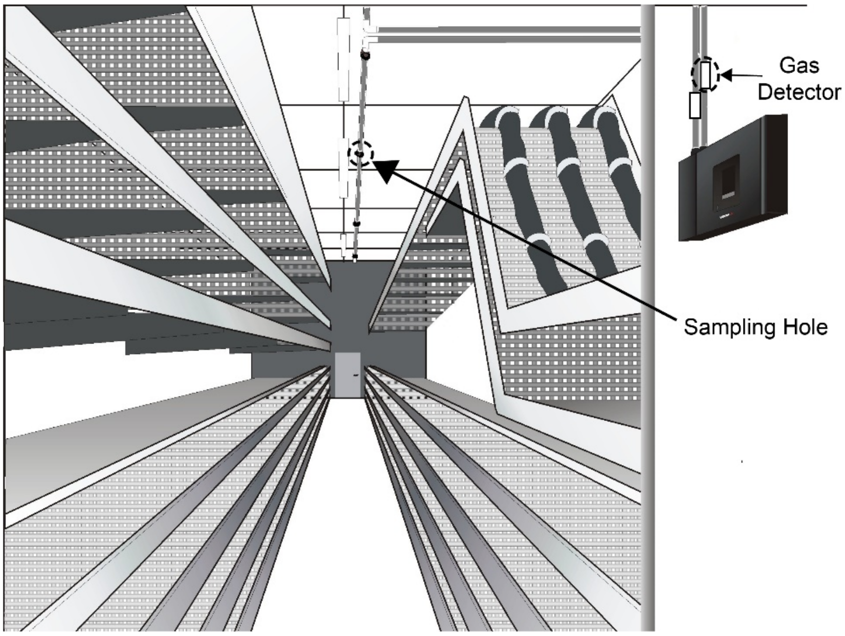

Figure 4: VESDA protection of a cable tunnel

2.8 Charging Locations

Challenges to fire/smoke detection systems in charging locations of airports include:

1. Smoke diluted by complex air movement increases difficulties in detecting smoke at early stages of fires

The following VESDA protection options are recommended for charging locations, and an illustration of protection of a battery room is shown in Figure 5.

- Ceiling detection – VESDA detection has sampling pipes under the ceiling of the charging locations.
- Return air detection – when return air grilles are present in the charging locations, VESDA detection across return grilles or inside return air ducts should be considered. VESDA Pipe Network Installation Guide (Doc No. 10255) and VESDA Ducts Application Note (Doc No. 10760) should be followed for return air grill detection and duct detection respectively.

Flammable and toxic gases may be present in the charging locations which require a gas detection system placed/sample at appropriated locations. VESDA ECO / VESDA Sensepoint XCL gas detection can be used for the detection of a range of gases.

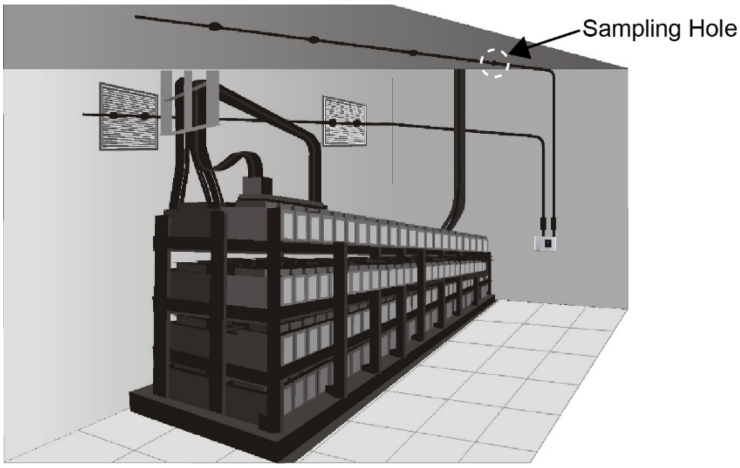

Figure 5: VESDA protection of battery room

2.9 Switch Gear

Challenges to fire/smoke detection systems in airport switch gear facilities include:

1. Smoke diluted by complex air movement increases difficulties in detecting smoke at early stages
2. Nuisance alarms

The following VESDA protection options are recommended for switch gear.

- Ceiling detection – VESDA detection has sampling pipes under the ceiling of switch room.
- Cabinet detection – In/On cabinet detection provides sampling within or around high-risk equipment to enable earliest possible smoke detection. Where detection addressability is desired, the following VESDA detectors should be considered:
  - VESDA-E VEA for addressability of individual cabinet,
  - VESDA-E VES for addressability of row of cabinets, and
  - small area detectors for addressability of small number of cabinets.

  More details of the design guidelines for the cabinet detection can be found from VESDA Pipe Network Installation Guide (Doc No. 10255).
- Return air detection – when return air grilles present, detection across return grilles or inside return air ducts is an effective option. VESDA Pipe Network Installation Guide (Doc No. 10255) and VESDA Ducts Application Note (Doc No. 10760) should be followed for return air grill and duct detection respectively.

An Illustration of the three detection options are shown in Figure 6. More guidelines on Switch Gear protection can be found in the Xtralis Substations Design Guide (Doc No. 11737).

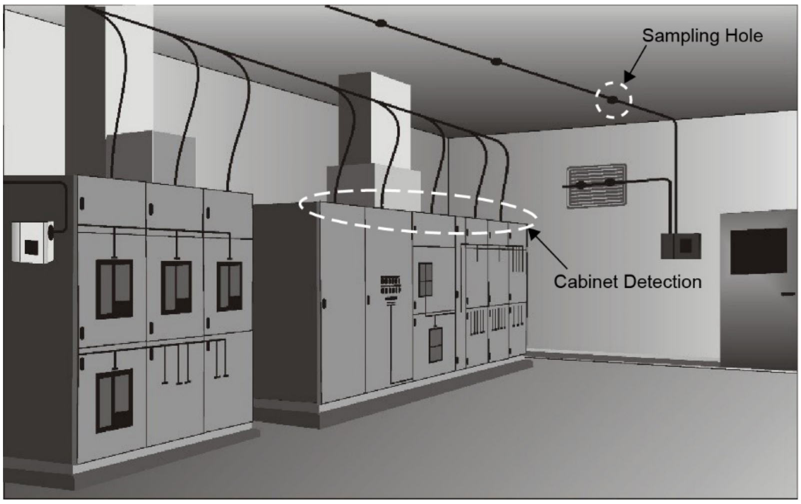

Figure 6: VESDA protections in Switch Gear

Note!

VESDA detectors MUST NOT be installed in areas where high EMI (Electro Magnetic Interference) / EMC (Electro Magnetic Compatibility) sources are present. A good practice is to install detectors outside the protected area with sampling pipes entering the area where high EMI/EMC sources are present.

3 Commissioning, Service and Maintenance

Once the VESDA system has been installed, its performance and pipe network integrity must be verified against the ASPIRE design file. Calculated smoke transport times for each zone should be applied conservatively. Smoke tests, as per local codes and standards are strongly recommended to check system performance for both VESDA systems and any integration with other fire safety systems.

Standardized hot smoke tests, such as those specified in Australian Standard AS 4391, are suitable for testing smoke management systems in large open space, like terminal and aircraft hangar. For the validation of VESDA early warning smoke detection, the smoke pellet test method (Doc No.13608) is recommended.

The VESDA system shall be serviced and maintained according to the local codes and standards and as per the instructions provided in relevant VESDA detector Product Guides.

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