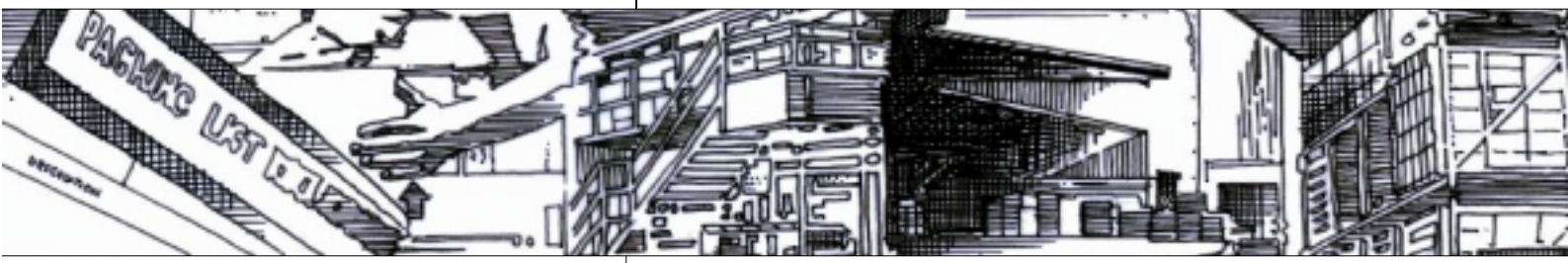
VESDA®

ASPIRATING SMOKE DETECTION



DESIGN GUIDE

Warehouses

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CONTENTS

1. INTRODUCTION

Warehouses, distribution centres and superstore facilities are environments that contain a diverse scope of inventory that range from raw manufacturing materials and wholesale goods, through to retail consumables and finished products.

Insurance and logistics companies and the owners of the stored goods require total protection (detection and suppression) to minimise and/or eliminate loss through fire. The loss of inventory or equipment is only a small part of the overall loss incurred as a result of a fire or thermal event.

It is essential that reliable, very early smoke detection systems be deployed to protect the facility and stock from the threat of fire.

As an innovative pioneer of aspirating technology, VESDA provides the earliest possible warning of a potential fire by detecting the incipient (pre-combustion) stage of a fire event. A team of VESDA engineers who have extensive design and installation knowledge in warehouse environments have assisted in the development of this Design Guide.

The content herein is to be used as a reference by designers and consultants when specifying a VESDA system. It discusses the relevant design considerations, and recommends the installation of an aspirating smoke detection system in warehouse facilities.

NOTE: The Design Guide has been produced as a global reference and should be used in conjunction with region specific fire codes and national standards.

2. DESIGN CONSIDERATIONS

The following aspects should be considered during the specification and design of an aspirating system:

- Facility height and volume
- Racking and storage arrangements
- Airflow characteristics of the area
- Maintenance requirements – access to conventional detectors
- Loading/unloading method
- Public access areas (if applicable)
- External environmental conditions – humidity and temperature change

3. WAREHOUSE PROTECTION - GENERAL

The diversity in the layout configuration, fire risk, operational hours and variety of stored goods are primary factors when determining the appropriate detection system for a warehouse facility.

For example, warehouse facilities such as 'deed stores' (i.e. archive storage) typically contain concentrated storage racking and run automated picking systems with reduced manning levels on a 24-hour basis. In comparison, high-density stores that house fast moving consumer goods such as packaged food require high-bay racking that can affect airflow and impede the detection of, and response to a fire.

Additional key hazards include electrical faults from conveyor/transport equipment, faults on robotic equipment or forklifts, faulty electrical services or overload conditions, and illicit smoking or careless maintenance work. The highly combustible nature of polystyrene and polyurethane foams, wooden pallets, cardboard boxes and plastic wrapping also increase the risk factor.

Although suppression (i.e. sprinklers) is required in most warehouse applications, they may be ineffective at extinguishing a fire. While such systems will provide containment, the risk of water and smoke damage to business-critical stock is increased.

A fire must be detected at the earliest stage to reduce the risk of facility and stock loss. VESDA's reliable, very early warning system minimises the likelihood of product loss, facility damage and operational/supply downtime. The simple maintenance requirements and the ease of servicing the VESDA system significantly reduce the long term costs (i.e. lifecycle costs) of the detection system.

The following guidelines are to assist consultants and designers achieve the optimum level of detection required within warehouse storage applications. International standards and codes of practice should always be taken into consideration.

The spacing or density of the sampling holes (detection points) is dictated by local standards. The flexibility of pipework location allows detection to be placed where it is required, as well as complying to the code requirement. Alarm levels and appropriate levels of response are determined by each individual application environment and are not addressed in the Design Guide.

Table 1 shows the possible areas of protection of a warehouse facility.

Area	Required	Recommended	Optional
Storage area	✓		
Racking	✓		
Public areas		✓	
Loading bay		✓	
Ceiling void			✓

Table 1 Areas of protection

The following sections describe design recommendations related to the different detection areas. All pipe work designs should be verified using the VESDA Sampling Pipe Modeling Program – ASPIRE™. This program illustrates the significance of various parameters in an aspirating smoke detection system so that the most appropriate design can be applied.

3.1. DESIGNING A SYSTEM ACCORDING TO STANDARDS

The choice and level of protection is dependent on the identified risks and requirements of the local fire codes and standards, the insurance company and the client. VESDA's ability to provide performance-based solutions allows for the requirement to install the system to meet an individual warehouse specification, in addition to the general method of installing the sample pipe work to replace conventional point or beam detectors.

VESDA provides the functionality to address the individual configuration criteria, while maintaining adherence to the grid-based (codes and standards) layout.

Sampling pipes for aspirated smoke detection systems are typically located at the roof level and within the racking system. Pipe work layout and sampling point location should be installed as per the standards for point detection. In facilities where the layout prevents this code adherence (e.g. high-bay racking) the design should be specific to the individual facility.

Points for consideration

1. **Smoke stratification:** It is essential to consider the possibility of stratification. It is advisable to conduct smoke tests using a smoke pellet or other approved method. VESDA sampling pipes can be located down the walls or within the racking to overcome stratification problems. See Section 3.2.1 – Stratification.

2. **Height restrictions:** Local codes indicate limitations and height coverage specifications. Positioning VESDA sampling pipes within the racks can overcome any such restriction.

3. **Rack layout:** The layout configuration of the storage racks may not allow for convenient positioning of sampling points in compliance with the relevant code (i.e. at the defined maximum fixing intervals). It is often necessary to provide a greater density of sampling points in order to match the rack configuration.

   NOTE: Applying the same design approach with a conventional detection system will result in a significant cost increase and provide minimal improvement to the detectors performance.

4. **Maintenance:** The on-going maintenance requirements for a detection system is a major consideration. VESDA's system flexibility allows the detector to be positioned to facilitate convenient maintenance access, e.g. at standing height on the end of racks or on the warehouse wall. See Section 3.2.3 – System Maintenance and Testing.

3.1.1. SAMPLING PIPEWORK CONFIGURATION AND POINT LOCATION

Various sampling methods can be used in warehouse facilities. Pipework can either be positioned along the underside of the ceiling/roof with holes directly in the pipework, as drop pipes (if in-rack or stratification issues are apparent) or capillary sampling (if sampling through the ceiling is required). The selection of sampling configuration is dependant upon the application and internal requirements of the warehouse facility (i.e. operational activity, high-bay racking, access to voids and aesthetics).

The method of locating sampling holes is identical for pipe work sampling, drop pipes or capillary sampling; sampling holes in aspirating smoke detection systems are typically positioned where conventional detectors would normally be placed.

Global codes and standards recommend an area of coverage per detector; usually determined by a using a grid layout. Most standards define different area coverage dependent on certain criteria and reference should be made to your relevant standard. Refer to Figure 1.

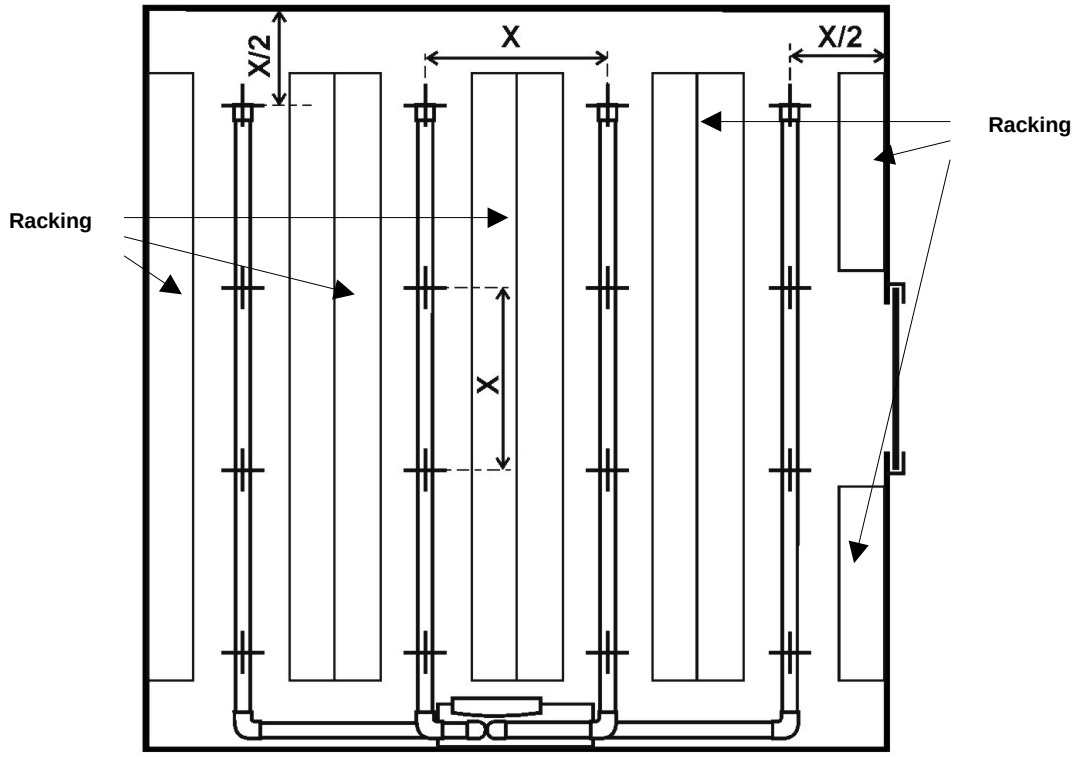

Figure 1 Grid Layout for Sampling Hole Locations

3.1.2. GRID LAYOUT

VESDA's aspirating smoke sampling enables performance based systems to be designed and installed to meet the requirements of the warehouse facility. For example, if high-bay racking is present, detectors and sampling points should be considered in addition to the codes and standards grid layout specification. This provides full protection of the racking and the actual warehouse facility.

The sample pipe should also be in accordance with the VESDA systems design manual and all systems must be designed using ASPIRE™ pipe work design software.

Sample pipe work and fittings supplied by Vision Fire & Security are designed for most applications and are recommended for use as an integral part of the system design to meet response criteria. System design should be the responsibility of an accredited VESDA distributor or agent to ensure the correct application design is maintained.

3.1.3. SAMPLING ALONG UNDERSIDE OF THE CEILING

The sampling pipes are positioned along the underside of the ceiling/roof and reference should be given to the grid layout method as mentioned above. In typical warehouse layouts, the pipework is fitted to the underside of the 'C' section girder supporting the steel deck roof.

Pipe Fittings

For ease of installation, a rigid pipe (PVC, ABS etc.) is used in ceiling/roof mounted sampling, with particular consideration given to temperature fluctuations. External climatic changes can cause expansion and contraction of the pipework. It is recommended conduit saddles be used to allow for small amounts of movement.

The expansion and contraction caused by temperature variation may also necessitate the installation of airtight expansion joints in the pipe work. The placement of expansion joints allows the pipe to contract and expand without exerting pressure on the pipe fixtures.

VESDA detectors can either be positioned in the ceiling void, within the protected area, or external to the protected area; its location primarily dependant upon factors such as internal configuration, operational processes and logistics/access requirements. To ensure ease of mounting and maintenance, the detector is typically mounted at working height. Refer to Figure 2

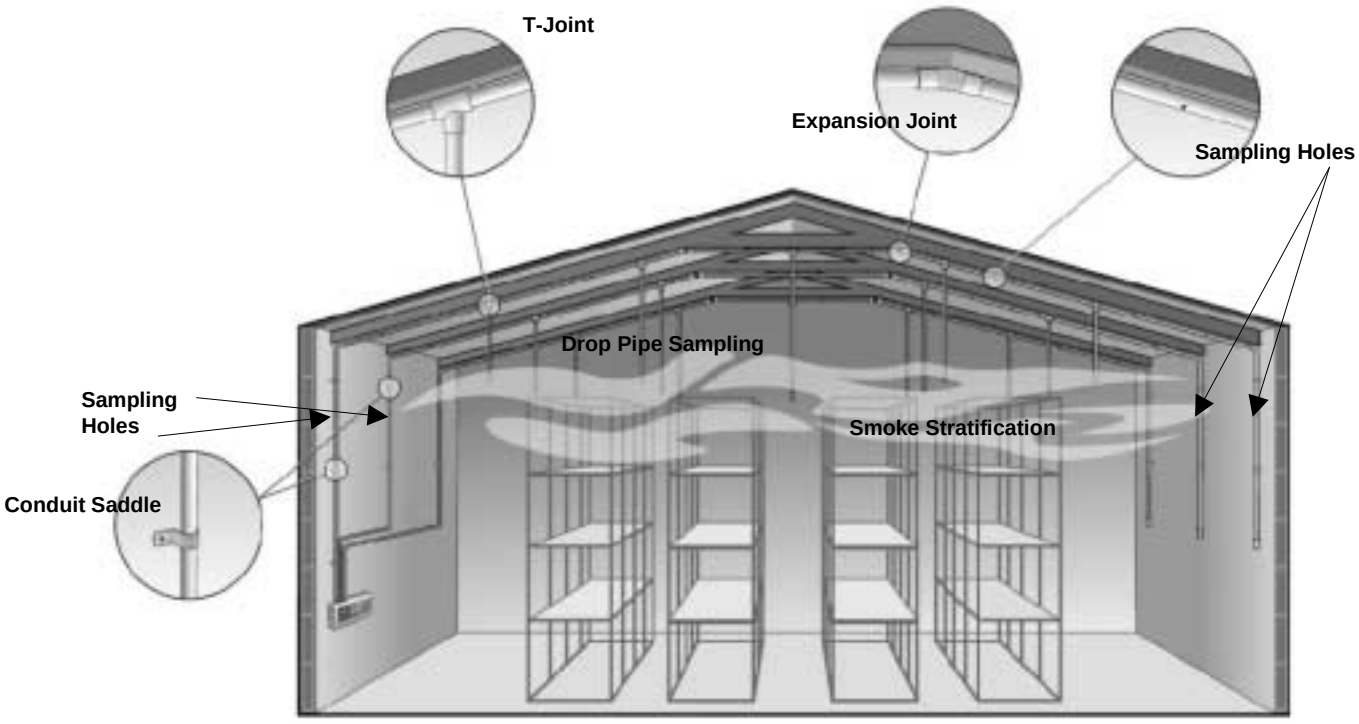

Figure 2 Pipework Configuration

3.2. PERFORMANCE BASED DESIGN

Performance-based design determines the best fire protection system by assessing the environmental risks at the concept design stage. Traditional prescriptive codes and standards have proven to provide an appropriate level of fire protection with a reasonable safety margin. However, as tools and industry expertise continues to develop, the fire protection strategy in many installations is being designed from a risk and performance-based design approach. This may include the use of computerised modeling tools (i.e. Computational Fluid Dynamics) and analysis of on-site tests (i.e. smoke testing) to determine airflows, fire loading, ventilation, ignition sources and other physical conditions that may affect the likely development of a fire.

VESDA systems complement performance-based designs by detecting a fire event earlier than conventional detection systems. VESDA is also easily incorporated into the overall Fire Response Plan, and verification tests can be administered to confirm that the installed system is providing the specified protection.

The following sections address physical conditions and risks that occur in warehouses, relevant to a performance-based design approach to fire protection.

NOTE: The arrangement of stock may alter the air dynamics (airflow and air direction) of the facility. It is recommended that performance tests (i.e. smoke testing or CFD) are undertaken as part of the evaluation and design program as outlined by local code procedure.

3.2.1. STRATIFICATION

Smoke stratification occurs in many warehouse and factory environments and refers to the incidence of smoke layering, which is a result of heating and cooling of the air within the facility.

A key example of this would be a warehouse with a steel deck in the summer. The air below the roof may reach temperatures in excess of 60 to 70°C (140 - 158°F).

If a small, incipient fire were to occur within a lower level of the racking, smoke would rise and form a layer below the hot air layer located at the roof level.

To assist in sampling or detecting smoke within the stratification layer, it is recommended to sample at differing levels within the warehouse. This allows air to be drawn from multiple heights or layers and therefore provides earlier detection. Several multiple level sampling methods are discussed below.

3.2.1.1 DROP PIPES – GENERAL

Drop pipes detect the presence of incipient smoke by penetrating the hot air layer at the roof level. To provide complete detection of the warehouse area, it is recommended that both drop pipe and roof mounted sample points are installed. This allows for optimal sampling when the air at the roof level is either hot or cold. Drop pipes can be up to a maximum of 8 metres (26ft) long, however, local codes and standards should be consulted to determine the correct length for individual facility configurations.

3.2.1.2 IN-RACK PIPES – HORIZONTAL

In-rack drop pipe sampling is normally confined to high-bay storage facilities, but may also be used with enclosed racking or to address smoke stratification. The detector is generally mounted at the end of the racking at working height, and pipework is located horizontally through the racking at different levels. Refer to Figure 3

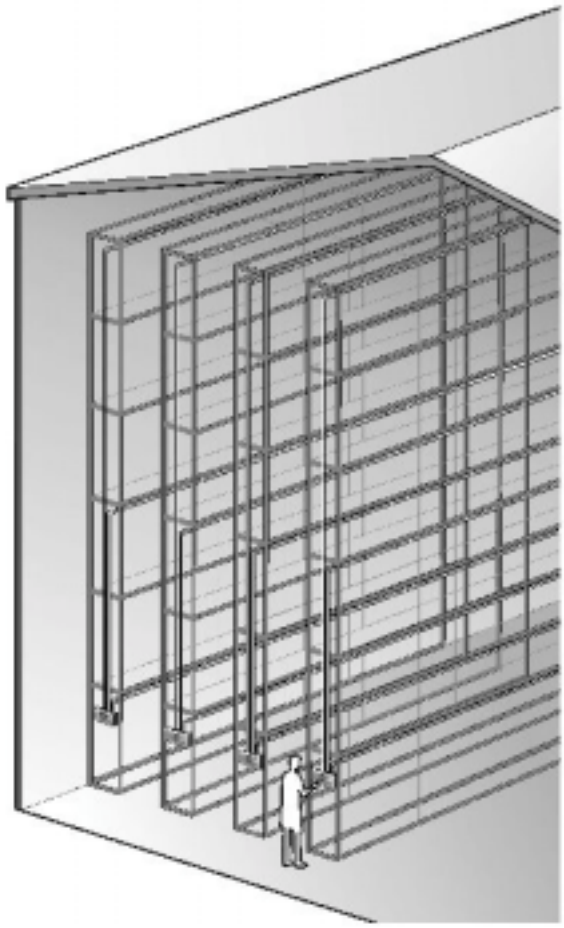

Figure 3 Horizontal In-Rack Sampling

This allows for sampling at different heights through the racks and provides very early detection and minimises the downtime that would be experienced in the event of fire. The pipework is normally installed between back to back racks allowing for mechanical protection (i.e. forklift activity).

3.2.1.3 IN-RACK PIPES – VERTICAL

When installing above-rack drop pipe sampling, it is essential to ensure that the sample pipework is not at risk of damage by the operation of forklift trucks. The drop pipes can be fitted to the sheltered side of the box section of the racking. If this is not possible, the pipework can be installed parallel with the rack frame. Drop pipes normally have two to three (2 to 3) holes drilled along their length, allowing sampling at different heights throughout the racking system. Refer to Figure 4.

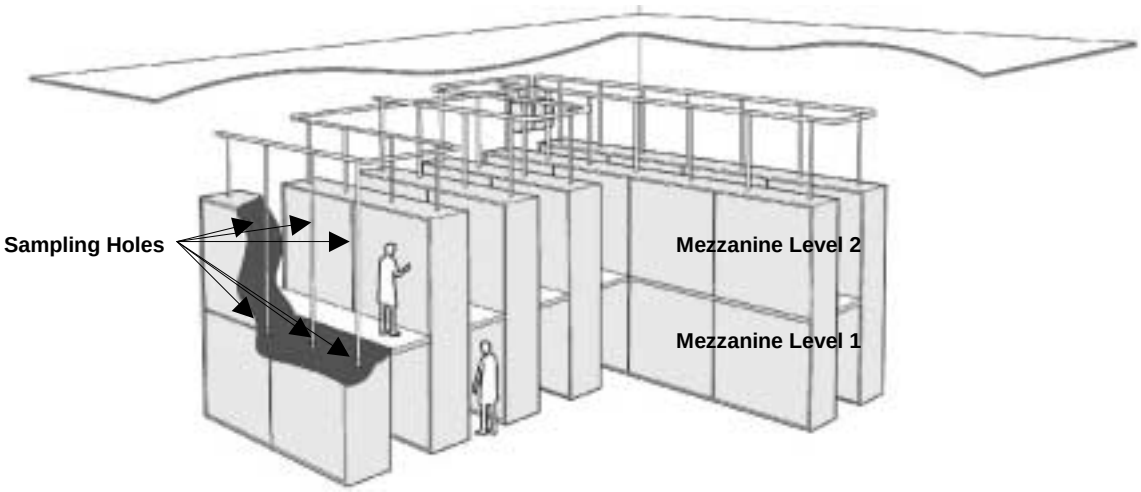

Figure 4 Vertical In-Rack Sampling

3.2.2. VOLUME OF AIR/SMOKE DILUTION

VESDA has several major advantages over conventional smoke detection systems, including the ability to provide 'cumulative detection'. As the smoke spreads and diffuses throughout the warehouse, it becomes diluted and increasingly difficult to detect by conventional detection.

3.2.2.1 ACCUMULATION OF SMOKE

VESDA is the only detector able to cope with smoke dilution without compromising early detection. Cumulative detection refers to the ability to draw air from many points within the protected area into a single detector. For example, a point detector requires between 3 – 20% obsc/m (1 – 6% obsc/ft) of smoke at any given point to register an alarm. VESDA continuously samples small amounts of smoke from throughout the protected area and transports it back to the VESDA detector.

3.2.3. SYSTEM MAINTENANCE & TESTING

System maintenance requiring access and service of a conventional detection system to code requirement is a major cost factor in warehouse facilities.

VESDA reduces the long term costs of maintenance and servicing as normal maintenance does not require access to the pipework, therefore there are no logistic issues or requirements such as disruption to operations (i.e. area closure, out-of-hours work, scaffold hire or specialist handling equipment). The system design provides the ability to determine airflow and/or blocked or broken pipework via the sampling pipe. A simple method has been devised to allow cleaning of the sampling holes from ground level. This is referred to as 'Backflushing' and can be conducted by using compressed air to reverse flush the pipework.

3.2.3.1 POSITIONING THE DETECTOR AND END CAP

The VESDA system detector is normally mounted at an easily accessible height and position within the facility. This allows for easy maintenance and servicing. By extending the end of the sampling pipe to a similarly convenient position, it is possible to perform annual performance (transport time) tests. This eliminates the need to check the sampling points and pipework that is mounted in inaccessible areas.

4. ANCILLARY AREAS

Some warehouses such as superstores have ancillary areas such as public access zones and office space etc. that may feature a suspended ceiling. While fire codes and standards may not require the protection of ceiling voids in premises such as warehouses, there is very little cost impact of installing VESDA to protect this area.

CAPILLARY SAMPLING

Capillary sampling is a complementary sampling method to pipe work sampling. The sampling pipe is located in the ceiling space, a capillary sampling tube connected from the pipe through the ceiling tile, and air is directly sampled from the protected area. Refer to Figure 5

Location of the capillary sampling points should coincide with the grid layout as described in Figure 1- Grid Layout for Sampling Hole Locations.

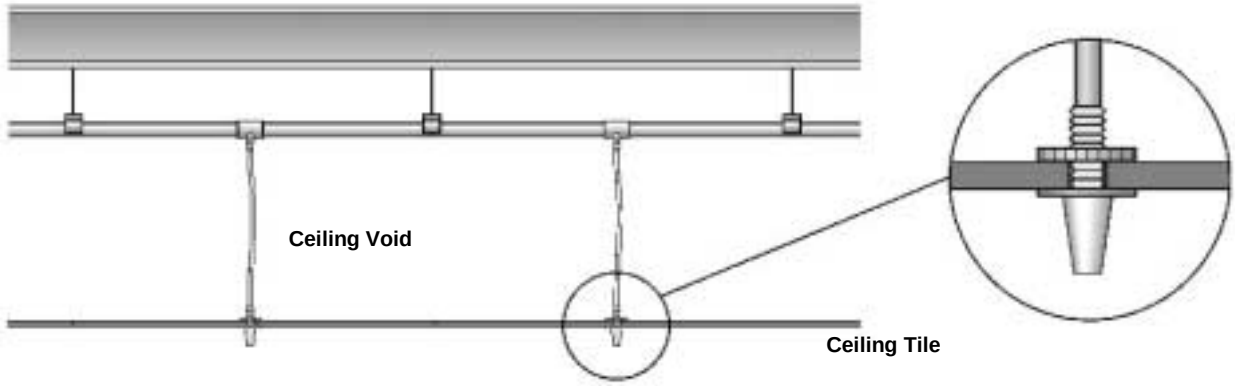

Figure 5 Capillary Sampling

4.1. PLANT ROOM

Warehouse plant rooms such as the air handling plant, forklift battery charge bay and workshop facilities exist as areas that normally contain high power appliances, volatile fuels and other combustible equipment and materials. It is recommended that either capillary sampling or ceiling mounted pipework be installed to facilitate early detection in these areas.

4.2. CEILING VOIDS

VESDA can also protect the ceiling void space often present in plant and maintenance rooms and office areas. This is especially relevant if the void contains cabling and equipment which increases the risk of fire. To determine the spacing of the aspirating sampling holes, the grid layout method described in Figure 1 should be employed.

Protection of the ceiling void area is achieved by either placing sampling holes directly in the sampling pipe (normally at maximum spacings - Refer to Figure 6) or by locating separate pipe runs.

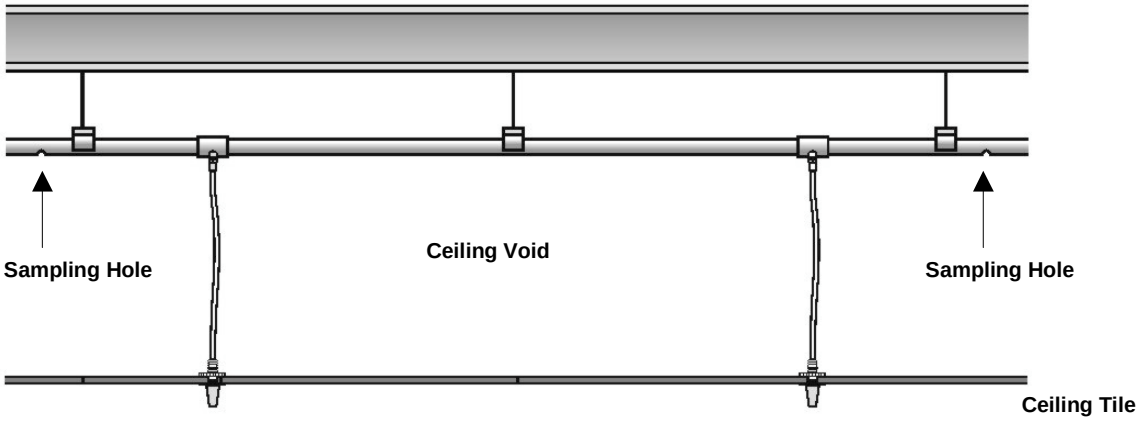

Figure 6 Ceiling Void Sampling

5. CHOICE OF VESDA DETECTOR

VESDA detectors are available in numerous models and configurations. The three (3) main types of detectors: LaserSCANNER, LaserPLUS and LaserCOMPACT can be configured as required with displays and programmers. This flexibility provides the Consultant or End User with the ability to customise the product to the specific protection requirements.

5.1. VESDANET

VESDAnet is a networked system of VESDA detectors, remote displays and programming systems.

5.2. LOCALISATION – SCANNER

The VESDA LaserSCANNER detector allows detector coverage to provide four levels of alarm for four separate sectors. These systems are usually positioned in areas that are difficult to search or identify the event source.

6. INTERFACING WITH OTHER SYSTEMS

VESDA detectors interface easily with fire alarm panels and suppression systems to create a complete fire protection system.

Its staged alarm threshold levels address the configuration and operational requirements of a warehouse facility and are integral to the 'cause and effect' risk management plan. For example, VESDA's wide sensitivity range can be programmed to action a dry pipe suppression sprinkler system at Fire 1 or 2.

Output functionality on the VESDA system provides numerous options to provide warning and annunciation. Each detector is supplied with relays (LaserCOMPACT, LaserPLUS, and LaserSCANNER), and either stand alone or multiple remote displays can then be added. For high level interfacing (HLI), VESDA's technology will allow porting into other proprietary systems.

7. INSTALLATION SCENARIO

Figure 7 and 8 represent a multi-functional warehouse facility with high-bay double-depth racking, mezzanine storage area, office, loading bays and a forklift charge bay.

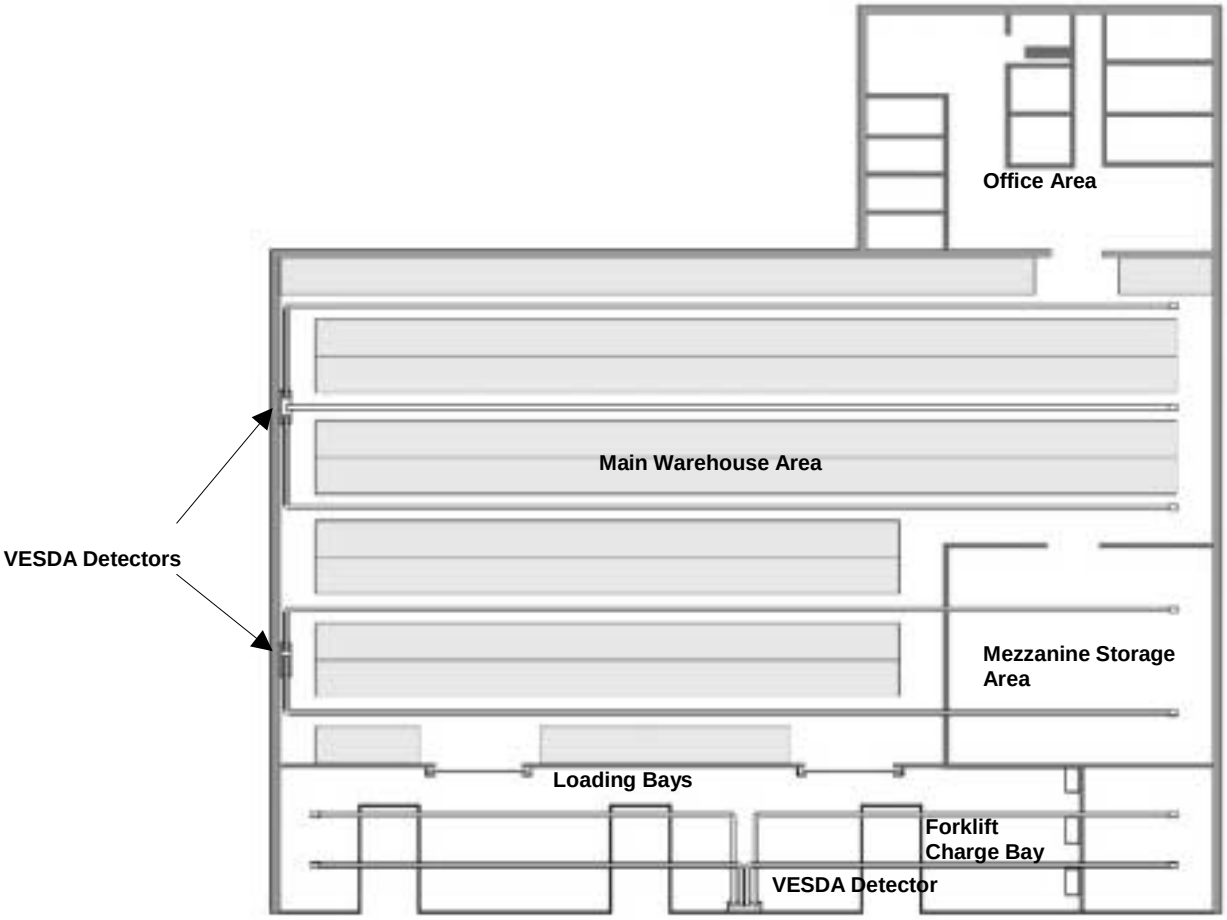

Figure 7 Warehouse Top View – Roof Mounted Pipework Configuration

7.1. CODE COVERAGE

The warehouse facility fulfils the requirements of local codes and standards by locating sampling holes and VESDA LaserPLUS as per the standard grid layout.

The effect of smoke stratification is addressed by installing drop pipe sampling from the roof level. In the illustrated example, the drop pipes are positioned to lengths of six (6) metres to sample from multiple levels, and positioned as per the standard grid layout. Refer to Figure 8.

7.2. RACKING

In-rack drop pipe sampling protects the high-bay racking located in the main warehouse area. The drop pipes are positioned inside the racking to prevent breakage by forklift, etc. The dual-level mezzanine storage area has above-rack drop pipe sampling positioned above the storage racking. Refer to Figure 8

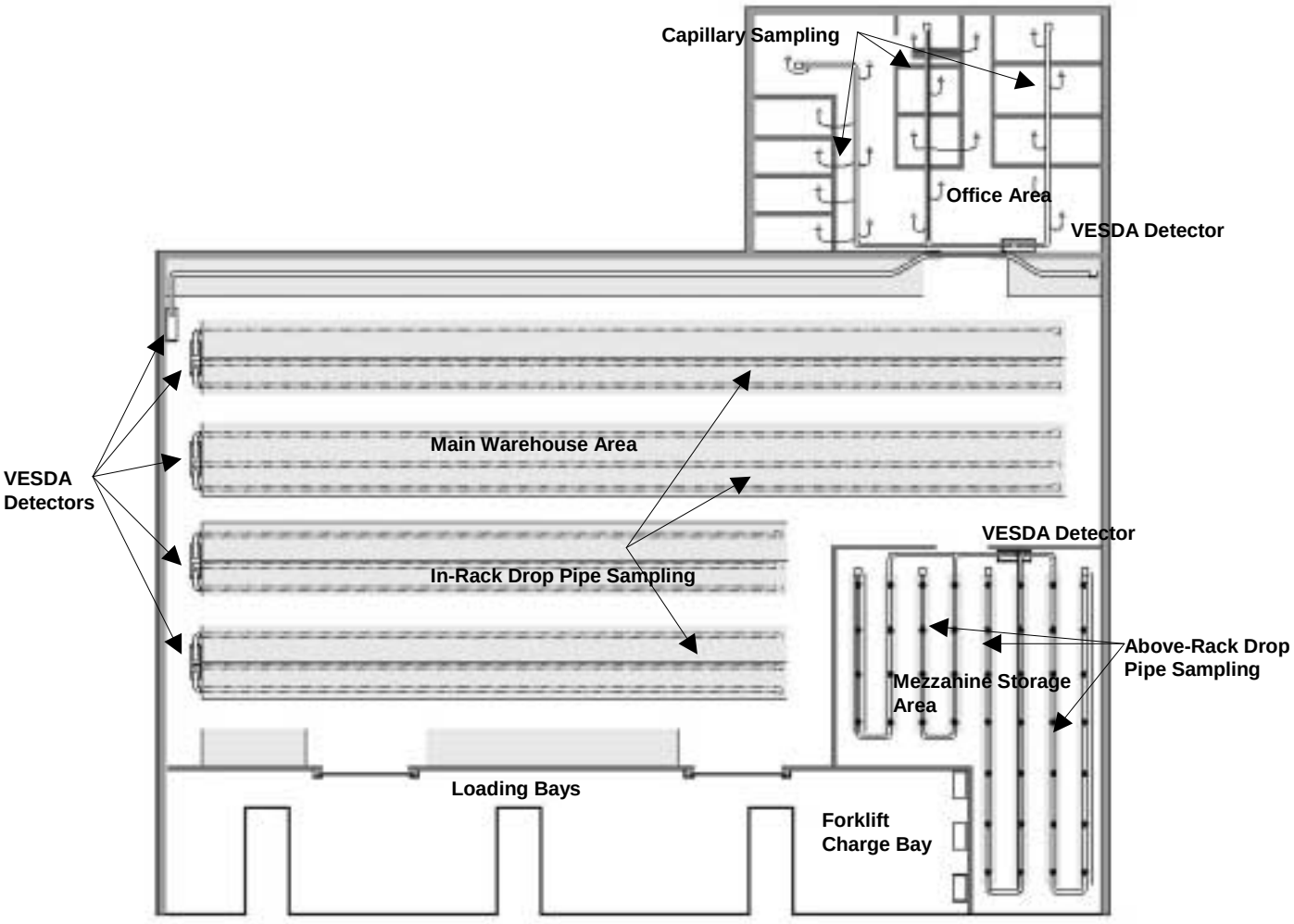

Figure 8 Warehouse Top View - In-Rack, Above-Rack & Capillary Pipework Configuration

7.3. LOADING BAY

The VESDA LaserPLUS detector has been configured to a lower sensitivity to accommodate the truck exhaust that routinely enters the loading bay environment.

7.4. OFFICE/EMPLOYEE ACCESS AREAS

The consideration of aesthetics in the office area is addressed by locating capillary sampling in the ceiling void.

8. GLOSSARY

Backflushing: The application of high-pressure air through the pipework at the detector to flush the sampling holes clean.

CFD Modeling: Computational Fluid Dynamics Modeling provides an accurate representation of the airflow in a particular environment. This allows for changes/additions in the application environment (e.g. placement of equipment) to be factored without expensive real world tests. An estimation of the path that the particulate stream would follow in the modelled airflow is provided.

Conduit Saddle: A saddle shaped pipe fitting for ceiling mounted pipework that allows for movement caused by temperature fluctuations.

Deed Store: An archival storage warehouse that contains valuable documentation (paper, data tape, disk, CD etc.) and usually runs 24 hours, 7 days a week.

Expansion Joint: A flexible pipe expansion coupling to be used where pipe expansion or contraction is an issue. It is similar to a regular coupling adaptor, however, a flexible ‘concertina’ section is located in the middle to accommodate movement in either direction.

T-Joint: A T-shaped PVC pipe joint that is used when installing drop pipes from ceiling mounted pipework.

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