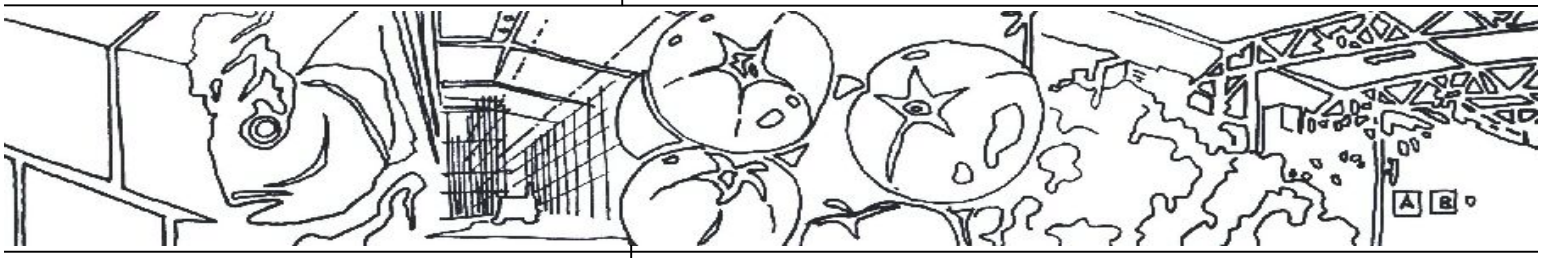
VESDA®

ASPIRATING SMOKE DETECTION



DESIGN GUIDE

COLD STORES

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1. INTRODUCTION

Refrigerated warehouses and cold storage facilities are temperature controlled environments that contain a wide range of inventory such as fresh and frozen foods, pharmaceuticals and pre-packaged product lines. The ultra dry environment, and highly combustible nature of the insulation and packaging materials present a significant fire risk in these facilities. Reliable, very early smoke detection systems can assist in protecting these facilities and the associated stock assets 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. This guide has been developed by VESDA engineers who have extensive design and installation knowledge in cold storage environments.

The Cold Store Design Guide is intended as a reference for consultants and designers involved in the specification of refrigerated storage facilities. It discusses relevant design considerations and recommendations regarding the installation of an aspirating smoke detection system in cold storage environments.

2. DESIGN CONSIDERATIONS

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

- Temperature ranges of the cold store and associated rooms;
- Airflow characteristics of the room;
- Defrost cycles and associated condensation;
- Product flammability and toxicity risks; and
- Penetrations in the ceiling insulation.

3. LEVEL OF PROTECTION

Cold storage environments exhibit harsh climatic conditions. Their operating temperatures typically range between 8°C to –40°C (46°F to –40°F) resulting in extremely dry atmospheres. Key cold store risks include: a) ignition hazards from electrical and mechanical faults from conveyor/transport equipment, b) lighting or hot spots caused by maintenance operations, and c) the fuel hazards from the highly combustible nature of polystyrene and polyurethane foams, wooden pallets and plastic wrapping. The low humidity levels of cold stores further exacerbate the heat release rate of burning materials.

High-bay storage racking can also affect the airflow and impede the detection and response to a fire event.

The extreme temperatures of refrigerated storage facilities are a primary challenge to detecting a cold store fire as most forms of detection are not designed to operate in harsh climatic environments. High airflows created by blast chiller units and condensation (ice formation within the facility) can impede the operation of conventional "passive" detectors. Internationally recognised fire standards further state, that unless specified, smoke detectors should not be installed if the operating temperature is below 0°C (NFPA 72[1]).

Although water supression i.e. sprinklers, may be used in warehouse applications, they may be ineffective in cold storage environments. In the event of a fire, the activation of water can create environmental and occupational hazards such as ice formation (black ice*). The release of water can also generate large amounts of dense fog, causing reduced visibility and impeding an appropriate fire brigade response.

To minimise damage and loss in cold stores, a fire must be detected at a very early stage. VESDA's reliable, very early warning minimises the likelihood of product loss (either from fire and/or contamination), facility damage and operational downtime.

The following guidelines are to assist consultants and designers to achieve the optimum level of protection required by a cold store facility. Internationally recognised fire standards and codes of practice or requirements should always be taken into consideration.

The spacing or density of the sampling holes are dictated by local standards. Sensitivity levels are determined by the application environment and the level of response to specific tests and will not be addressed in this guide.

Table 1 shows the possible areas of protection of a cold store environment.

Areas	Required	Recommended	Optional
Freezers/Chillers	✔		
Plant/Maintenance Areas	✔		
Return Air Path Protection	✔		
Ante-Rooms/Loading Bays	✔	✔	
Racking Protection			✔
Ceiling Void			✔

Table 1 Areas of Protection

The following sections will describe design recommendations related to the different protection areas. All pipework designs should be verified using the VESDA Sampling Pipe Modelling 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.

[1] NFPA 72 National Fire Alarm Code, 1999.

* A thin layer of ice, which forms on concrete due to sprinkler activation.

3.1. PERFORMANCE-BASED DESIGN

Performance-Based design determines the best fire protection system by assessing the environmental risks at the concept design stage. VESDA's advanced detection technology complements existing cold store operations of continual refrigeration, humidity control and storage configurations by utilising this performance-based approach.

It is recommended that smoke testing be performed to determine the optimal location for the VESDA detection system. This also allows accurate identification of direction of smoke travel and level of smoke stratification. These tests are usually performed during the commission phase of the cold store, i.e. prior to containing goods.

NOTE: The addition of stock will further alter the air dynamics (airflow and air direction) of the cold store facility. This should be acknowledged during the design stage.

3.2. ROOM PROTECTION

VESDA provides early warning smoke detection of freezers/chillers, ante-rooms, loading bays, plant and maintenance rooms via pipework positioned either along the underside of the ceiling or directly through the ceiling using capillary tubes.

The first consideration is achieving the best air sampling configuration. There are two (2) alternate approaches:

1) Sampling pipe installed inside the cold store;
2) Sampling pipe installed external to the cold store with capillary tubes entering the cold store.

In most cold store facilities, sampling pipework installed within the cold store is the preferred option as fewer ceiling penetrations are required.

3.2.1. Sampling Point Location

The method of locating the sampling holes is identical in either pipework sampling configuration. Sampling holes in aspirated smoke detection systems are positioned where conventional detectors would normally be placed, and according to local prescriptive standards.

International codes and standards recommend both the area of coverage per detector, and also area coverage at various air change rates. The positioning of the actual detector is usually determined by a simple grid layout. Most standards define different grid spacing dependent on certain criteria. Reference should be made to your relevant standard. Refer to Figure 1.

NOTE: It is advisable to locate the sampling holes outside the direct airflow path of the Chiller unit.

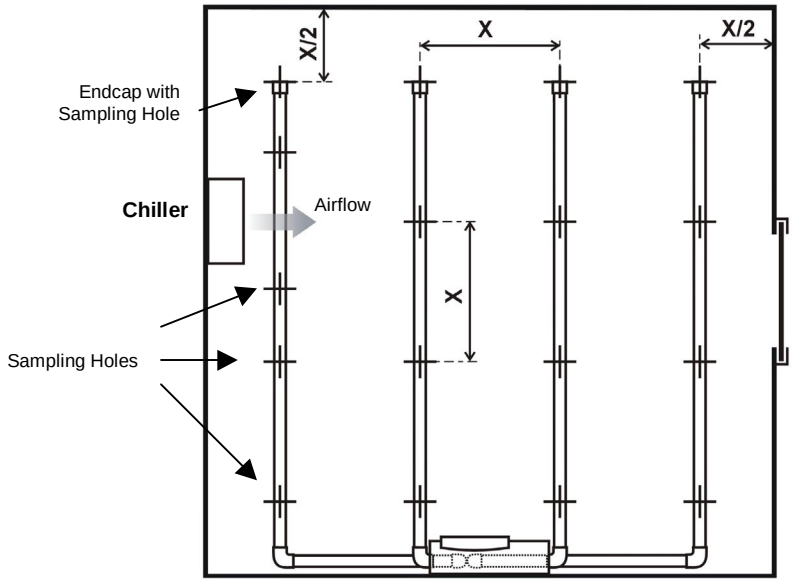


Figure 1 Grid Layout for Sampling Hole Locations
(X = sampling hole distance – refer to relevant standard)

3.3. ALONG UNDERSIDE OF CEILING

Using the above grid layout method, the sampling pipes may be positioned along the underside of the ceiling. Refer to Figure 2.

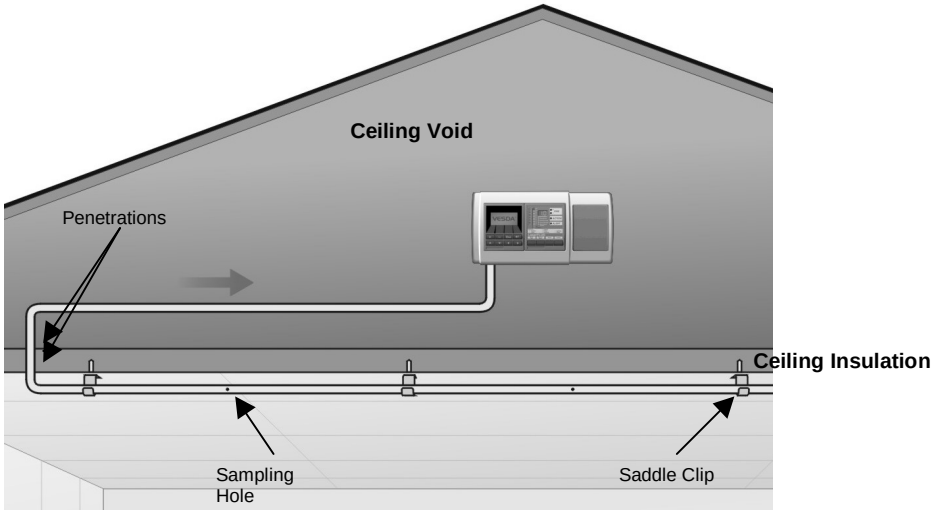


Figure 2 Sampling Pipe Along Underside of Ceiling

When installing ceiling mounted pipework, penetrations are drilled through the ceiling insulation panels and must be fully sealed by either urethane foam (solid/rigid material) or mastic (flexible). The pipe may also have a seal and/or insulation boot installed to seal the penetrating pipe through the cold store ceiling. Refer to Figure 3.

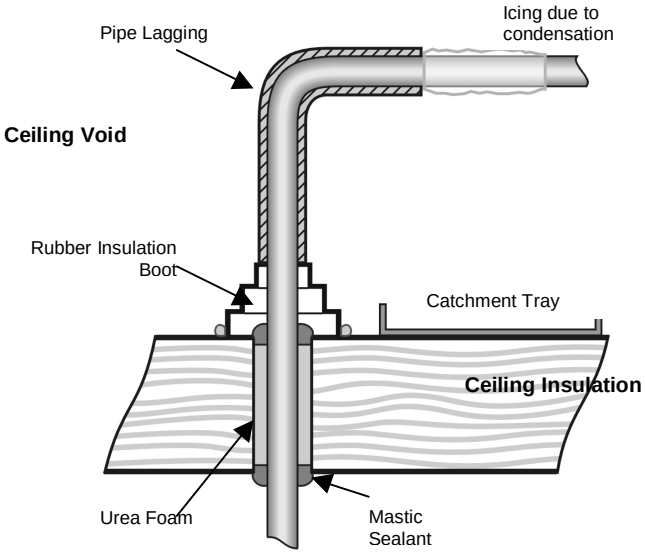


Figure 3 Sealing Holes Through Cold Store Ceiling

For ease of installation, a semi flexible pipe material (e.g. PVC, UPVC, HFT, ABS) is used with ceiling mounted sampling, with particular consideration given to internal temperature fluctuations.

Any mounting clip must allow for pipe movement to accommodate expansion and contraction caused by temperature fluctuations. In particular, where the pipe is installed in ambient conditions, reference must be made to the amout of contraction that will occur as the temperature is reduced.

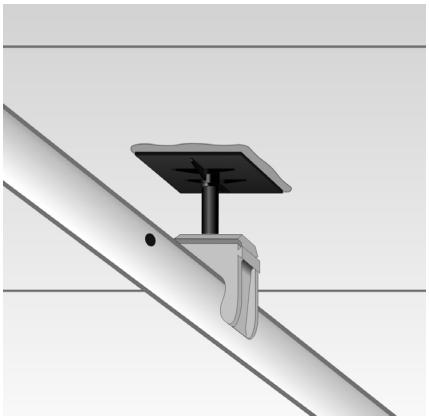
For example, ABS pipe will contract by 0.1% for each 10° C (50°F) drop in temperature. This is equivalent to 40mm (1.57”) in a length of 40m (131.2ft) pipe, and will cause the pipe to pull apart if the

mounting clips constrain the contraction. It may be necessary to locate expansion/contraction offsets every 10 – 20m (32.8 – 65.6ft) to accommodate the change in pipe length.

NOTE: Pipe connectors should not be positioned adjacent to the mounting clip as this may also constrain movement.

To reduce the effect of pipework expansion and contraction caused by climatic changes, pipework is supported by either saddle or offset clips. Refer to Figure 4.

Offset clips are the preferred option in cold store environments. This allows for expansion and contraction of the pipework during defrosting cycles and other major temperature changes and removes the need to penetrate the insulation.



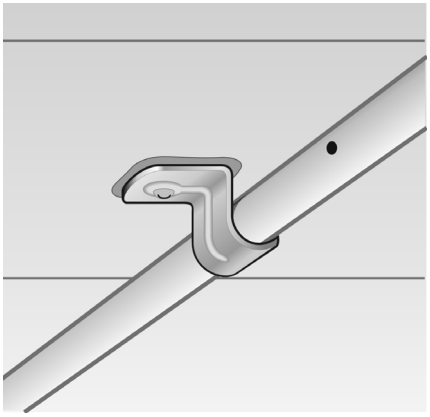


Figure 4 Offset Clip ***Saddle Clip***

NOTE: Sampling holes should be drilled in the side of the sampling pipe. This reduces the accumulation of condensation and ice, which could block sampling holes if drilled underneath the pipe. Refer to Figure 4.

The VESDA detector can be positioned in the ceiling void or external to the protected cold store area.

NOTE: The incidence of condensation accumulating in the sampling pipes and entering the detector is prevented by ensuring the detector is in an inverted position, i.e. the pipework enters the detector from underneath.

VESDA detectors can reliably detect smoke samples to a minimum temperature of -20°C (-18°F), however, it is recommended that the air sample enters the detector at a temperature of 0°C (32°F).

This is most easily achieved by extending the sampling pipe length outside the 0° area and allowing the ambient air to increase the temperature of the sampled air in the pipe. Copper pipe may be used for this process due to its heat transfer abilities;

This configuration is sufficient in the majority of cold storage facilities, and pipe runs of 5-10m (16 – 32.8ft) in the ambient environment is often sufficient.

In cold store conditions where space is limited or pipe runs in ambient temperatures is not possible, the following options may be employed:

Heat Tracing:

If extending the pipe length is not possible, it may be necessary to trace heat the pipe or capillary tube. This involves a combination of sampling pipe with heat tracing if the detector is positioned in the ceiling void. Refer to Figure 5.

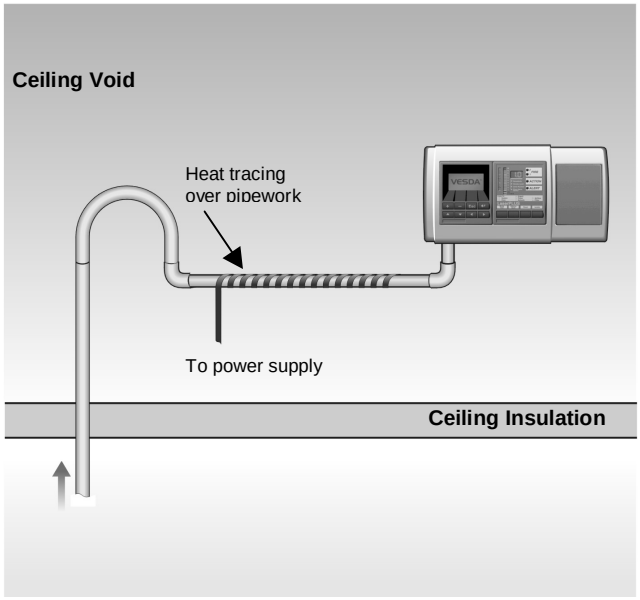


Figure 5 Heat Tracing

Heater Box:

- A heater box may be employed if the length of sampling pipe is not sufficient to allow the air to warm naturally. The heater is housed within an airtight box and is designed to raise the temperature of the sampled air before it reaches the VESDA detector. Refer to Figure 6.

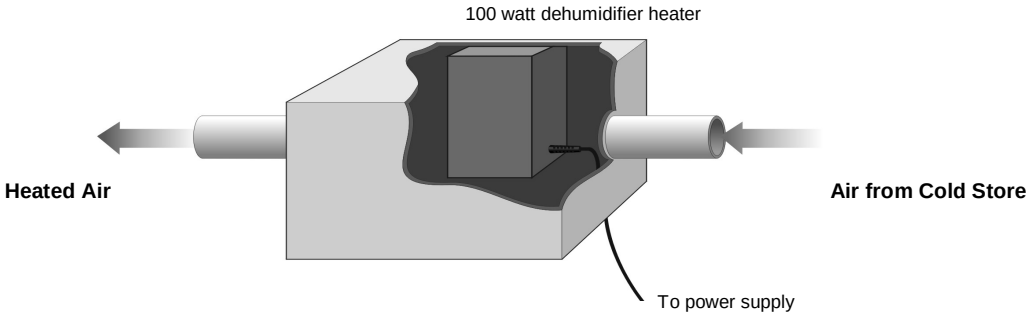


Figure 6 Heater Box Arrangement

3.4. CONDENSATION CONSIDERATIONS

3.4.1. External Condensation

Sampling pipes or capillary tubes that penetrate the insulation layer are inevitably cold as they enter the ambient air space (ceiling void). As a result, condensation is likely to occur on the outside of the sampling pipe and may freeze.

Consideration should be given to insulating the pipe or tube for a short length as it exits the cold store and to move the risk of 'melt condensation' (i.e. water) away from the penetration to an area where it can be tolerated or contained. A water catchment tray is recommended to capture the melt condensation. Refer to Figure 3.

3.4.2. Internal Condensation

Condensation may occur inside the sampling pipe if the external environment is cooler than the VESDA protected area. While unlikely, some cold store applications may present freezing fog which, if drawn through the sampling pipe, may melt. The occurance of freezing fog is usually present in the vicinity of doors and chillers during defrost cycles.

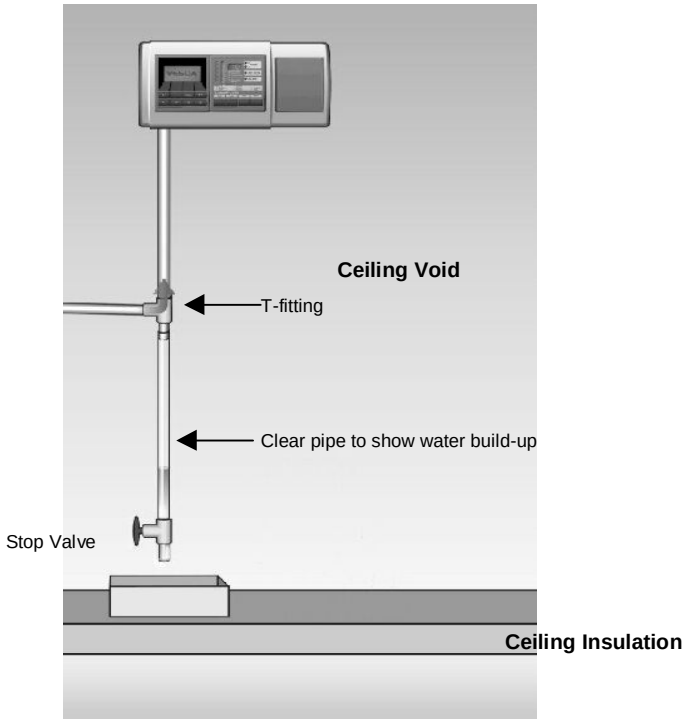


Figure 7 Condensation/Water Trap

A typical water trap configuration requires a T-fitting before the pipe enters the inverted detector, allowing any presence of water to pool at the stop valve. Refer to Figure 7.

The clear section of the sampling pipe allows maintenance personnel to identify and release ay water accumulation by opening the stop valve.

NOTE: It is advised that the stop valve should be open no more than 5 seconds to minimise the occurance of an airflow fault being reported by the detector.

VESDA's ASPIRE Sampling Pipe Modelling Program should be used to verify the performance of the system. As cold temperatures cause air to travel at a slower rate, the sample temperature can be set

to a range of values in the ASPIRE program and response times can then be recorded. It is always recommended that a smoke test be performed to verify the detection system.

Points to Consider:

- It is recommended the VESDA system be fully installed and powered up to ensure optimum air movement through the pipe, and to avoid the incidence of icing. This is performed during the commissioning stage of the cold storage facility.

- To minimise heat transfer during installation in existing cold store retrofits, it is recommended that pipework is blocked at the point that the pipe leaves the protected area into the ceiling void. The pipework can be unblocked once the VESDA detector is connected.

- To avoid icing and condensation, sampling holes should be positioned a minimum of 5 m (16.4 ft) from doorways or chillers (refer to local codes/standards).

NOTE: Temperature and humidity fluctuations may cause condensation to form on the exterior of the pipe as it enters the ceiling void from the cold store area. Insulating the pipework as it enters the ceiling void decreases the level of icing that may form on the exterior of the sample pipe as it exits the freezer. (Refer to Figure 3)

- Capillary sampling is an alternative method to ceiling pipework sampling. The sampling pipe is located in the ceiling space and a capillary sampling tube is connected from the pipe through the ceiling insulation. Air is then directly sampled from the cold store area. Refer to Figure 8.

The capillary sampling hole position should coincide with the grid layout as described in Section 3.2.1.

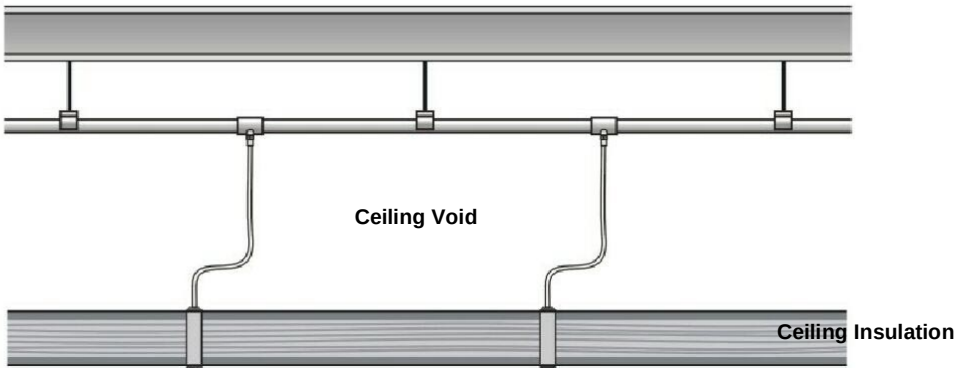


Figure 8 Capillary Sampling

Capillary sampling can be labour intensive as each sampling point must be drilled through the insulation skin of the ceiling. Penetrations need to be fully sealed to prevent 'melt condensation' seeping into the insulation barrier and causing damage to the panel.

Points to Consider:

- Ceiling mounted pipework only requires one pipework penetration through the cold store ceiling. (Refer to Figure 2)

- In comparison, capillary sampling requires a penetration per sampling point. Refer to Figure 8.

3.5. IN-RACK PROTECTION

Sampling pipes for aspirated smoke detection systems may also be located along the cold store racking systems. It is recommended that the detector is positioned in an external area with easy access for service and maintenance. Refer to Figure 9.

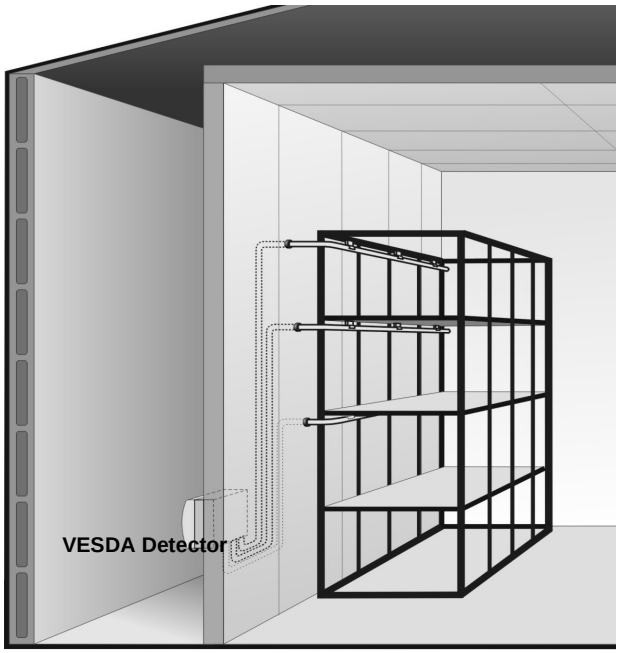


Figure 9 In-Rack Sampling

The identical sampling pipe configuration can also be achieved for racking systems in storage/loading bay areas i.e. ante-rooms.

3.6 VOID PROTECTION

Freezers/Chillers, ante-rooms, loading bays, plant and maintenance rooms can also have protection in the ceiling voids. This is especially relevant if the void contains cabling and equipment which increases the risk of fire. Refer to Figure 10.

To determine the spacing of the sampling holes, the previously described grid layout method should be employed with reference to local codes and standards.

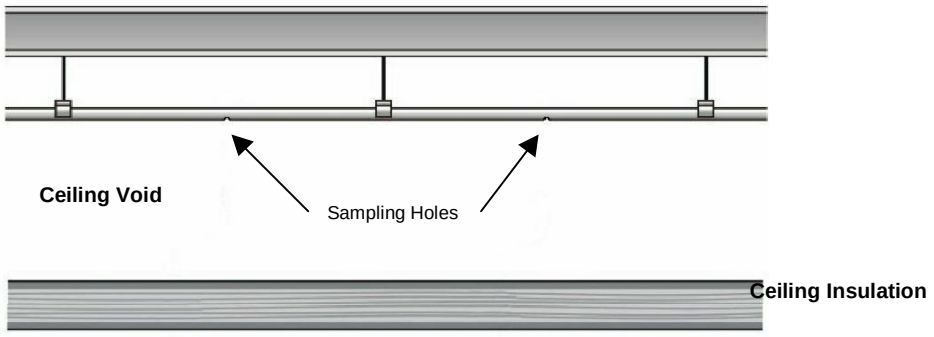


Figure 10 Ceiling Void Protection

4.0 GLOSSARY

Black Ice: A thin layer of ice that forms on concrete due to sprinkler activation.

Heater Box: An airtight box that typically houses a 100 watt dehumidifier heater. The heater raises the temperature of the sampled air before it reaches the VESDA detector.

Heat Tracing: A method of wrapping tape around a copper sampling pipe and running a current through the pipe to produce approximately 30 watts per metre. The temperature of the sampled air is raised by the heat generated in the copper sampling pipe before it reaches the VESDA detector.

Insulation Boot: A watertight seal made of rubber which is fitted around the sampling pipe to keep the sampled air at freezer temperature until it passes through a raised section in the pipework.

Smoke Stratification: Thermal layers which can occur in high roof applications that can prevent smoke from rising to the roof level.

Melt Condensation: The condition that occurs after sampled air is withdrawn from the protected area, and begins to rise in temperature once outside the cold store, causing moisture to become liquid.

Freezing Fog: Moisture cloud which typically form near doors or other areas of heat entry into the cold store.

Commissioning (a cold store): The process of sealing the cold store area (including all fixtures), installing the chillers and bringing the cold store to an operational temperature.

Vision Systems

VESDA®

www.vesda.com

Australia and Asia

Vision Fire & Security
495 Blackburn Road
Mount Waverley VIC 3149
Australia

Ph +61 3 9211 7200
Fax +61 3 9211 7201

Europe and the Middle East

Vision Fire & Security
Vision House
Focus 31 Mark Road
Hemel Hempstead
Herts HP2 7BW UK

Ph +44 1442 242 330

The Americas

Vision Fire & Security
35 Pond Park Road
Hingham, MA 02043, USA

Ph +1 781 740 2223
Toll Free 800 229 4434
Fax +1 781 740 4433