

VESDA[®]

ASPIRATING SMOKE DETECTION



DESIGN GUIDE

Refrigerated Storage

COPYRIGHT INFORMATION

This document may not be reproduced, in whole or in part, by any means without the prior express written permission of the copyright owner.

Copyright © 2003 Vision Fire & Security Pty Ltd. A.C.N. 008 009 514

DISCLAIMER

The manufacturer reserves the right to change designs or specifications without obligation and without further notice. VESDA, LaserTEKNIC, LaserPLUS, LaserSCANNER, LaserCOMPACT, VESDAnet, VESDALink, ASPIRE, AutoLearn, VSM, VConfig, InfoWORKS, PROACTIV and PRECISION are trademarks used under licence by the distributor.

CODES AND STANDARDS INFORMATION

Vision Products strongly recommends that this guide is read in conjunction with the appropriate local codes and standards for smoke detection systems and electrical connections. This guide contains generic information and some sections may not comply fully with all local codes and standards. In these cases, the local codes and standards must take precedence.

CONTENTS

1.	INTRODUCTION.....	4
2.	QUICK GUIDE.....	5
3.	FIRE SAFETY ASPECTS.....	6
4.	PERFORMANCE-BASED DESIGN	7
5.	KEY DESIGN ISSUES.....	8
6.	EFFECTIVE PROTECTION	9
6.1.	Sample Pipes	9
6.2.	Sampling Point Location	10
6.3.	Along Underside of Ceiling	11
6.4.	Through the Ceiling Using Capillary Tubes	12
6.5.	In-Rack Protection.....	13
6.6.	Void Protection.....	13
6.7.	Office/Monitoring Area Protection.....	13
7.	CONDENSATION AND CRYSTALLISATION.....	14
7.1.	External Condensation and Crystallisation.....	14
7.2.	Internal Condensation	15
7.3.	Internal Crystallisation.....	15
8.	OTHER CONSIDERATIONS.....	16
8.1.	Ambient Air Warming.....	16
8.2.	Heat Tracing.....	16
8.3.	Exhaust Air Treatment	17
8.4.	Water Trap.....	17
8.5.	Further Considerations.....	18
9.	CONCLUSIONS.....	19
	APPENDIX A: ESTIMATED COPPER AND PVC PIPE LENGTH.....	20
	APPENDIX B: ESTIMATED COPPER PIPE AND HEAT TAPE LENGTH	21
	GLOSSARY	22
	SUMMARY OF LIMITATION OF LIABILITY FOR VISION FIRE & SECURITY	23

1. INTRODUCTION

Refrigerated warehouses and storage facilities are temperature-controlled environments that contain a wide range of inventory from fresh and frozen foods to pharmaceuticals. Plant and heavy machinery such as forklifts and conveyors, coupled with a dry environment and high airflow present a significant fire risk in these facilities. Unforeseeable events can lead to rapid fire spread between wooden pallets and other packaging materials. Reliable, very early smoke detection systems can assist in protecting these facilities and associated stock assets from the threat of fire.

As an innovative pioneer and market leader of aspirating (air sampling) technology, VESDA provides the earliest possible warning of a potential fire by detecting the incipient (pre-combustion) stage of a fire event. VESDA has been a proven solution in refrigerated storage protection for many years.

The purpose of this Design Guide is to provide installation and application considerations for suitably qualified and competent fire engineering practitioners involved in the specification of refrigerated storage facilities. It discusses relevant design considerations and recommendations regarding the installation of the VESDA aspirating smoke detection system in refrigerated storage environments.

VESDA engineers who have extensive design and installation knowledge in refrigerated storage environments have developed this Design Guide.

2. QUICK GUIDE

The Quick Guide shown in Table 1 provides an overview of key design considerations and may be used as a quick reference only. It should be used in conjunction with the entire Refrigerated Storage Design Guide and VESDA System Design Manual¹ principles to produce a robust system design.

Table 1: Quick Guide

Component	Key Design Considerations	Details
Pipe	<ol style="list-style-type: none"> 1. Ensure airtight connection in sampling network 2. Use suitable low temperature pipe material 3. Avoid subjecting sampled air to differing sub-freezing temperature inside freezer area 4. Ensure freezer integrity is maintained at all pipe penetration points 5. Return exhaust air back to the protected zones 6. Use water traps only when the external temperature is lower than protected zone 	<p>Section 6.1</p> <p>Section 6.1</p> <p>Section 7 (7.3)</p> <p>Section 6.1, 6.3, 7.1, 8.3</p> <p>Section 8.3</p> <p>Section 8.4</p>
Sampling Points	<ol style="list-style-type: none"> 1. Keep sampling points distant from freezer openings 2. Avoid sampling directly from chiller supply airflow 	<p>Section 6.2, 7.1</p> <p>Section 7.3</p>
VESDA Detector	<ol style="list-style-type: none"> 1. Detectors must be situated outside sub-freezing areas 2. Install detectors in inverted position to avoid possible water entering detector through sampling network 3. Consider sampled air warming techniques when necessary 	<p>Section 5</p> <p>Section 6.3, 6.4, 7</p> <p>Section 8.1, 8.2</p>

¹ VESDA System Design Manual Version 2.2 December 1997, Vision Systems Ltd.

3. FIRE SAFETY ASPECTS

Refrigerated storage environments exhibit diversified and harsh climatic conditions. Their operating temperatures typically range between -40°C (-40°F) (freezers for frozen goods in very dry atmospheres) to 18°C (65°F) (coolers for foods)². In any sub-freezing environment, the relative humidity is typically in the order of 10 to 15% but can change rapidly, due to small changes in temperature.

Key refrigerated storage risks include:

- a) Ignition hazards due to electrical and mechanical faults from conveyor/transport equipment.
- b) Lighting or hot spots caused by maintenance operations.
- c) In the event of fire, health and safety issues and damage to goods stored in the facility due to toxic smoke created from the heating of polystyrene, urethane foams, fire rated rockwool panels and plastic wrapping.
- d) Fire spread from outside or roof space due to equipment faults and large quantity of wood pallets.
- e) Human factors such as cigarette butts thrown out by truck drivers and arson.

The extreme temperatures and a variety of room environments in refrigerated storage facilities are a primary challenge to detecting a refrigerated storage fire. This is because most forms of detection technologies are not designed to operate in harsh climatic environments and those which are, do not provide early warning of a fire event. High airflows created by blast chiller units and condensation (ice formation within the facility) will impede the operation of conventional "passive" detectors. The distinctiveness of this challenge is also recognised by internationally recognised fire standards that state unless specified, "*smoke detectors shall not be installed if the ambient temperature is below 32°F (0°C)*" (NFPA 72³).

Although water suppression mechanisms i.e. sprinklers, can be used in warehouse applications, they may be less effective in refrigerated storage. In the event of fire, the activation of water can create environmental and occupational hazards, e.g. ice formation on the floor (black ice). The release of water can generate large amounts of dense fog, causing reduced visibility and impeding appropriate fire service response and human evacuation in areas where the frozen goods are handled. When sprinklers are pre-action type, VESDA can serve as a driver (detection) system.

To minimise damage and loss in refrigerated storage, a fire event must be detected at a very early stage. VESDA's reliable and very early warning minimises the likelihood of asset loss (either from fire and/or contamination), facility damage and operational downtime. Due to the nature of air-sampling technology, detectors can be located outside the protected zones for ease of maintenance.

Using this Design Guide, fire engineering consultants and designers can achieve a risk management solution for refrigerated storage facility protection. Fire standards and codes of practice or requirements having jurisdiction must always be taken into consideration.

The spacing or density of the detection points (sampling holes) can be dictated by local prescriptive standards. Sensitivity levels are determined by the application environment and the level of response to specific tests. VESDA allows the flexibility for system designers and engineers to adjust the spacing and placement of sample holes to suit individual performance requirements.

² FM Global Property Loss Prevention Data Sheets 8-29, Revision 2000

In this Design Guide, Freezers temperature range is -40°C (-40°F) to -15°C (5°F), Chill Rooms temperature range is -9°C (16°F) to 2°C (36°F), Coolers and Loading Bays temperature range is 0°C (32°F) to 18°C (65°F), Ceiling Void and detector mounting area temperature is above freezing 0°C (32°F).

³ NFPA 72 National Fire Alarm Code, 1999, Page 72-35, Section 2-3.6.1.1.

4. PERFORMANCE-BASED DESIGN

Performance-Based design determines alternative fire protection solutions and methods by assessing the environmental risks and fire safety objectives at the conceptual design stage. Standard risk management concepts (such as AS/NZS 4360, 1999⁴ and SFPE Handbook Third Edition, 2002⁵) can be used to assess the management of the fire safety in refrigerated storage facilities.

Utilising a performance-based approach, VESDA's advanced detection technology complements refrigerated storage operations and ensures business continuity.

Table 2 shows the possible areas of protection of a refrigerated storage.

Table 2: Areas of Protection

Areas	Required	Recommended	Optional
Freezers/Chill Rooms	✓		
Coolers	✓		
Plant & Maintenance Areas	✓		
Return Air Path Underside Protection		✓	
Loading Bays & Surrounding Areas	✓		
Office/Monitoring Area Protection			✓
Ceiling Void	✓		
In-Rack			✓

NOTE: *The addition of stock and racking may alter the air dynamics (airflow and air direction) of the protected zones. This should be acknowledged during the design stage.*

⁴ AS/NZS 4360 Risk Management, Standard Australia, 1999.

⁵ The SFPE Handbook of Fire Protection Engineering, Third Edition, 2002, Section Five.

5. KEY DESIGN ISSUES

The following aspects should be taken into consideration during the specification and design of a VESDA aspirating smoke detection system:

- Level of protection required and fire safety management;
- Airtightness and integrity of the entire pipe network.
- Temperature ranges of the refrigerated storage and associated areas of interest;
- Future room function changes (e.g. from a Chill Room to a Cooler) due to demand or operation;
- Temperature and humidity characteristics of protected zones, areas for extended pipe network and area where detectors are situated;
- Airflow characteristics of the protected zones, entrance and loading areas and pipe insulation requirements;
- Implication of defrost cycles and associated condensation;
- Possible frost formation in pipes across two different sub-freezing zones;
- Detector exhaust air handling and possibility of condensation outside the protected zones;
- Racking configuration within each protected zone;
- Penetrations through the ceiling and wall insulation.

NOTE: Detectors MUST be located outside sub-freezing environment or within a temperature controlled enclosure.

6. EFFECTIVE PROTECTION

This section describes design methodologies and considerations related to different functional areas. All pipe network designs should be verified conservatively using the VESDA Pipework Modelling Program – ASPIRE⁶. This program illustrates the significance of various parameters in an aspirating smoke detection system so that the most appropriate design can be applied.

6.1. Sample Pipes

VESDA provides early warning smoke detection of freezers/chill rooms, coolers, loading bays, plant and maintenance rooms via pipe network positioned either along the underside of the ceiling or directly through the ceiling using capillary tubes.

The main objective is to achieve the best air-sampling configuration. There are two (2) alternative approaches:

- 1) Sampling pipe installed inside the refrigerated storage along underside of the ceiling (Figure 2). This approach is recommended and requires minimal pipe penetrations through the ceiling or wall. It can be applied in most applications.
- 2) Sampling pipe installed external to the refrigerated storage with capillary tubes entering the refrigerated storage areas (Figure 5). This approach requires a penetration per sampling point. Penetrations need to be fully sealed to prevent 'melt condensation' seeping into the insulation barrier and causing icing on the ceiling panel. It has been proven suitable only in refrigerated storage with ceiling void space.

For ease of installation, semi-flexible pipe material suitable for low temperatures (e.g. PVC, CPVC, HFT, ABS and HDPE) is used with ceiling mounted sampling, with particular consideration given to internal temperature fluctuations. If the freezer runs at a temperature below – 28 °C (– 18 °F), run the sampling pipes in HFT or similar to prevent the pipe becoming brittle and breaking. Table 3 provides details of some commonly used pipes in refrigerated storage applications.

Table 3: Pipe Contraction and Applications⁷

Material	Operating Temperature	Thermal Contraction	Recommended Applications
PVC	-18 to 49 °C (0 to 120 °F)	7.0 mm ± 1mm per 10m per 10 °C (0.28" ± 0.04" per 32.8ft per 18 °F)	Above -20 °C (Above 0 °F)
HFT	- 40 to 140 °C (- 40 to 284 °F)	7.0 mm per 10m per 10 °C (0.28" per 32.8ft per 18°F)	Above - 40 °C (Above - 40 °F)
ABS	- 40 to 80 °C (- 40 to 176 °F)	10.1 mm per 10m per 10 °C (0.4" per 32.8ft per 18 °F)	Above - 40 °C (Above - 40° F)
CPVC	- 18 to 94 °C (0 to 201 °F)	6.7 mm per 10m per 10°C (0.26" per 32.8ft per 18°F)	Above – 20 °C (Above 0 °F)
PE-80	- 50 to 60 °C (-58 to 140 °F)	20 mm per 10m per 10°C (0.79" per 32.8ft per 18°F)	Above –50 °C (Above –58 °F)
PE-100	- 50 to 60 °C (-58 to 140 °F)	13 mm per 10m per 10°C (0.52" per 32.8ft per 18°F)	Above –50 °C (Above -58 °F)

Consider Armaflex⁸ or similar Pipe Insulation for pipe insulation. For a single 25mm (0.98") pipe, use at least 9mm (0.35") insulation wall thickness. Use 13mm (0.51") or 19mm (0.75") wall thickness when number of pipes is insulated together.

⁶ ASPIRE Pipework Modelling Program Version 3.09.10, ©Copyright 2002, Vision Systems Ltd.

⁷ Operating temperature range for different types of PVC/ABS pipes vary. (1) PVC/CPVC - The Plastics Pipe Institute, Inc (www.plasticpipe.org) "Suggested Temperature Limits for the Operation and Installation of Thermoplastic Piping in Non-Pressure Applications TN-11/99", December 1999; (2) ABS - Plastic Pipe and Fittings Association (PPFA) (www.ppfahome.org) "Information & Technical Guide – ABS Plastic Pipe & Fittings"; (3) HFT - Clipsal (www.clipsal.com) "HFT Conduits & Fittings"; (4) PE - George Fisher (www.piping.georgefisher.com) "Planning Fundamentals Industrial Piping Systems", 2002.

⁸ Armaflex pipe insulation temperature range is -40 °C (-40 °F) to 105 °C (221 °F), density 88-105kg/m³, excellent flexibility.

6.2. Sampling Point Location

Sampling holes in aspirated smoke detection systems can be positioned where conventional detectors would normally be placed, according to local prescriptive standards. Alternatively, the configuration can be altered to meet performance requirements.

International codes and standards recommend spacing and/or the area of coverage per detector. The spacing requirements are modified by factors such as sloping ceilings, ceiling height, beams, air change rate in the protected environment, etc. The positioning of the actual sampling holes is usually determined by a simple grid layout as shown in Figure 1. Most standards define different grid spacing dependent on certain criteria. Reference should be made to your relevant codes and standards.

NOTE: *It is advisable to locate the sampling pipes (a) outside the direct supply airflow path of the chiller unit; (b) away from any entrance.*

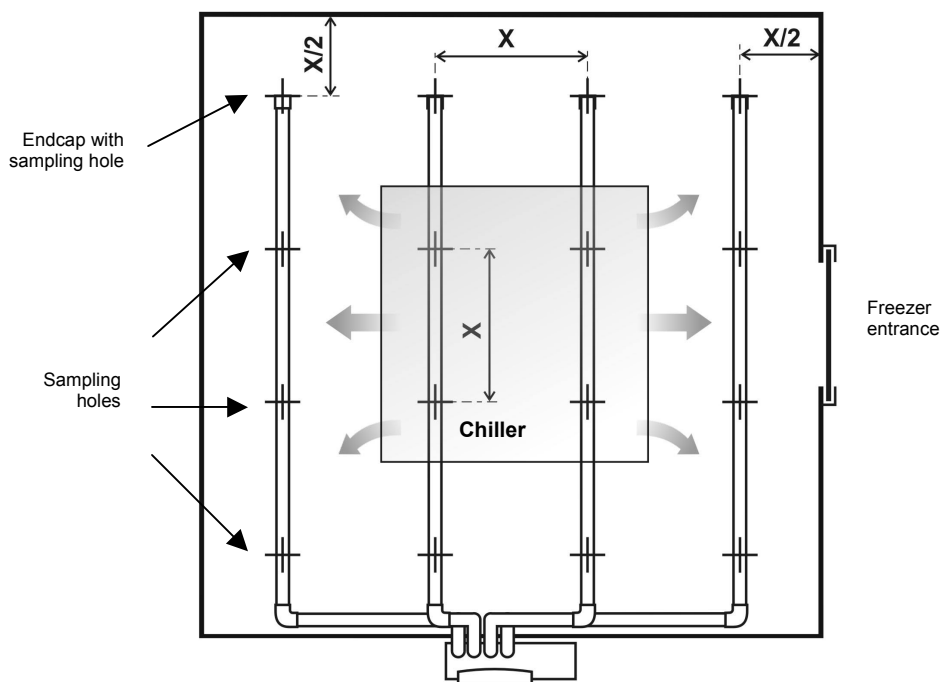


Figure 1: Top View - Grid Layout for Sampling Holes
(*X = sampling hole distance – refer to relevant standard*)

6.3. Along Underside of Ceiling

Using the above grid layout method, the sampling pipes may be positioned along the underside of the ceiling as shown in Figure 2.

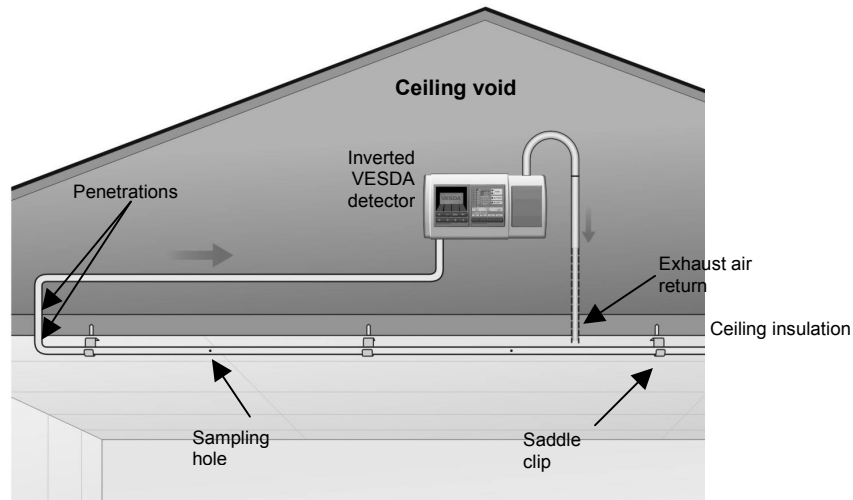


Figure 2: Sampling Pipe Along Underside of Ceiling

NOTE: When the detector temperature is lower than the protected room temperature (due to seasonal change, etc.), the incidence of condensation accumulating in the sampling pipes and entering the detector can be prevented by ensuring the detector is in an inverted position, i.e. the pipe enters the detector from underneath (Figure 2).

When installing ceiling mounted pipe network, penetrations are drilled through the ceiling or nearby wall insulation panels and must be fully sealed by either urethane foam (solid/rigid material) or mastic (flexible). To ensure airtightness, the pipe may also have a seal and/or insulation boot (Figure 3) installed to seal the penetrating pipe through the ceiling or wall.

Ice or water due to condensation will form if any air leakage occurs through penetration.

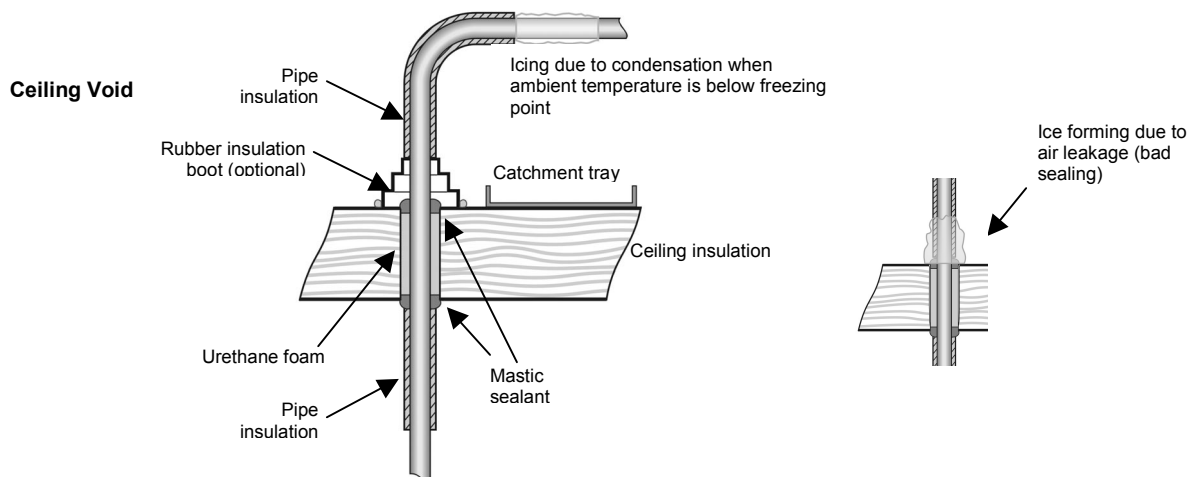


Figure 3: Sealing Holes Through Refrigerated Storage Ceiling or Wall

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 amount of contraction that will occur as the temperature is reduced.

For example, according to the thermal expansion coefficients, ABS pipes 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 installed in the freezer and chill room at ambient temperatures. It may be necessary to locate expansion/contraction offsets every 10 – 20m (32.8 – 65.6ft) to accommodate the change in pipe length. Refer to Table 3 for details of commonly used pipe contraction.

To reduce the effect of pipe expansion and contraction caused by climatic changes, pipe clips must not restrict longitudinal movements of the pipe. The pipe is supported by either saddle or offset clips as shown in Figure 4.



Figure 4: Pipe Network Supports

NOTE: Clips should allow pipe movement. Pipe connectors should not be positioned adjacent to the mounting clip as this may also limit movement.

An offset clip is an acrylic adhesive mounting pad with a threaded rod that is mounted to the normal mounting clip and allows for expansion and contraction of the pipes due to major temperature changes. Offset clips or similar are the preferred option for sampling pipe mounting in the freezers and chill rooms, as they do not require penetrations to be drilled through the ceiling insulation panel.

6.4. Through the Ceiling Using Capillary Tubes

When it is impossible to run the sampling pipe along underside of the ceiling, capillary sampling can be an alternative method. The sampling pipe is located in the ceiling void space and a capillary sampling tube is connected from the pipe through the ceiling insulation. Air is then directly sampled from the refrigerated storage area as shown in Figure 5.

The capillary sampling hole position should coincide with the grid layout as described in Section 6.2.

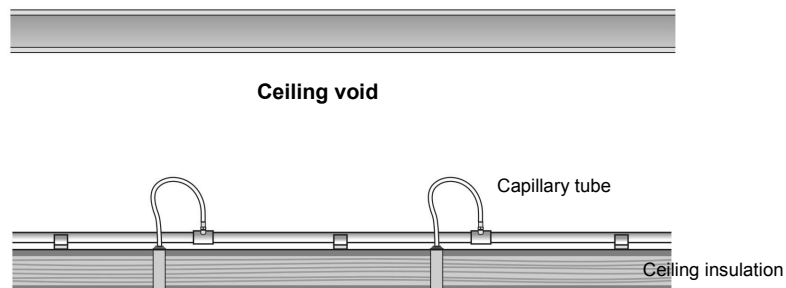


Figure 5: Capillary Sampling

6.5. In-Rack Protection

Sampling pipes for aspirated smoke detection systems may also be located along the storage racking systems within the refrigerated storage areas as shown in Figure 6.

In-rack sampling pipes should access the protected area at the pipe level. When capillary tubes are used, excessive tube length must be avoided when very fast response is required. It is recommended that the tube length be less than four (4) meters.



Figure 6: In-Rack Sampling

6.6. Void Protection

Ceiling voids usually have a lot of electrical cables, machinery and other refrigerated storage control equipment installed. It represents the greatest fire risk in a refrigerated storage environment. It is important to provide very early warning protection in these spaces.

To determine the spacing of the sampling holes (Figure 7), the previously described grid layout method should be employed with reference to local codes and standards. Dedicated VESDA detectors must be used to protect the void area.

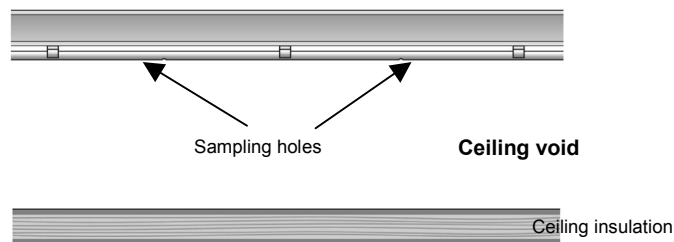


Figure 7: Ceiling Void Protection

6.7. Office/Monitoring Area Protection

Office and facility monitoring areas may contain important business information and mission critical control and monitoring equipment, and therefore require VESDA very early warning smoke detection.

The sampling hole spacing, pipe network layout guidelines, etc. are identical to the general office environment recommendations made in the VESDA System Design Manual, with reference to local codes and standards where appropriate. Detection sensitivity can be adjusted to meet performance requirements.

7. CONDENSATION AND CRYSTALLISATION

Condensation only occurs when air is cooled. This can be caused when (1) external temperature is lower than the sampled air temperature; and (2) sampled air travelling along the pipe is cooled by environment such as a chiller supply air. Even though the temperature is low inside the freezers and chill rooms, the average relative humidity is around 10 to 15%. For other areas such as Coolers, the temperature is higher therefore the water content is higher too.

When relatively higher temperature air travels to a lower temperature environment, condensation occurs if the dew point temperature is higher than the air temperature⁹. Moisture leaves the air turning into water droplets (Condensation when temperature is above freezing) or frost (Crystallisation when temperature is sub-freezing).

To provide a total smoke detection solution using VESDA, all protected zones must be characterised during the design. The following points must be taken into consideration to prevent pipe and/or sampling hole blockage:

- Understand the temperature and humidity changes of protected zone when the function of the zone is changed, e.g. from a chill room to a cooler to meet operation requirement.
- Assess potential condensation spots throughout the entire pipe network by looking at sampled air temperature, pipe surrounding environment and pipe surface temperature.
- The distance from the pipes and sampling holes to the protected zone entrances and chiller unit supply air path.

The entire pipe network must be airtight to prevent moisture content (warmer air) getting into the pipe.

7.1. External Condensation and Crystallisation

Sampling pipes or capillary tubes that penetrate the insulation panels are inevitably cold as they enter the ambient air space (ceiling void or area outside the protected zones). As a result, condensation is likely to occur on the outside of the sampling pipe and may freeze if environment temperature is below 0°C (32° F).

Occasionally there will be a build-up of ice on the sampling pipe, especially if located near doorways inside the freezer or chill room (Figure 8). This type of ice build-up is considered normal and has no adverse effects on the sampling pipe as long as the sampling holes are located away from the sections that are susceptible to ice build-up. It is recommended that silicon spray be used on these sampling holes and sections of pipe near the entrances to minimise ice build-up.

A catchment tray (Figure 3) is recommended to capture any water outside the protected zone.

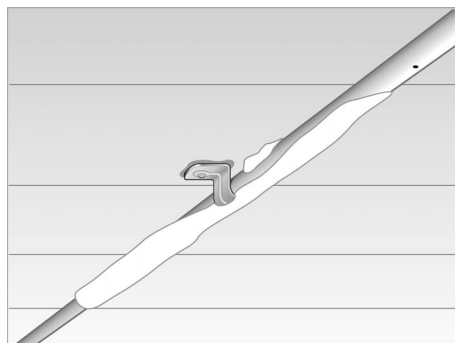


Figure 8: Ice Build-up on the Pipes

⁹ Refer to ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc) Psychrometric Chart for more information (www.ashrae.com).

7.2. Internal Condensation

Internal condensation outside the protected zones is rare. However, it can occur when changing the function of the protected zone and/or be caused by seasonal changes.

For example, if a chill room ($-9^{\circ}\text{C}/16^{\circ}\text{F}$) is turned into a cooler ($8^{\circ}\text{C}/18^{\circ}\text{F}$), the sampled air temperature in the pipe is increased. If the pipe between the cooler and the detector is subject to temperature below 8°C (18°F) during winter, condensation will form if the humidity is high in the cooler.

To minimise the possible condensation accumulating inside the pipe in these circumstances, a water trap is recommended as shown in Figure 12. It is important when designing the pipe network that the sampling pipe exits the protected area on the same horizontal plane as the pipe inside the protected zone. Where the pipes exit from the coolers or loading bays, they must be installed so that any water accumulated around the penetration area due to condensation will “run-away” from the coolers and toward water traps.

7.3. Internal Crystallisation

In order to eliminate the potential of ice plugs forming inside the sampling pipe, the use of pipe elbows to transition the sampling pipe from horizontal to vertical runs should be avoided. Where bends are required use only long radius bends or two 45° elbows.

Chiller supply air temperature is several degrees lower than the average room temperature. To prevent crystallisation inside this section of the pipe, it is important not to install the sampling pipes in the direct supply airflow of the chiller units. If impractical, insulation must be used to ensure that the temperature of the pipe surface is not lower than that of the sampled air. Refer to Figure 9.

NOTE: Pipe network must not cross two different temperature (from “warmer” to “colder”) zones. Use separate VESDA detectors for freezers, chill rooms and other storage areas, and additional detector(s) for void, office and monitoring areas.

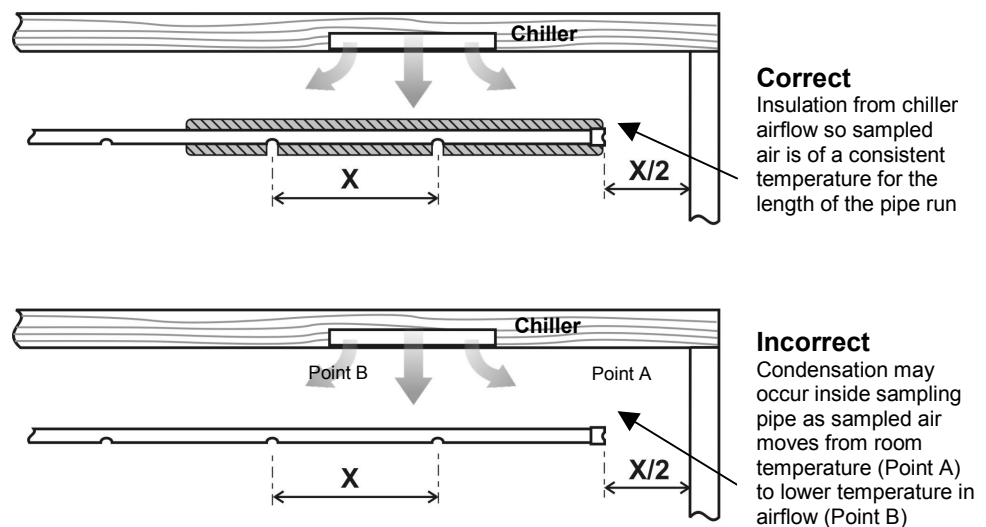


Figure 9: Overcoming Condensation Caused by Chiller Supply Airflow Path

Consideration must also be given to insulating the pipe or tube for approximately one meter (3.28 ft), **on the exit and entry of the penetration of the protected zones** to prevent ice blockage near the penetration areas.

8. OTHER CONSIDERATIONS

VESDA detectors can reliably detect smoke sampled from an environment temperature of -40°C (-40°F). However, it is recommended that the detector to be installed in above freezing environment for optimum detection and easy maintenance access. In circumstances where sampled air temperature need to be increased from -40°C (-40°F), use of the “Ambient Air Warming” can be considered.

It is also recommended to feed the exhaust of the detector back into the protected zone to construct an airtight pipe network and conserve the energy.

8.1. Ambient Air Warming

This is most easily achieved by extending (if necessary) the sampling pipe length outside the sub-freezing protected zones and allowing the ambient air to increase the temperature of the sampled air in the pipe.

This configuration is sufficient in the majority of refrigerated storage applications. Refer to Appendix A for PVC and copper pipe length estimation. Usually only a short pipe extension is needed.

8.2. Heat Tracing

Vision Fire & Security does not recommend the use of heat tracing. However, in extreme conditions where air warming is required but space is limited and pipe runs in ambient temperatures are not possible or where ambient temperature varies greatly throughout the year, a Heat Tracing option may be employed. You must consult engineering personnel for the correct application of a heat tracing. This section serves a general information purpose, not an application guideline.

There are several options including hot water heat exchangers, electrically heated tape or passing the pipe through an area that is heated to around $5 - 10^{\circ}\text{C}$ ($41 - 50^{\circ}\text{F}$). However heat tape is usually used for ease of installation. An example of a pipe fitted with a heated tape¹⁰ is illustrated in Figure 10. If surface temperature is high, insulation is applied over the heat tapes. Refer to Appendix B for copper pipe and heat tape length estimation.

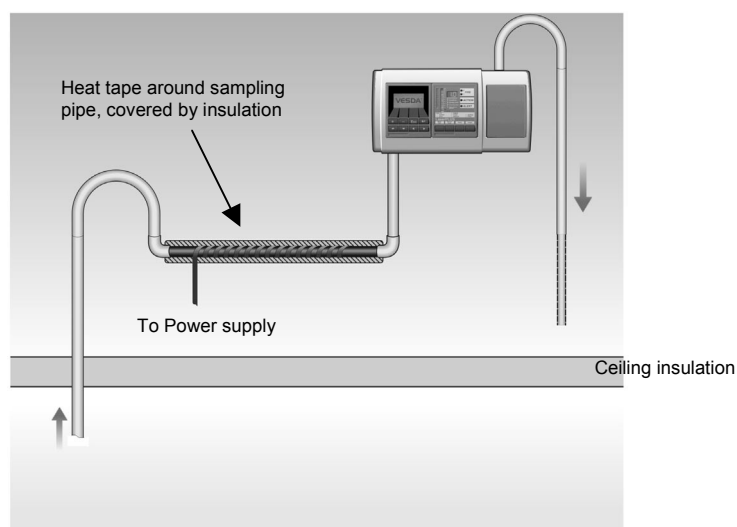


Figure 10: Heat Tracing

¹⁰ Heat tape 5BTV2-CT or 3BTV1-CR from Raychem may be used.

To apply a heat trace solution, further guidance and assistance should be obtained from the supplier on use of their products. Only a qualified technician should install these products.

8.3. Exhaust Air Treatment

Consideration should be given to return the exhaust air from the VESDA back into the freezers and chill rooms. Sampling from the freezers should be maintained as a closed environment, otherwise when the VESDA detector is powered down, for any length of time a small pressure difference may result in warm and highly humid air entering the detector exhaust port and travelling through the pipes into the freezers. Feeding exhaust air back into the freezers can also conserve energy and eliminate any possible condensation around an open exhaust pipe.

Figure 11 illustrates how the exhaust port pipe is fed back into the freezer or chill room. The return pipe must be kept as short as practical. Otherwise as a minimum, all inlet/exhaust pipes must be blocked during routine power-down or when detectors are removed for service and maintenance.

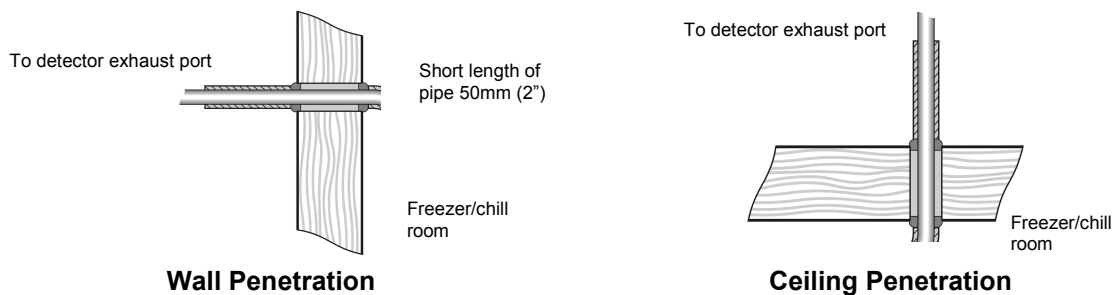


Figure 11: Example of Exhaust Air Fed Back to Protected Zone

8.4. Water Trap

As described in Section 7.2, water trap is only required in very special circumstance. It is not a requirement of the VESDA detection system. It is a measure to accommodate diversity of environment conditions encountered in refrigerated storage applications.

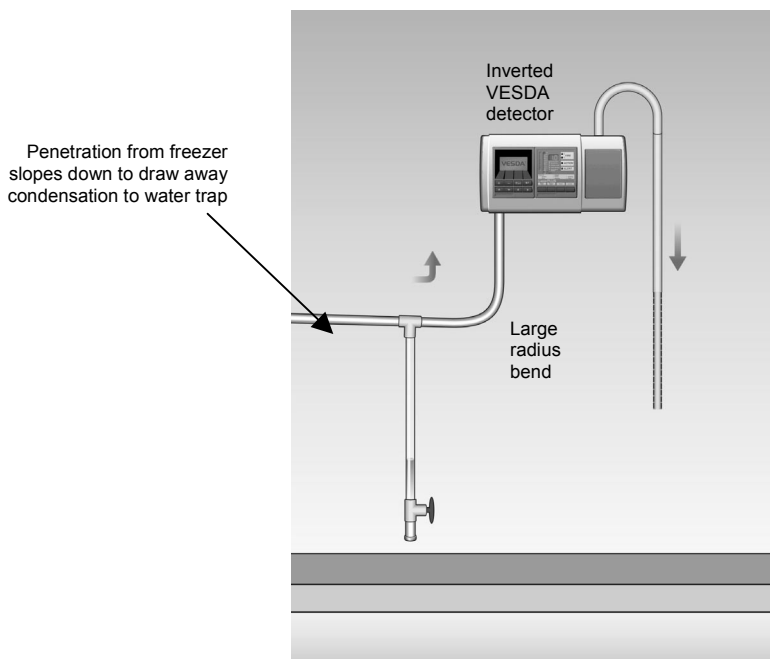


Figure 12: Sample of Water Trap

A typical water trap configuration requires a T-fitting before the pipe entering the inverted detector, allowing any presence of water to pool at the stop valve. The clear section of the sampling pipe allows maintenance personnel to identify and release any water accumulation by opening the stop valve. An End Cap should be installed and fully sealed as shown in Figure 12.

NOTE: The stop valve must be closed immediately after water is drawn. The water trap may be removed if there is no sign of condensation after months of operation.

8.5. Further Considerations

VESDA's ASPIRE Sampling Pipe Modelling Program can be used to verify the performance of the system and integrity of the pipe network. 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 transport times can then be calculated. Calculations should be applied **conservatively** to satisfy strict smoke transport time requirements.

Smoke tests can be performed to verify the performance of the detection system. Other considerations include:

- Ensure the VESDA system is fully installed and powered up during the commissioning stage of the refrigerated storage to ensure detectors adjust to the environment gradually.
- For existing refrigerated storage retrofits, it is recommended that pipework be blocked at the point where the pipe leaves the protected zone to outside the protected area. The pipework can be unblocked once the external pipework and the VESDA detector are connected to minimise heat transfer during installation.
- Consider high sensitivity smoke detection in refrigerated storage support rooms, as this is usually where the control and plant equipment is located. It represents one of the greatest risks to business continuity.
- Protection enclosures may be required to guard against weather or mechanical damage of the detectors.
- Service and maintenance of the installed VESDA systems should be performed in accordance with the procedures outlined in the Maintenance section of the VESDA System Design Manual. The frequency of the inspection and testing of the sampling piping should be scheduled to coincide with the rate of ice build-up on the sampling pipes to keep all sampling holes free of ice.

9. CONCLUSIONS

This Design Guide provides in-depth explanations of how to implement a very early warning smoke detection system VESDA to provide effective protection in refrigerated storage environments. VESDA provides performance-based solution to prevent asset loss and ensure business continuity.

VESDA also provides flexible and reliable early warning detection in this very challenging environment. Using performance-based fire safety system design, VESDA can be implemented for all freezers, chillers, general cooler areas, loading bays, ceiling voids, offices. It has been proven a very beneficial and fit-for-purpose solution in refrigerated storage asset protection.

Experience and innovation in protecting refrigerated storage in the past ten years has resulted in many successful VESDA installations around the world. However, if this Design Guide does not cover the unique situation of your application please consult your local VESDA representatives for further information.

APPENDIX A: ESTIMATED COPPER AND PVC PIPE LENGTH

The following charts estimate the pipe length requirement for sampled air ambient warming. The calculations assume a constant ambient temperature of 20°C (68°F). Pipe surface temperature is 4°C (39°F) throughout the entire pipe length. The pipe length is estimated conservatively.

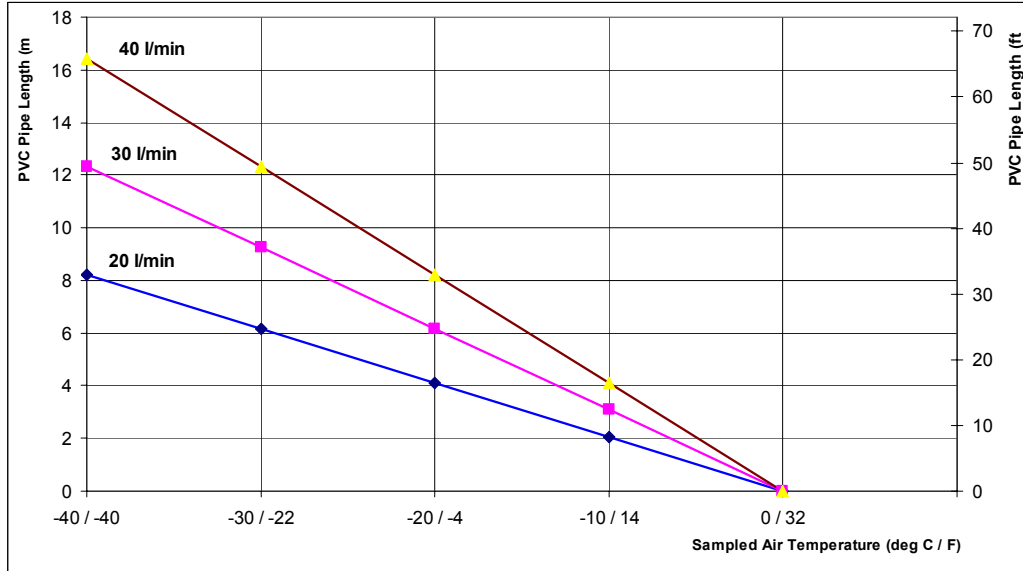


Chart 1: Estimated PVC Pipe Length

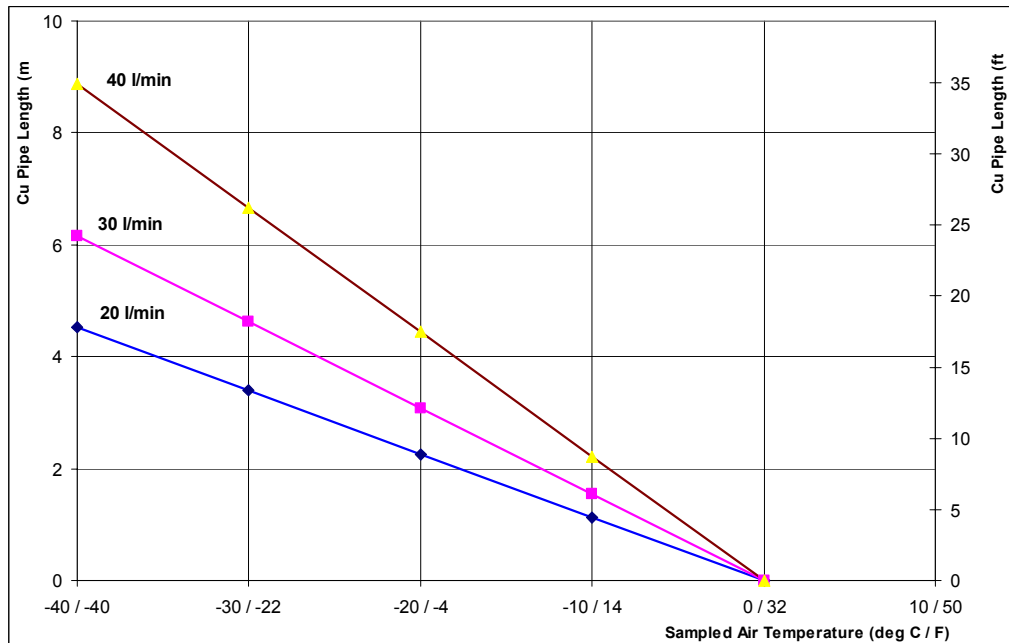


Chart 2: Estimated Cu Pipe Length

Example:

Refer to Chart 1 and 2, if sampled air leaving a freezer is - 40°C (- 40°F), and needs to be raised to 0°C (32°F), the volumetric airflow in the pipe is 30 l/min, the length of PVC pipe and copper pipe required is approximately 12 m (39.36 ft) and 6 m (19.68 ft) respectively.

APPENDIX B: ESTIMATED COPPER PIPE AND HEAT TAPE LENGTH

The following charts estimate the copper pipe and heat tape length requirement for sampled air warming. The calculations assume ambient temperature effect is neglected due to insulation, and copper pipe surface temperature is 35°C (95°F) throughout the entire copper pipe length and tape wrap spaced at 100 mm (3.94”).

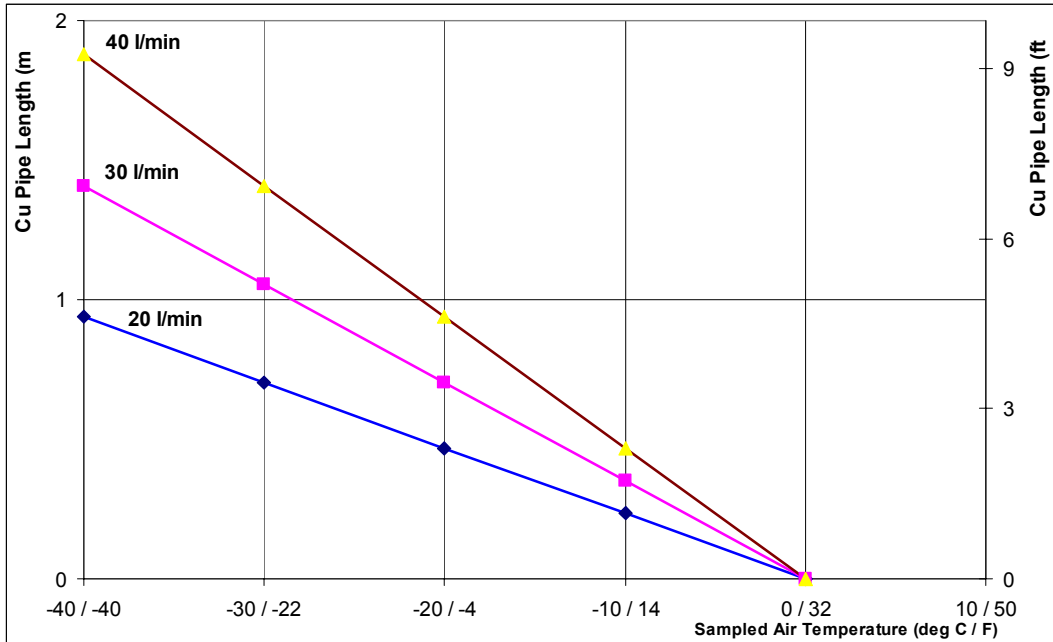


Chart 3: Estimated Cu Pipe Length for Heat Tape

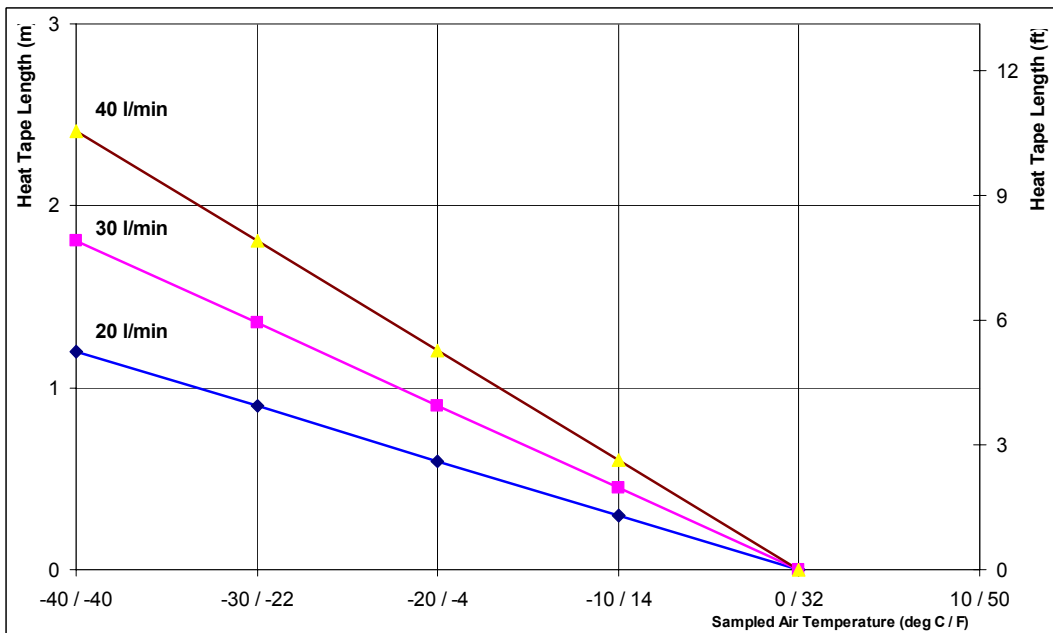


Chart 4: Estimated Heat Tape Length

Example:

Refer to Chart 3 and 4, if sampled air leaving a freezer is - 40°C (- 40°F), and needs to be raised to 0°C (32°F), the volumetric airflow in the pipe is 30 l/min, the length of copper pipe and heat tape required is approximately 1.5m (4.92ft) and 1.8 m (5.90ft) respectively.

GLOSSARY

Black (Slick) Ice:	A thin layer of ice that forms on concrete due to sprinkler activation.
Commissioning:	The process of sealing the refrigerated storage area (including all fixtures), installing the chillers and bringing the refrigerated storage to an operational temperature.
Commissioning (VESDA):	The process of implementing the design of a fire safety solution using VESDA.
Crystallisation:	Frost, a deposit of small white ice crystals formed in or outside the pipes. When a pipe network runs across two different temperature zones, ice may form inside the pipe at the interface of the two areas if the air is moving from “warmer” to “colder” area.
Dew point:	The atmospheric temperature (varying according to pressure and humidity) below which water droplets begin to condense and dew can form.
Freezing Fog:	Moisture clouds that typically form near doors or other areas of heat entry into the refrigerated storage.
Heat Tape:	An electrical heating element that is wrapped around a copper sampling pipe. The heat generated in the copper sampling pipe before it reaches the VESDA detector raises the temperature of the sampled air.
Heat Transfer:	A physical phenomenon to re-distribute heat or energy across objects and media. The theory is applied to calculate pipe length requirements as shown in Appendix A and B.
Insulation Boot:	A watertight seal made of rubber, which is fitted around the sampling pipe to ensure airtight seal around the pipe penetration areas.
Melt Condensation:	The condition that occurs after sampled air is withdrawn from the protected area, and the surrounding warmer air hits the cold pipe surface, causing moisture to become water droplets.
Panel:	“Sandwich panels” commonly used in refrigerated storage structure, usually consist of non-fire rated polystyrene, urethane and fire rated rockwool (85 min) foams.
Pipe Insulation:	A flexible insulation layer to insulate pipe from surrounding environment.
Plastic Pipe	Material used to construct a pipe network for VESDA detectors. Commonly used pipes include PVC, CPVC, ABS, HFT (Halogen Free, Fire Resistance, Temperature Stability), HDPE (High Density Polyethylene).

SUMMARY OF LIMITATION OF LIABILITY FOR VISION FIRE & SECURITY

This VESDA Aspirating Smoke Detection System must only be installed, configured and used strictly in accordance with the General Terms and Conditions and System Design Manual available from Vision Fire & Security. You acknowledge that you have read and agree to those terms and conditions.

You acknowledge that you have been provided with a reasonable opportunity to appraise the VESDA System and have made your own independent assessment of the fitness or suitability of the VESDA System for your purpose. You acknowledge that you have not relied on any oral or written information, representation or advice given by or on behalf of Vision Fire & Security or its representatives.

Vision Fire & Security has no liability to you or any person for incidental or consequential loss, expense or damages including, without limitation, loss of business, loss of profits or loss of data. You indemnify Vision Fire & Security for any claim, amount or liability brought against Vision Fire & Security in connection with the VESDA System.

You expressly agree that you assume the entire risk as to the results and performance of the VESDA System resulting from the configuration of the VESDA System. Vision Fire & Security does not warrant, guarantee or make any representations, either expressly or implied, regarding the current or future use, or the results of the use, of the VESDA System, with respect to its correctness, accuracy, reliability, completeness, interworking, functionality, currentness or otherwise resulting from the configuration of the VESDA System.

To the full extent permitted by law, Vision Fire & Security expressly excludes all conditions, warranties and liability, whether imposed or implied by statute or by rule of law or otherwise, which are not expressly set out in the General Terms and Conditions.

To the extent permitted by law, your sole recourse for any defect of, damage to, or performance standard of the VESDA System will be under the express warranties the General Terms and Conditions (if applicable) and Vision Fire & Security will in no event be liable to pay any amount or damages resulting from or in connection with the VESDA System.

To the extent by law that any limitation or exclusion can not apply, the total liability of Vision Fire & Security in relation to the VESDA System is limited to:

- a) in the case of services, the cost of having the services supplied again; or
- b) in the case of goods, the lowest cost of replacing the goods, acquiring equivalent goods or having the goods repaired.

To the extent permitted by law, Vision Fire & Security has no liability with respect to damage to or arising out of, or the condition or performance of, the VESDA System resulting from negligence or improper use, storage, installation, configuration or handling of the VESDA System (where 'improper' includes treatment other than in accordance with the VESDA manual, these terms and conditions or the information provided at a training session); or accident, unforeseeable circumstances or disaster; or modifications to the VESDA System other than in accordance with Vision Fire & Security's instructions; or attachment of or interoperation with features, software or products not approved by Vision Fire & Security in writing; or where the VESDA System has been serviced by persons not authorized by Vision Fire & Security in writing to service the VESDA System.



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
Fax +44 1442 249 327

The Americas

Vision Fire & Security
700 Longwater Drive
Norwell, MA 02061, USA

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