Vision Fire & Security

VESDA®

Generic Warehouses

Application Note

April 2007

Vision Systems

Preface

This warehouses application note provides generic information on the key design considerations and VESDA detection options available, to fire protection system designers planning a VESDA system for warehouses or other large spaces with or without storage facilities.

Important Note: The recommendations made in this document should be considered with reference to any relevant local codes and standards, to ensure compliance.

We also recommend that this document be used in conjunction with the Warehouses Design Guide[1] and any region specific documentation produced by Vision Fire & Security. Contact your local VFS office to enquire as to what, if any, documentation exists for your region.

Introduction

The performance of VESDA detectors, in the challenging environments of warehouses, is well proven; VESDA fire protection systems being installed in numerous warehouse facilities around the world. The reliability and very early warning smoke detection capability of VESDA air-sampling smoke detection devices provides for a more rapid response to fire events which, in turn, minimizes revenue losses due to stock damage or business disruptions.

The design suggestions presented in the remainder of this document are generic guidelines only. It is impossible to produce a single document for all regions due to the enormous global variations in building codes, fire protection system regulations and the definitions of what type of facility constitutes a warehouse. This document is, therefore, intended merely to assist fire system designers with the categorization of their particular facility, the isolation of the key design considerations and the design of a VESDA system that complies with their particular local codes and standards.

Many buildings can be treated like a warehouse as they are essentially large open spaces with or without storage racks. Some examples are listed below:

- Refrigerated storage warehouses, which we consider separately due to their unique design requirements.
- Archive storage areas.
- Carousel storage and retrieval facilities.
- Automated storage and retrieval warehouses.
- Retail warehouses for the storage of commodities such as, food, furniture, rubber tyres, oxidising substances, aerosols, tobacco, alcohol, textiles etc. All of which present different levels of risk.
- Aircraft Hangers and other large storage and maintenance areas.
- Computer equipment and other assembly plants.
- Supermarkets and other large department stores.
- Indoor Sports Facilities and theatres.

Often, more than one type of commodity is stored in a single warehouse facility.

Building Attributes And Environment

Building Geometry

The design guidelines in this document are applicable to warehouses possessing any of the following building attributes:

- Building Areas ranging from a few hundred square metres to tens of thousands of square metres, both single storey and with mezzanine floors.
- Normal Ceiling Height – 12 m (39 ft) or less.
- High Ceiling – Greater than 12 m (39 ft) but less than or equal to 30 m (98 ft).
- Very High Ceiling – Greater than 30 m (98 ft).

Note: For very high ceiling heights, 30 m (98 ft) or more, a Performance-based design (PBD) approach and evaluation process may be required, including verification from local fire experts.

Separation Rules

Separation Rules are common when dealing with fire safety and are applicable to the design of fire protection systems in warehouses. For the purposes of fire detection and fire control, the following provides an example of such rules[2]:

- Passageways – When any warehouse wall is more than 220 m (721 ft) long, there shall be a fire separation passageway of at least 6 m (20 ft) on the ground floor. Both sides of the passageway must have fire rated walls and shall not have any doors or openings. If a door is necessary, Grade One fire rated door shall be used.
- Fire separation zone - When the depth of a fire zone is greater than 120 m (394 ft) or storage racks have a continuous length of more than 90 m (295 ft), except for fully automated storage facilities, there must be an interior fire separation zone of no less than 8 m (26 ft) in width. There shall be windows installed evenly, at the ceiling of the fire separation zone, with a combined opening size of no less than 5% of the total area of the fire zone.

Fire Zones

The dimensions of the fire zones should be as follows:

- Less than 6,000 m^2 (64550 sq.ft) for a single storey
- Less than 4,800 m^2 (51638 sq.ft) for multi-storeys.

In fully automated storage facilities, with ceiling height exceeding 10.5 m (34.5 ft), the fire separation zone can be doubled in size.

Note: For fire zones exceeding the above dimensions, a Performance-based design (PBD) approach and evaluation process may be required, including verification from local fire experts.

The zone dimensions for the VESDA system should be as follows:

- Alarm zone per detector – up to 2000 m^2 (21516 sq.ft).
- Detection zone per sampling pipe – less than 500 m^2 (5379 sq.ft).

Ventilation

It is important to consider the ventilation within the warehouse facility. The structure of the building may promote drafts due to building leakage. Normal operation of the facility may also cause air movement, which will affect the normal dispersion of smoke. In particularly draughty enclosures, for example, smoke may be completely diverted away from detection points.

Stratification

Smoke stratification can also present a problem to smoke detection. In high ceiling enclosures, with unpredictable air movement, smoke that has been cooled by the moving air can become suspended at a distance above the floor instead of rising all the way to the ceiling mounted detectors.

Temperature gradients can also occur where the outside temperature is greater than that inside the warehouse. The warehouse roof becomes heated and in turn heats the air inside, just beneath the ceiling. This hot air layer then acts as a thermal barrier against the rise of the cooler smoke plume.

Local Codes And Practices

The table below summarizes the similarities and differences in some regional local fire codes: Australian Standards AS 1670-1, British Standard BS 5839-1, and NFPA 72.

Table 1 – Comparison of three major fire codes.

Parameter	AS 1670-1 [3]	BS 5839-1 [4]	NFPA 72 [5]
Ceiling Height Limitation	Between 4 m (13 ft) and 20 m (66 ft), detectors must be no more than 600 mm (2ft) below the ceiling. For heights of 20 m (66 ft) or more, additional engineering considerations may be necessary.	Three maximum ceiling heights according to detector sensitivity: normal sensitivity 10.5 m (35ft), enhanced sensitivity 12 m (39ft) and very high sensitivity 15 m (49ft).	No recommendations for ceiling heights over 30 ft (9.1 m) but ceiling heights of more than 16 ft (4.9 m) are the fundamental influence with regard to detection performance.
Maximum Transport Time	90 seconds	120 seconds	120 seconds
Sampling Hole Spacing (Flat Ceiling)	10.2 m (34 ft)	10.6 m (35 ft)	9.1 m (30 ft)
Maximum Area of Detection Zone	2000 m^2 (21516 sq.ft)	2000 m^2 (21516 sq.ft)	2093 m^2 (22517 sq.ft)
Dropdown pipes	0.6 m (2 ft) maximum from ceiling	0.6 m (2 ft) maximum from ceiling	0.9 m (3 ft) minimum from ceiling

VESDA System Design

General Considerations

The key design considerations, when designing a VESDA system for a generic warehouse, are as follows:

- The structural features of the area to be protected – What is the size and shape of the rooms and/or bays?
- The purpose for which the warehouse is being used – How much activity will take place and what risks does this activity pose?
- Ceiling Structure – What is the ceiling height, shape and surface? Are there any smoke movement obstructions present, for example, beams or joists?
- Ventilation – is there air conditioning, natural ventilation etc and how might this affect detector performance?
- The ambient environmental conditions – is the area to be protected dusty or does its internal environment vary greatly from that outside?
- Burning characteristics of the combustible materials present – What fire growth rates and spread might be expected with the available fuel load? Will the commodities stored assist or retard fire?
- The configuration of the contents in the area to be protected – How many racks, if present, are there and how high are they? Shelving can range from mesh baskets to solid shelves. Other facilities use five sided storage bins or wooden pallets, all of which would obviously interfere with the movement of smoke from an in-rack fire. Sprinkler water also has to be able to penetrate the racks and their contents in order to dowse fires in the lower levels. In many cases racks must be treated like walls with detectors in every aisle.
- The location of the VESDA detectors – It is desirable to have as short a distance as possible between the detector and the first sampling hole, to reduce transport time. However, this may not always be practical. For example, if sampling pipes are mounted on a high ceiling, placing the detector close to the first sampling hole would make it more difficult to maintain.

- Maximum transport time – This must be less than 90 or 120 seconds to comply with fire codes.
- VESDA system pipe network design – Typically, a branched pipe network would be used, instead of a single long pipe, to reduce smoke transport time. Local code requirements will influence the location of sampling pipes. If smoke stratification is deemed to be a potential problem, vertically orientated sampling pipes or sampling pipes at different heights may be necessary.

VESDA Pipe Network Design Options

The following VESDA pipe network design options, 1 to 3, are recommended for warehouses without mezzanines; option 4 is for warehouses with multi-level mezzanines. Option 5 is for warehouses containing storage racks and option 6 is for use where significant detection difficulties resulting from smoke stratification is anticipated. Different codes will stipulate different areas of coverage per detector, sampling pipe lengths, maximum transport times, sampling hole spacing and sampling hole sizes:

1. Option 1 – Ceiling Detection.
2. Option 2 – Below Ceiling Detection.
3. Option 3 – High-Low Alternating Detection.
4. Option 4 – Multi-level Detection.
5. Option 5 – In-rack Detection.
6. Option 6 – Vertical Sampling Pipe Detection.

Note: The VESDA sampling pipe network should not be in close proximity to ceiling mounted supply or extraction fans, heaters, skylights etc.

Important Note: The design examples provided in this Section are for illustration purposes only and may be altered to suit the specific Warehouse's geometry and fire zone requirements.

Design Option 1 – On Ceiling Detection

In this design option, all VESDA sampling pipes are mounted on the ceiling. The sampling hole spacing will depend on the warehouse facility's racking characteristics. An example of this is shown below (Figure 1).

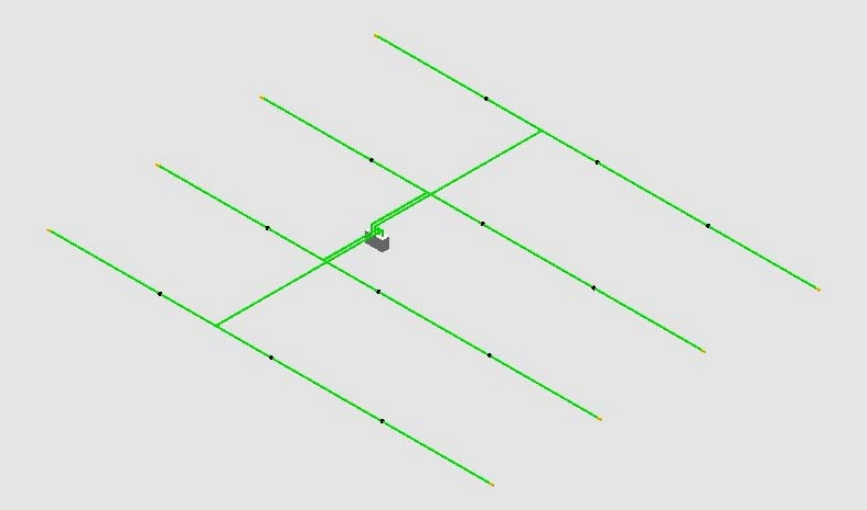


Figure 1– Example of a ceiling detection design.

Design Option 2 – Below Ceiling Detection

This option is similar to ceiling detection, except that there is a dropdown pipe for each sampling hole. In a Performance-Based Design approach, the length of the dropdown pipes will depend on the following:

- Codes and standards requirements
- Predicted hot smoke stratification level
- Vertical temperature gradient in the facility

The following figure (Figure 2) illustrates the “Below Ceiling” protection option.

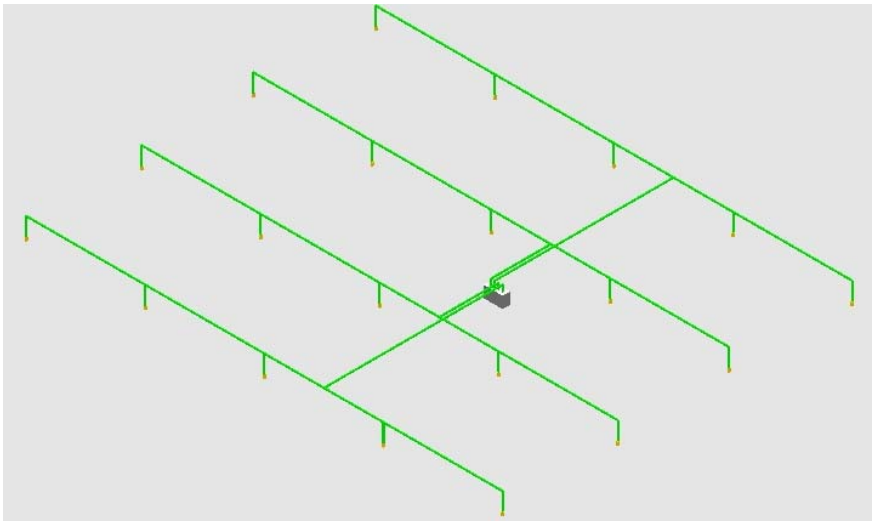


Figure 2 – Example of below ceiling detection.

Design Option 3 – High-Low Alternating Detection

This design option is specifically for high rack warehouses and consists of dropdown pipes, alternating with ceiling sampling holes, above each aisle as shown (Figure 3).

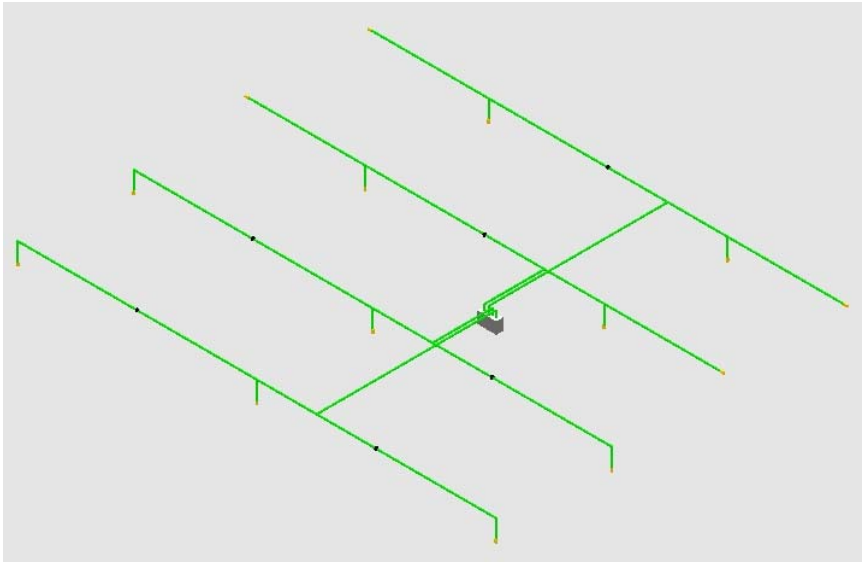


Figure 3 – Example of high-low alternating detection.

Design Option 4 – Multi-level Detection

This option is similar to high-low alternating detection, except that the dropdown pipes, alternated with ceiling sampling holes, extend a longer distance below the ceiling. These longer dropdown pipes are used to provide protection beneath mezzanine levels, which could delay or hinder smoke detection. The figure below (Figure 4) illustrates this option.

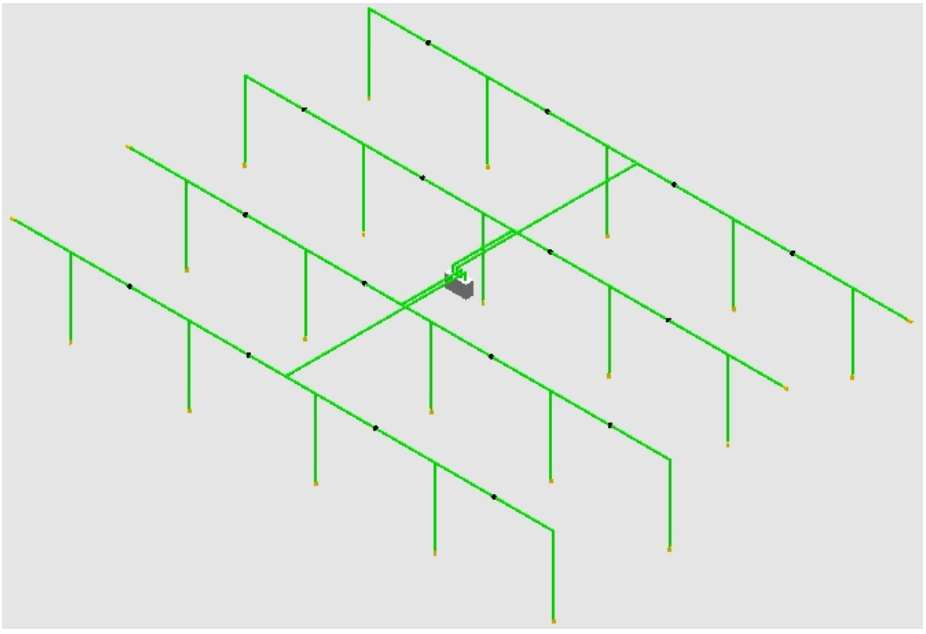


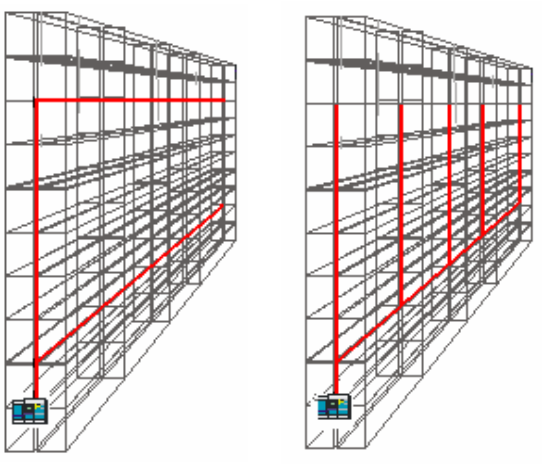
Figure 4 – Example of multi-level detection.

Design option 5 – In-rack Detection

Generally, in-rack protection is not recommended. However, it may be used in installations where any of the following exists:

- An in-rack sprinkler system
- High-bay racking
- Stratification
- Where localized protection is required.

The sampling pipe can have either horizontal or vertical in-rack protection configurations as shown in (Figure 5). The detector is installed at the end of the rack at an accessible level. As a safeguard against mechanical damage from forklift trucks, sampling pipes are located between back-to-back racks out of harms way.



(a) Horizontal in-rack protection

(b) Vertical in-rack protection

Figure 5 – Example of In-rack protection

In the case of non-high-bay racking, dropdown pipes may also be used for in-rack protection. When installing dropdown pipes, it is important to ensure that the pipes will neither be damaged by forklifts nor be in close proximity to the stored goods (refer to Table 1 for BS 5839 requirements). The dropdown pipes can be fitted to the sheltered side of the racking which can be fixed to the rack frame as shown in (Figure 6). In-rack dropdown pipes normally have two or three sampling holes drilled in them to provide sampling at different heights within the racking system.

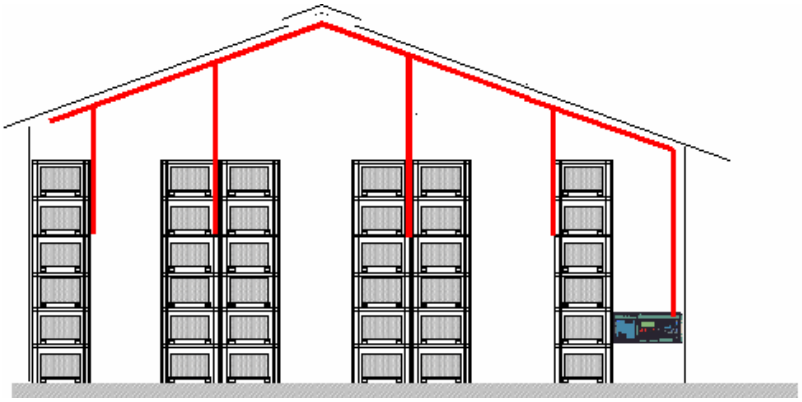


Figure 6 – Example of vertical drop pipes for in-rack protection

Design Option 6 – Vertical Sampling Pipe Detection

Instead of in-rack design, VESDA sampling pipes can be installed vertically where it is practical to do so. This design option is illustrated below (Figure 7).

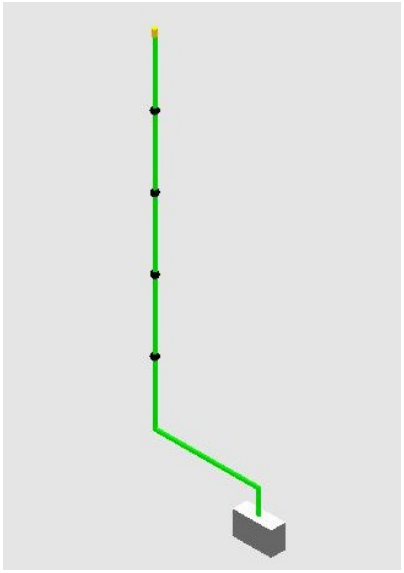


Figure 7– Example of a vertical sampling pipe design.

VESDA Design Guidelines

Low Rack Warehouses

The Table below provides ASPIRE2 calculated VESDA parameters for compliance with three national standards.

Table 2 – Examples of VESDA design parameters for selected national standards.

VESDA Design Option	Parameter	AS 1670-1	BS 5839-1	NFPA 72
	Sampling Hole Spacing	10.2 m × 10.2 m (34 ft × 34 ft)	10.6 m × 10.6 m (35 ft × 35 ft)	9.1 m × 9.1 m (30 ft × 30 ft)
On Ceiling	Coverage per Detector	2000 m^2 (21516 sq.ft)	2000 m^2 (21516 sq.ft)	1900 m^2 (20452 sq.ft)
	No. of Sampling Holes	20	18	23
	No. of Dropdown Pipe Sampling Holes	NA	NA	NA
	Dropdown Pipe Length	NA	NA	NA
	Sampling Hole Size	Pipe 1, 2, 3, 4: 3.5 mm (0.137”)	Pipe 1, 2, 3: 3.5 mm (0.137”)	Pipe 1, 2, 3, 4 3.5 mm (0.137”)
	Max. Transport Time (s)	53	44	51
	Ave. Transport Time (s)	33	31	39
	Total Sampling Pipe Length	206 m (676 ft)	187 m (614 ft)	211 m (690 ft)

(Table 2 Continued)

Below Ceiling	Coverage per Detector	2000 m^2 (21516 sq.ft)	2000 m^2 (21516 sq.ft)	1900 m^2 (20452 sq.ft)
	No. of Ceiling Sampling Holes	NA	NA	NA
	No. of Dropdown Pipe Sampling Holes	20	18	23
	Dropdown Pipe Length	0.6 m (2 ft)	0.6 m (2 ft)	0.9 m (3 ft)
	Sampling Hole Size	Pipe 1, 2: 3.5 mm (0.137") - Pipe 3, 4: 4 mm (0.157")	Pipe 1, 2: 3.5 mm (0.137") - Pipe 3: 4 mm (0.157")	Pipe 1, 2: 3.5 mm (0.137") - Pipe 3, 4: 4 mm (0.157")
	Max. Transport Time (s)	57	60	62
	Ave. Transport Time (s)	34	38	42
	Total Sampling Pipe Length	211 m (690 ft)	197 m (644 ft)	221 m (723 ft)
	Main Sample Pipe Length	205 m (670 ft)	187 m (611 ft)	211 m (690 ft)
High-Low Alternating	Coverage per Detector	2000 m^2 (21516 sq.ft)	2000 m^2 (21516 sq.ft)	1900 m^2 (20452 sq.ft)
	No. of Ceiling Sampling Holes	10	9	12
	No. of Dropdown Pipe Sampling Holes	10	9	11
	Dropdown Pipe Length	0.6 m (2 ft)	0.6 m (2 ft)	0.9 m (3 ft)
	Sampling Hole Size	Pipe 1, 2: 3.5 mm (0.137") - Pipe 3, 4: 4 mm (0.157")	Pipe 1, 2: 3.5 mm (0.137") - Pipe 3: 4 mm (0.157")	Pipe 1, 2: 3.5 mm (0.137") - Pipe 3, 4: 4 mm (0.157")
	Max. Transport Time (s)	57	60	62
	Ave. Transport Time (s)	34	38	42
	Total Sampling Pipe Length	211 m (690 ft)	197 m (644 ft)	221 m (723 ft)
	Main Sampling Pipe Length	205 m (670 ft)	187 m (611)	211 m (690 ft)

(Table 2 Continued).

Multi-Level	Coverage per Detector	1600 m^2 (17213 sq.ft)	1700 m^2 (17425 sq.ft)	1600 m^2 (17213 sq.ft)
	No. of Ceiling Sampling Holes	15	15	20
	No. of Dropdown Pipe Sampling Holes	15	15	20
	Dropdown Pipe Length	6 m (20 ft)	6 m (20 ft)	6 m (20 ft)
	Sampling Hole Size	Pipe 1: 3 mm (0.117") Pipe 2: 3.5 mm (0.137") Pipe 4: 4 mm (0.157")	Pipe 1: 3 mm (0.117") Pipe 2: 3.5 mm (0.137") Pipe 4: 4 mm (0.157")	Pipe 1: 3 mm (0.117") Pipe 2: 3.5 mm (0.137") Pipe 4: 4 mm (0.157")
	Max. Transport Time (s)	79	81	91
	Ave. Transport Time (s)	39	41	46
	Total Sampling Pipe Length	255 m (834 ft)	261 m (853 ft)	323 m (1056 ft)
	Main Sampling Pipe Length	165 m (540 ft)	171 m (559 ft)	203 m (664 ft)

Note: The ceiling mounted detectors in the above table were 0.5 m (1.65 ft) beneath ceiling level. Main sampling pipe length represents the "Total" pipe length excluding the dropdown pipe sections.

For VESDA pipe network designs incorporating 1.8 m (6 ft) dropdown pipes, refer to Appendix A.

High Rack Warehouses

Where a warehouse contains high-bay racking that comes to within 0.5 m (1.65 ft) of the ceiling, it is necessary to reduce the sampling hole spacing. The Table below provides ASPIRE2 calculated VESDA parameters, compliant with three national standards, for this situation.

Table 3 – Example VESDA design parameters for high rack warehouses.

VESDA Design Option	Parameter	AS 1670-1	BS 5839-1	NFPA 72
	Sampling Hole Spacing	10.2 m × 3.6 m (34 ft × 12 ft)	10.6 m × 3.6 m (35 ft × 12 ft)	9.1 m × 3.6 m (30 ft × 12 ft)
On Ceiling	Coverage per Detector	1800 m^2 (19364 sq.ft)	1800 m^2 (19364 sq.ft)	1700 m^2 (18268 sq.ft)
	No. of Sampling Holes	48	48	56
	No. of Dropdown Pipe Sampling Holes	NA	NA	NA
	Dropdown Pipe Length	NA	NA	NA
	Sampling Hole Size	Pipe 1, 2, 3, 4: 3.5 mm (0.137”)	Pipe 1, 2, 3: 3.5 mm (0.137”)	Pipe 1, 2, 3, 4 3.5 mm (0.137”)
	Max. Transport Time (s)	60	60	68
	Ave. Transport Time (s)	32	32	33
	Total Sampling Pipe Length	201 m (657 ft)	203 m (664 ft)	211 m (690 ft)
Below Ceiling	Coverage per Detector	1500 m^2 (15061 sq.ft)	1500 m^2 (15061 sq.ft)	1300 m^2 (13985 sq.ft)
	No. of Ceiling Sampling Holes	NA	NA	NA
	No. of Dropdown Pipe Sampling Holes	40	40	40
	Dropdown Pipe Length	0.6 m (2 ft)	0.6 m (2 ft)	0.9 m (3 ft)
	Sampling Hole Size	Pipe 1, 2: 3.5 mm (0.137”) - Pipe 3, 4: 4 mm (0.157”)	Pipe 1, 2: 3.5 mm (0.137”) - Pipe 3, 4: 4 mm (0.157”)	Pipe 1, 2: 3.5 mm (0.137”) - Pipe 3, 4: 4 mm (0.157”)
	Max. Transport Time (s)	59	59	57
	Ave. Transport Time (s)	34	34	32
	Total Sampling Pipe Length	196 m (641 ft)	198 m (647 ft)	192 m (628 ft)
	Main Sample Pipe Length	172 m (562 ft)	174 m (569 ft)	156 m (510 ft)

(Table 3 Continued).

High-Low Alternating	Coverage per Detector	1500 m^2 (15061 sq.ft)	1500 m^2 (15061 sq.ft)	1300 m^2 (13985 sq.ft)
	No. of Ceiling Sampling Holes	20	20	20
	No. of Dropdown Pipe Sampling Holes	20	20	20
	Dropdown Pipe Length	0.6 m (3 ft)	0.6 m (3 ft)	0.9 m (3 ft)
	Sampling Hole Size	Pipe 1, 2, 3, 4: 3.5 mm (0.137”)	Pipe 1, 2, 3, 4: 3.5 mm (0.137”)	Pipe 1, 2, 3, 4: 3.5 mm (0.137”)
	Max. Transport Time (s)	52	53	51
	Ave. Transport Time (s)	32	34	34
	Total Sampling Pipe Length	184 m (602 ft)	186 m (608 ft)	180 m (589 ft)
	Main Sampling Pipe Length	172 m (562 ft)	174 m (569 ft)	162 m (530 ft)
Multi-Level	Coverage per Detector	1200 m^2 (12908 sq.ft)	1200 m^2 (12908 sq.ft)	1200 m^2 (12908 sq.ft)
	No. of Ceiling Sampling Holes	32	32	36
	No. of Dropdown Pipe Sampling Holes	32	32	36
	Dropdown Pipe Length	6 m (20 ft)	6 m (20 ft)	6 m (20 ft)
	Sampling Hole Size	Pipe 1, 2, 3, 4: 3.5 mm (0.137”) - Pipe 2, 3, 4 end cap: 4.5 mm (0.175”)	Pipe 1, 2, 3, 4: 3 mm (0.117”)	Pipe 1, 2, 3, 4: 3 mm (0.117”)
	Max. Transport Time (s)	77	92	105
	Ave. Transport Time (s)	34	41	40
	Total Sampling Pipe Length	343 m (1122 ft)	344 m (1125 ft)	377 m (1236 ft)
	Main Sampling Pipe Length	151 m (494 ft)	152 m (497 ft)	161 m (526 ft)

Note: The ceiling mounted detectors in the above table were 0.5 m (1.65 ft) beneath ceiling level. Main sampling pipe length represents the “Total” pipe length excluding the dropdown pipe sections.

For VESDA pipe network designs incorporating 1.8m dropdown pipes, refer to Appendix B.

Other Considerations

Mechanical System Activation

VESDA detectors can be used to actuate smoke management and suppression systems, for example, smoke extraction fans, heat/smoke vents and pre-action sprinklers.

To trigger a smoke extraction system, VESDA detector alarm settings can be set to levels comparable with those of conventional point (spot) type smoke detectors.

To actuate a pre-action sprinkler system, VESDA sampling holes should be positioned next to every second sprinkler head. Due to its very early warning and reliable detection of smoke, a VESDA system alarm signal can be used as one of the multiple signals needed to activate a sprinkler system.

Designing For Future Expansion

When designing and installing a VESDA system, where the future intention is to expand the warehouse facility by adding mezzanine levels or high rack storage, there are a number of steps that must be followed:

1. Consider any future rack storage layouts and identify those areas that will be occupied by storage racks and aisles.
2. Design the VESDA pipe network using the multi-level option outlined above and obtain ASPIRE2 calculations for the design.
3. During pipe network installation, instead of connecting the long dropdown pipes that will be used for mezzanine protection, insert shorter pipe lengths (0.3 m (1 ft)) in the T-junctions at the identified locations. Note that sampling holes on any particular length of pipe are identical in size. The VESDA detector should be mounted close to ground level as shown (Figure 8). On completion of the warehouse expansion, insert the longer pipe lengths in place of the shorter ones. Ensure that the sampling hole size is correct. The VESDA detector should now be mounted as close to the ceiling level as possible as shown (Figure 9).
4. Conduct smoke transport time tests, at the sampling holes furthest away from the detector, to ensure that pipe design complies with the ASPIRE2 calculations and any local code requirements.

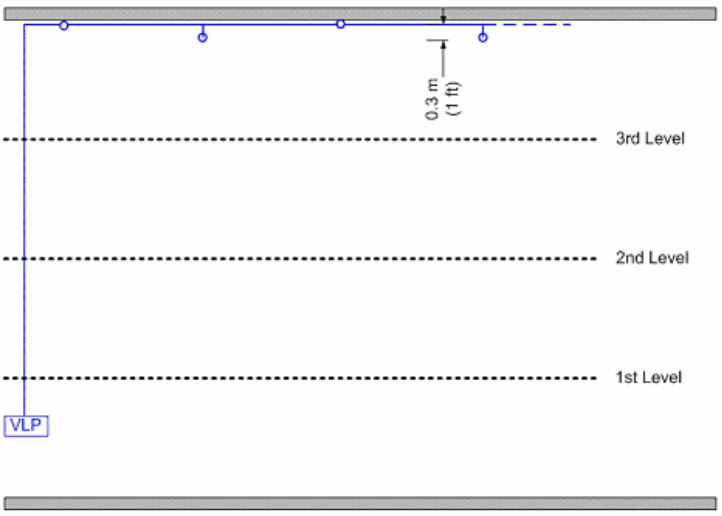


Figure 8 – The VESDA detector and sampling pipe network locations in an example warehouse.

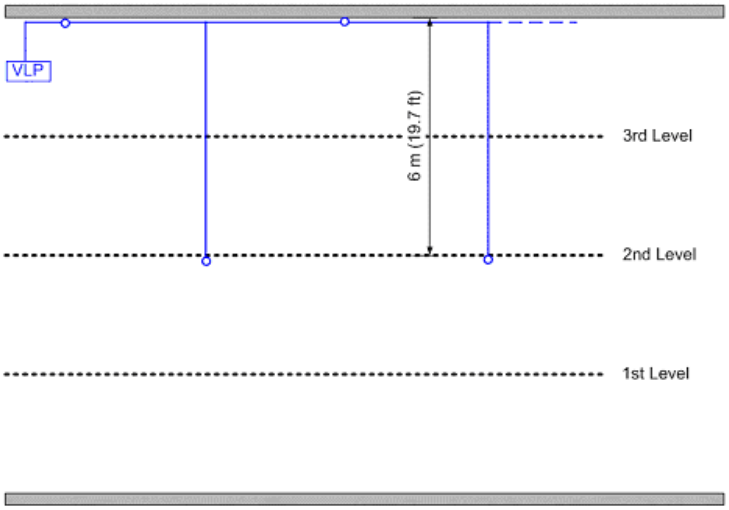


Figure 9 – The VESDA detector and sampling pipe network locations in the above warehouse after expansion.

Appendix – ASPIRE2 Calculated VESDA Design Parameters For Long Dropdown Pipes

The following tables provide the code compliant VESDA parameters when using dropdown pipes of length 1.8 m (5.5 ft).

Table 4 – VESDA design parameters for low rack warehouses with long dropdown pipes.

VESDA Design Option	Parameter	AS 1670-1	BS 5839-1	NFPA 72
	Sampling Hole Spacing	10.2 m × 10.2 m (34 ft × 34 ft)	10.6 m × 10.6 m (35 ft × 35 ft)	9.1 m × 9.1 m (30 ft × 30 ft)
Below Ceiling	Coverage per Detector	2000 m^2 (21516 sq.ft)	2000 m^2 (21516 sq.ft)	2000 m^2 (21516 sq.ft)
	No. of Ceiling Sampling Holes	NA	NA	NA
	No. of Dropdown Pipe Sampling Holes	20	18	24
	Dropdown Pipe Length	1.8 m (6 ft)	1.8 m (6 ft)	1.8 m (6 ft)
	Sampling Hole Size	Pipe 1, 2: 3.5 mm (0.137") - Pipe 3, 4: 4 mm (0.157")	Pipe 1, 2, 3: 3.5 mm (0.137")	Pipe 1, 2, 3, 4: 3.5 mm (0.137")
	Max. Transport Time (s)	67	60	62
	Ave. Transport Time (s)	40	38	42
	Total Sampling Pipe Length	242 m (791 ft)	219 m (716 ft)	264 m (863 ft)
	Main Sample Pipe Length	206 m (674 ft)	187 m (611 ft)	221 m (723 ft)
High-Low Alternating	Coverage per Detector	2000 m^2 (21516 sq.ft)	2000 m^2 (21516 sq.ft)	2000 m^2 (21516 sq.ft)
	No. of Ceiling Sampling Holes	10	9	12
	No. of Dropdown Pipe Sampling Holes	10	9	12
	Dropdown Pipe Length	1.8 m (6 ft)	1.8 m (6 ft)	1.8 m (6 ft)
	Sampling Hole Size	Pipe 1, 2, 3, 4: 3.5 mm (0.137")	Pipe 1, 2, 3: 3.5 mm (0.137")	Pipe 1, 2, 3, 4: 3.5 mm (0.137")
	Max. Transport Time (s)	62	69	62
	Ave. Transport Time (s)	39	35	39
	Total Sampling Pipe Length	224 m (732 ft)	203 m (664 ft)	242 m (791 ft)
	Main Sampling Pipe Length	206 m (674 ft)	187 m (612 ft)	220 m (719 ft)

Table 5 – VESDA design parameters for high rack warehouses with long dropdown pipes.

VESDA Design Option	Parameter	AS 1670-1	BS 5839-1	NFPA 72
	Sampling Hole Spacing	10.2 m × 3.6 m (34 ft × 12 ft)	10.6 m × 3.6 m (35 ft × 12 ft)	9.1 m × 3.6 m (30 ft × 12 ft)
Below Ceiling	Coverage per Detector	1500 m^2 (15061 sq.ft)	1500 m^2 (15061 sq.ft)	1300 m^2 (13985 sq.ft)
	No. of Ceiling Sampling Holes	NA	NA	NA
	No. of Dropdown Pipe Sampling Holes	40	40	40
	Dropdown Pipe Length	1.8 m (6 ft)	1.8 m (6 ft)	1.8 m (6 ft)
	Sampling Hole Size	Pipe 1, 2: 3.5 mm (0.137”) - Pipe 3, 4: 4 mm (0.157”) – Pipe 4 end cap: 4.5 mm (0.175”)	Pipe 1, 2: 3.5 mm (0.137”) - Pipe 3, 4: 4 mm (0.157”)	Pipe 1, 2: 3.5 mm (0.137”) - Pipe 3, 4: 4 mm (0.157”)
	Max. Transport Time (s)	65	62	64
	Ave. Transport Time (s)	37	39	38
	Total Sampling Pipe Length	244 m (798 ft)	244 m (798 ft)	240 m (784 ft)
	Main Sample Pipe Length	172 m (562 ft)	172 m (562 ft)	211 m (690 ft)
High-Low Alternating	Coverage per Detector	1500 m^2 (15061 sq.ft)	1500 m^2 (15061 sq.ft)	1500 m^2 (15061 sq.ft)
	No. of Ceiling Sampling Holes	20	20	20
	No. of Dropdown Pipe Sampling Holes	20	20	20
	Dropdown Pipe Length	1.8 m (6 ft)	1.8 m (6 ft)	1.8 m (6 ft)
	Sampling Hole Size	Pipe 1, 2, 3: 3.5 mm (0.137”) - Pipe 4: 4 mm (0.157”)	Pipe 1, 2, 3, 4: 3.5 mm (0.137”)	Pipe 1, 2, 3, 4: 3.5 mm (0.137”)
	Max. Transport Time (s)	59	58	56
	Ave. Transport Time (s)	34	37	35
	Total Sampling Pipe Length	208 m (681 ft)	210 m (687 ft)	204 m (667 ft)
	Main Sampling Pipe Length	172 m (564 ft)	174 m (569 ft)	186 m (608 ft)

Note: The ceiling mounted detectors in the above table were 0.5 m (1.65 ft) beneath ceiling level. Main sampling pipe length represents the “Total” pipe length excluding the dropdown pipe sections.

References

1. Vision Fire & Security (2007) Warehouse Design Guide (Document Number 10885)

2. Shanghai Fire Bureau Doc [2006] 303, Shanghai City Large Logistics Warehouse Fire Protection System Design Directive.

3. AS 1670 (2004) Fire detection, warning, control and intercom systems—System design, installation and commissioning Part 1: Fire

4. BS 5839 (2002) Fire detection and fire alarm systems for buildings - Part 1: Code of practice for system design, installation, commissioning and maintenance

5. NFPA 72 (2002) National Fire Alarm Code

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