LIFT/ELEVATOR SHAFT APPLICATION NOTE

February 2025

Doc. No. 19109_05

Preface

This Application Note outlines the use of VESDA Aspirating Smoke Detectors (ASD) for lift/elevator shaft environments. The information contained in this document will assist you when designing a VESDA ASD system for this type of application.

Related Products

This Application Note can be applied to all VESDA detectors.

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1 Introduction

Lifts/elevators have contributed to the development of high-rise buildings by providing a safe and fast mode for people transportation. However, from a fire-engineering perspective lifts/elevators present a risk in the event of a fire by providing a ready path for the spread of heat, smoke and toxic gases to other floors of the building. Major fires such as the MGM Grand Hotel and Casino (1980) and First Interstate Building in the US (1988) started on lower floors but the majority of fatalities occurred at the upper floors where heat and smoke spread via the lift/elevator shafts.

The fire hazards to building occupants associated with the lifts/elevators design and operation are as follows:

- Lift/elevator shafts act as vertical channels for the spread of heat, smoke and toxic gases to other floors of the building.
- Transient pressures inside the shaft caused by elevator car motion “piston effect” will allow smoke to infiltrate the shaft as well as spread to other floors of the building.
- In the event of a fire lift/elevators might entrap occupants.

Increasingly, however, lifts/elevators are being considered both a means of timely evacuation for all building occupants (including disabled, mobility impaired, casualties) and a way of transporting fire fighters and emergency equipment closer to the fire incident for search & rescue and suppression efforts. This “evolution” in lifts/elevator utility can only be materialised through the introduction of innovative fire safety requirements such as shaft compartmentation, lift/elevator recall and smoke management to prevent smoke infiltration into the shaft and to other floors by way of the shaft. In line with these requirements smoke detection systems have been considered to actuate smoke relief equipment in shafts, recall cars before sprinkler actuation causes a shunt trip and provide recall feature to move cars away from a fire.

Lift/elevator shafts present a more challenging environment than that normally associated with a working environment within a building such as:

- Higher levels of dust and contamination exist that will affect the reliable operation of fire/smoke detection systems.
- Maintenance of fire/smoke detection systems installed in shafts require lifts/elevators to be isolated which will affect service levels in the building.
- Airflows created by the piston effect, stack effect and wind effect will increase dispersion and dilution of smoke in the shaft making detection for point-type detectors a challenge.

Whether a prescriptive or Performance-Based design method is adopted, early and reliable detection of fire/smoke in the lift/elevator shaft it critical for the safe evacuation of building occupants.

2 Why Use VESDA ASD?

The benefits of a VESDA system intended for lift/elevator shaft protection is as follows:

- VESDA detectors can be mounted external to the lift/elevator shaft providing direct access for maintenance and testing. This will allow for normal lift/elevator operation during maintenance, faster servicing times (lower servicing costs) and eliminates the need for having a lift technician on-site for fire system maintenance purposes.
- Very early detection and intervention provided by VESDA delivers the best prevention against unnecessary evacuation.
- Continued reliable smoke detection by the VESDA system allows the possibility of using lifts/elevators as part of the evacuation process.
- The active aspiration system accommodates the varying air flows and pressure differentials.
- Particle filtration ensures reliable operation in high levels of contamination.
- Multiple sample holes (cumulative sampling) deliver increased flexibility and performance in detecting smoke in both stagnant and high airflow situations (i.e. moving elevator car).
- VESDA systems allow a wide array of interfaces for configuration and monitoring purpose.

3 Code Compliance and Related Standards

VESDA systems are used to satisfy prescriptive code provisions. When a Performance-Based design method is used, the high sensitive and reliable VESDA systems can provide early warning, staged alarms and continued smoke monitoring. These features can be incorporated with other fire safety systems to improve safety margins and satisfy evacuation requirements.

The following codes are normally referenced for the design of smoke detection and smoke management systems for lifts/elevators.

- ASME A17.1-2001, Safety Code for Elevators and Escalators
- ASME A17.4, Guide for Emergency Personnel
- NFPA72 National Fire Alarm Code. NFPA 72 – Chapter 21.3 requires lift lobby, elevator machine room (including machine space, control room, control space), and shaft smoke detectors to cause Phase I Emergency Recall Operation.
- BS5839 "Fire detection and fire alarm systems for buildings – Part 1: Code of practice for system design, installation, commissioning and maintenance".
- Canadian Building Code
- CAN/CSA B44-94 Code for Elevators
- Dutch standard on elevator shafts: NEN2535
- The International Building Code (IBC)
- Elevator Code Compliance RPSA Report

4 Designing for Effective Fire Protection

Below are the primary elements to consider during the design process of a VESDA system in a lift/elevator shaft.

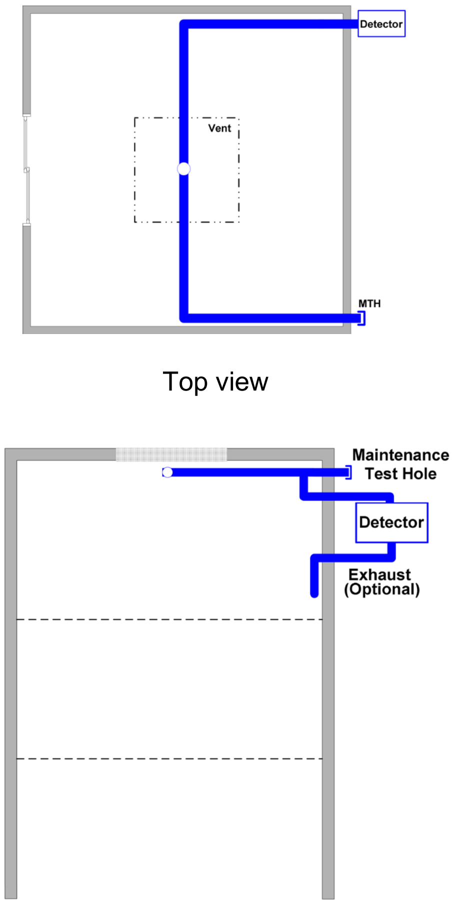
5 Pipe Network / Sample Holes

For buildings up to 4 floors, it is recommended to place sample holes at the top of the shaft and upstream from smoke vents if present (Figure 1). Sample holes should have a 30° orientation to the direction of the air flow across the vent.

For buildings greater than 4 floors, it is recommended to place sample holes at the top of the shaft and at each floor level (Figure 2). Sample holes along the shaft should be placed at one corner of the shaft approximately 0.5m above the height of the elevator door.

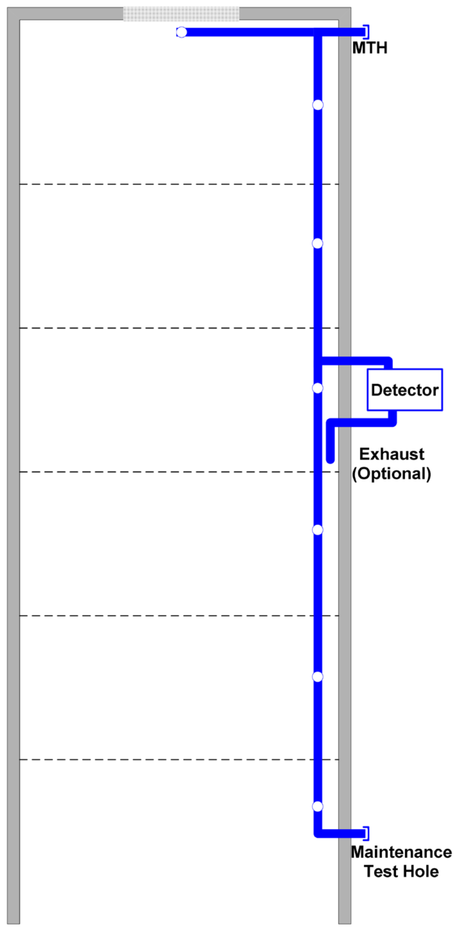
Where dampers (top or bottom of shaft) or vents are used to relieve shaft pressure or remove smoke, the sample pipe should be placed upstream the damper or vent with sample holes at a 30° orientation to the direction of the air flow (Figure 3).

Where the machine room is separate from the lift/elevator shaft it is recommended the VESDA system is designed to protect both areas. The addressable features of the detectors will ensure to pinpoint any event of fire (Figure 4).



Side view

Figure 1: Shaft Protection (≤4 floors)



Side view

Figure 2: Shaft Protection (>4 floors)

MTH: Maintenance Test Hole (See Commissioning and Maintenance section).

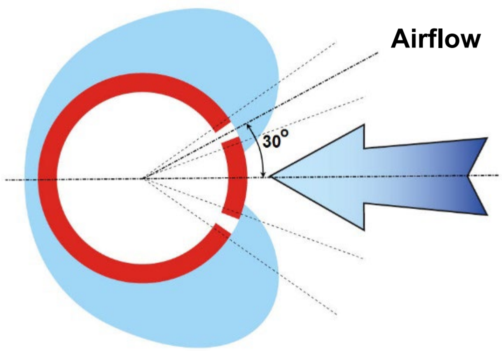


Figure 3: Sample Hole Orientation (30°) to airflow

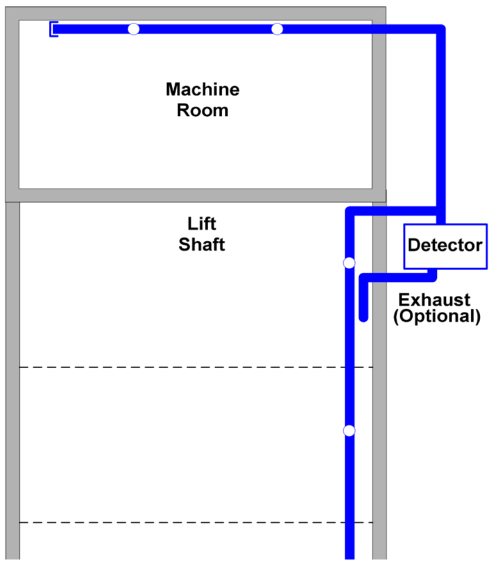


Figure 4: Machine Room / Shaft Protection

Note!

Holes can be sited on either side of the pipe at 30˚ angle to the incoming flow.

Sample holes are recommended to be placed at the shaft pit as this area normally consists of debris adding to the fuel load and inside elevator machine rooms to prevent fire damage to elevator machinery.

As shafts tend to experience higher contamination levels it is recommended sample holes be no smaller than 3 mm (1/8").

Notes!

- Consult local codes and standards on sample hole location, sitting and spacing.
- Pipe network designs must be verified by Xtralis pre-engineered designs or VESDA Pipe Network Modelling Tool (ASPIRE). Smoke transport times should be within the requirements of national codes and standards.

6 Shaft Pressure Effects

Important factors to consider for reliable VESDA system operation include designing against transient pressure differentials caused by elevator piston effect, stack effect (normal, reversed), wind effect.

- Elevator piston effect: caused by the motion of the elevator car i.e. car moving down the piston effect tends to increase the pressure below the car and to reduce the pressure above the car.
- Stack effect: caused by the temperature differential between the interior of the building and outside air. When it is cold outside there is an upward movement of air within shafts (normal stack effect). Downward flow of air occurs in air conditioned buildings when it is hot outside (reverse stack effect)
- Wind effect: the pressure from the wind causes a flow of air into the building on the windward side that might travel through the shaft.

To ensure reliable operation against these transient pressures it is recommended that:

- The VESDA detector exhaust pipe is directed back into the shaft with the open-end pipe facing downward
- Applying a delay for the flow alarm signal (alarm delay determined on a case-by-case basis depending on speed of elevator car, presence of pressure relies vents, leakage).

7 Contamination

VESDA detectors incorporate internal filtration systems to overcome the effect of contamination experienced in lift/elevator shaft and elevator machine rooms. In shafts that experience particularly high levels of contamination it is recommended that an Xtralis In-Line filter is used. For further information refer to the Xtralis In-Line Filter Application Note (Doc No. 17785).

The in-line filter should be placed in an accessible (as the VESDA detector) location for ease of maintenance.

8 Commissioning and Maintenance

The Commissioning process is designed to check and validate the VESDA system such as the performance and sample pipe network integrity. Smoke tests are used to test the following:

- System performance – detection performance against large scale fire tests under various lift/elevator operational modes (stationary, in-motion).
- Verification of ASPIRE smoke transport times or pre-engineered designs.
- Alarm (Fire, fault) signal relay to Fire Indicating Panels (FIP)

The VESDA system shall be serviced and maintained according to both local codes and standards and the instructions provided in the Maintenance section of the VESDA Product Manual.

One benefit of VESDA systems is that maintenance of the system is performed at an accessible location (both for the detector and sample pipe network). With regard to sample pipe network, smoke transport time tests can be performed through a “maintenance test hole” at an accessible location by extending the sample pipe outside the shaft. The design concept is shown below (Figure 5). Two points are noted:

- Point 1 is the last sample hole during “normal operation”.
- Point 2 is either:
  - A blocked end-cap fitted for the “normal operation” of the VESDA system.
  - The “maintenance test hole” (4 mm (5/32”)) fitted for smoke transport time test.

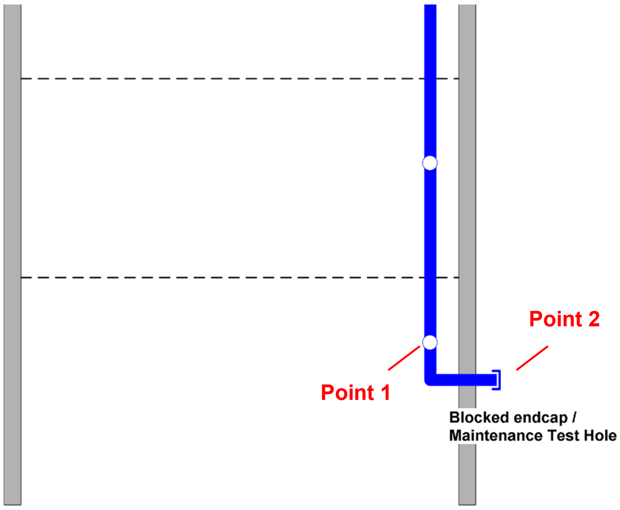


Figure 5: VESDA ASD pipe network – Maintenance

During commissioning two separate smoke transport time tests should be performed:

- At Point 1 (Point 2 comprises a blocked end-cap): This measurement validates the compliance of the “normal operation” of the VESDA system to regulatory requirements.
- At Point 2 (Point 2 comprises the maintenance test hole). This measurement is conducted during Commissioning and for subsequent Maintenance activities. Consistent smoke transport time measurements will indicate stable flow conditions and, thus, the compliance of the “normal operation” of the VESDA system to regulatory requirements.

Sampling holes inside the shafts can be cleaned by back-flush with compressed air; the frequency of cleaning will depend on the contamination level of the shaft. It is recommended flow levels are checked on each inspection and back flush be performed every 2 years.

9 Further Support

Contact an Xtralis office or distributor for further information.

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