VESDA SMOKE DETECTION IN REFRIGERATED STORAGE FACILITIES CASE STUDY

November 2020
Doc. No. 10860_01

Contents

Introduction

Almost 23,000 structure fires in storage properties are reported per year in the USA alone[1]. 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. Unforeseeable events such as arson can lead to rapid fire spread between wooden pallets and other packaging materials.

Typical storage operating temperatures range between – 40°C (– 40°F) (freezers for frozen goods in very dry atmospheres) to 18°C (65°F) (coolers for foods). Condensation and changing operation needs present even a greater challenge to provide a fit-for-purpose fire safety system. Conventional smoke detection technology is not suitable for such harsh environments and is not recommended by codes such as NFPA72 (1999 Edition). Linear Heat Detection responds to heat generated at fire development stage and is usually installed for in-rack detection, which makes it prone to damage. This case study highlights the advantage of very early warning in refrigerated storage facilities.

The Australian state of Victoria is a home to a number of large refrigerated storage facilities. One of Australia's most established refrigerated storage and distribution companies has been using VESDA detectors since 1999 to protect its assets and ensure business continuity. The company specialises in the management of temperature controlled and perishable products and offers fully racked storage, carton/unit picking/order assembly, and container loading/ unloading services to food manufacturers.

In June 1999 the company involved a number of fire professionals to conduct smoke tests aimed at identifying an effective fire safety system for a new construction of a large refrigerated store located in the suburb of East Brunswick. The objective is to assess the performance of sprinklers and smoke detection using VESDA detectors to support the fire engineering design brief.

Freezer Environment

The tested freezer is 30m (98.4 ft) long, 12m (39.4 ft) wide and has a ceiling height of 6m (19.7 ft). The air movement is approximately four (4) changes per hour, where the air is totally re-circulated. The room temperature is in the range of –22 °C to –28 °C (–7.6 °F to –18.4 °F).

A total of three (3) VESDA detectors were used for the purpose of the smoke tests. The layout of the VESDA sampling points was intended to ascertain the movement of smoke and the response of the VESDA detectors. One 21mm (0.83”) ID PVC pipe was used for each detector and individually inserted through the freezer insulating membrane. The following table shows the set up of the sampling points.

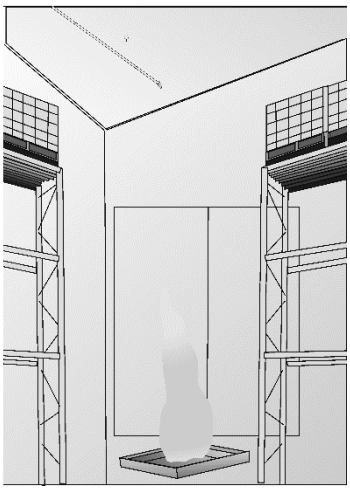
Detector #	Set Up
1	25mm (1”) below the ceiling
2	300mm (11.8”) below the ceiling
3	Next to return air grille

A sprinkler head was fitted on the ceiling next to the sampling points of Detectors #1 and #2.

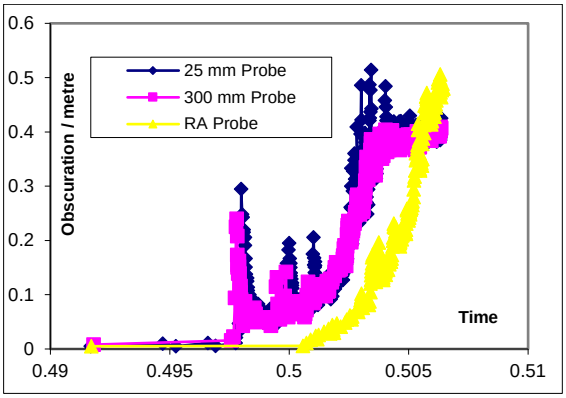
Smoke Tests

Representatives from the facility's owner, a fire engineering consulting firm, CFA[2] (the local Fire Brigade), a Building Surveyor and Xtralis were present on the day of the tests. The smoke tests involved the use of Styrene foam placed onto a tray filled with ethanol (at floor level in the middle of the room). The majority of the ethanol was allowed to burn off, and then the predominant packaging material commonly found in refrigerated storage environments, such as cardboard was added to the tray.

The installation environment was clean before the smoke tests. The average background level recorded on all three detectors was approximately 0.005 %/m (0.002 %/ft).



A smoke test was conducted between 11:55am to 13:30pm. The smoke level measurements in the first 20 minutes are shown in the following chart.



The chart indicates that the lower sampling point; 300mm (11.8") probe (pink curve) provides a faster response (approx. 6 seconds) to increased smoke level. However, the higher sampling point; 25mm (1") probe (blue curve), which is closer to the ceiling provides better overall detection than the 300mm (11.8") probe. The return air sampling point (yellow curve) lags behind initially but eventually picks up more smoke compared to the sampling points on the ceiling.

Note that the smoke source was placed in the middle of the enclosure and the return air grille (a Fan Coil Unit) was located on the side approx. 6m (19.68 ft) away. VESDA detector #2 reached a smoke level of 0.24%/m (0.0732 %/ft) within a minute. Therefore, if 10 sampling points were to be used to cover this 360 m^2 (3,873 ft^2) area, the sensitivity of the smoke detector would need to be set to 0.024 %/m (0.00732%/ft).

The VESDA detector sensitivity range is 0.005 - 20 %/m (0.0015 to 6.25 %/ft). The Alert, Action, Fire1 and Fire2 thresholds can be set to suit the conditions of the environment. The results show that only very high sensitivity and active smoke detection systems such as VESDA can provide sufficient protection and early warning in such harsh environment.

[1] Source: National estimates based on NFIRS and NFPA survey for the duration of 1994 to 1998.
[2] CFA: Country Fire Authority.

Sprinkler System

To activate the sprinkler a piece of frozen hemp rope was tied to the base of the sprinkler and set alight. The heat generated by the hemp rope caused the sprinkler to activate. Discharge was not observed until 5-7 seconds after the bulb had broken. At discharge, the water being pumped into the environment turned into fog (picture below) at which point visibility became very poor.

After the sprinkler was turned off, all the water had accumulated on the floor and turned to black ice. Concerns were raised in regards the safety of fire brigade personnel. This further highlights that a reliable and very early warning smoke detection technology is highly desirable in refrigerated storage facilities.

Conclusion

Fire risks are present in refrigerated storage facilities despite their very low temperature. VESDA detectors can detect smoke at a very early stage in such harsh environments. With the flexibility of ceiling, in-rack and return air smoke detection, VESDA provides an optimal, fit for purpose fire safety solution. Safety issues associated with the release of sprinklers in refrigerated storage facilities need to be taken into consideration.

Further Information

Contact your nearest Vision Fire & Security office or distributor for further information.

www.xtralis.com

Doc. No. 10860_01
November 2020