DET-TRONICS

WHITE PAPER

FRT fire protection:

Faster detection can mean the difference between suppression and disaster

Most codes and regulations require fire detection at the floating roof seal, where the risk of fire is greatest. While linear heat cables are a traditional detection choice, there is now an alternative technology that offers greater detection speed plus easier installation and less maintenance for Zone 1 and 2 applications.



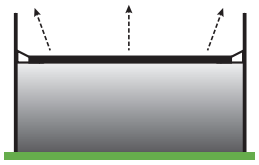
Around the world, there are over 4,800 oil terminals responsible for storing nearly a billion cubic meters of crude oil and other combustible or flammable petroleum products (source: www.tankterminals.com). Many of these terminals use floating roof tanks (FRTs). Though FRTs are considered safer than traditional fixed-roof and open-top storage tanks, they still afford the possibility of gas or vapor leaks that can ignite due to lightning or other causes.

An FRT is an aboveground tank in which a metal deck or pan (the roof) floats directly on the surface of the liquid. The roof is flush with the wall of the tank and moves up and down with the level of the liquid, much like a piston in a cylinder. The purpose of the system is to minimize the volume of vapor present in the tank, as well as to reduce the emission of vapors from the tank thanks to a rim seal between product fluid and the environment. When a failure occurs on a rim seal, there is the potential for flammable vapors or product to escape.

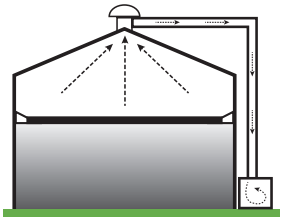
Escaped vapors are troublesome for two reasons: financial loss and the potential for fire. If a fire is not detected quickly, the impact can be disastrous in terms

Floating Roof Tank Designs

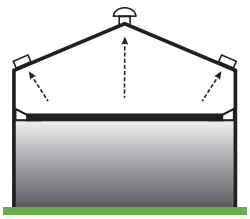
Below are descriptions of the most common types of FRTs. Please refer to NFPA 30 and/or your applicable local codes for a detailed description of all classified areas inside and surrounding FRTs.



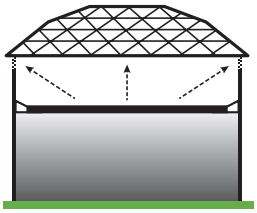
External Floating Roof Tank (EFRT)
The floating roof serves as the primary means of fluid containment and weather protection. Vapors are vented directly to the atmosphere through vents on the floating roof.



Closed Floating Roof Tank (CFRT)
This design is similar to the IFRT, except the vapors are drawn through a collection vent on the external roof to a collector, where they can be reclaimed if desired.



Internal Floating Roof Tank (IFRT)
In this design, an external roof protects the floating roof from the elements. Vapors are expelled directly to the atmosphere through the floating roof and vents on the external roof.



Geodesic Dome Floating Roof Tank
This style of tank is becoming more common for new construction and for retrofitting existing EFRTs. Designs vary by manufacturer, but typically include vents between the tank and roof.

of life safety, facility downtime, loss of production and environmental impact. For all of these reasons, most locally observed codes and regulations require fire detection at the floating roof seal, where the risk of fire is greatest.

Why fire detection?

All FRT types can be used to store flammable liquids that, if ignited, can lead to major fire events. In the event a fire does break out, early detection may make it possible to contain the blaze to one tank, thereby sparing the rest of the facility and maintaining operations. Linear heat detection has been the conventional choice for sensing FRT fires. This technique requires installation of a heat cable around the floating roof seal. If a fire breaks out around the seal, heat emitted from the fire should eventually trip the heat cable, which would then signal the control panel.

The concept might be simple, but installing the cable so it can travel up and down with the floating roof requires specialized knowledge of the application. In addition, exposure to the elements and/or wear caused by movement of the floating roof can cause the cable to fail. If this happens, the entire cable must be replaced in most cases. This can be costly in dollars and also in production time lost for maintenance, since the tank must often be drained prior to cable replacement.

Linear heat detection's most critical downside, however, is that it can take minutes to respond to a fire, depending on where the fire starts. The majority of FRT fires originate on top of the floating roof, with most of the fire's heat traveling upwards. Therefore, it can take a considerable amount of time for the temperature near the heat cable to rise sufficiently to trigger an alarm. If the alarm isn't tripped before the seal is compromised, the entire volume of combustible liquid would be exposed to the fire, possibly resulting in a dangerous event.



In this Zone 1 classified fixed-roof internal floating tank application, the optical flame detector is flange mounted. This installation technique allows for easier maintenance of the detector.



Optical flame detectors can be pole mounted for open-roof internal floating tanks.

Electrical classification considerations

The space above a floating roof and below an outer roof structure can be classified as Zone 0, Zone 1 or Division 1. The classification is dependent upon which region of the world the tank is located in, to which standards the user has chosen to engineer the design, and how the tank is ventilated.

Most standards prescribe general recommendations on how certain spaces should be classified; however, the defining means of prescribing an electrical classification for this space is the amount of time it can contain an explosive gas mixture. Zone 0 describes areas where an explosive atmosphere consisting of gas, vapor or mist is present continuously, for long periods or frequently. Zone 1 describes places where an explosive atmosphere is likely to occur in normal operation

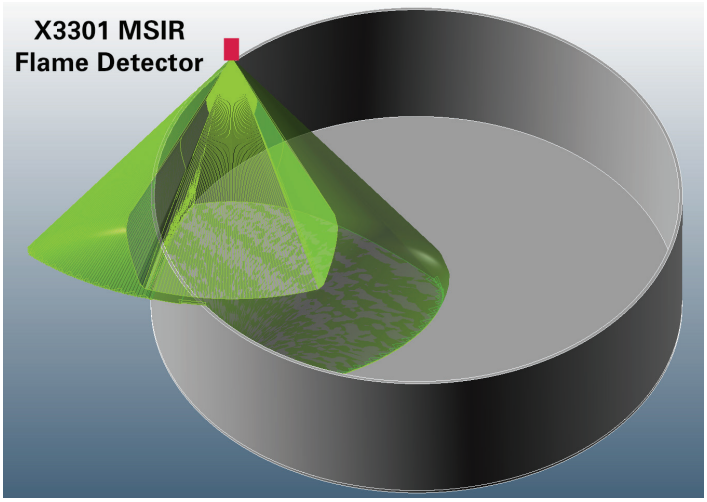
occasionally, while Zone 2 denotes that the explosive atmosphere is not likely to occur in normal operation but, if it does, will persist for only a short period.

Internal floating roof tank designs vary by manufacturer, so the Zone classification may vary depending upon the ventilation of the airspace and the flash point of the flammable liquid being stored in the tank.

A flame detection alternative

Over the last two decades, there has been a significant increase in the detection coverage and reliability of advanced optical technology. Optical flame detectors are designed to detect the electromagnetic spectrum because flames emit electromagnetic radiation in the infrared (IR), visible light and ultraviolet (UV) ranges, depending on the fuel source. Optical flame detectors offer very fast response speed (typically three to eight seconds), minimizing the chances that a fire will become a catastrophic event before an alarm reaches the fire control system. Unlike linear heat detectors, optical flame detectors can also provide detection coverage for the entire space above a floating roof.

In FRT applications, optical flame detectors are placed strategically around the edge of the tank wall or through the external roof based upon the device's stated detection performance in relation to the substance stored in the tank. Installation experts use two- or three-dimensional mapping of a given area to ensure sufficient detection coverage. The number of detectors required depends on tank size, the stored liquid and the specified fire size that requires detection. Under certain circumstances, some smaller tanks can be adequately protected with only two or three optical detectors.



The detection range of the Det-Tronics X3301 Multispectrum Infrared Flame Detector (FM approved to detect a 1 ft² heptane fire at 265 feet (0.09 m² fire at 80.7 meters)) allows one detector to cover a large portion of the floating roof seal along with the surface of the floating roof and, in some cases, the area outside of the tank wall.

During installation, optical flame detectors must be properly aimed to ensure the entire tank area that requires flame detection is protected. If desired, detectors can also be aimed to protect the area outside an FRT perimeter. Optical flame detectors are typically installed in Zone 1 or Zone 2 classified areas. Installers of optical flame detectors should observe the provisions in all applicable codes and standards. These include:

- NFPA 30 (2015): Flammable and Combustible Liquids Code
- FM Global Property Loss Prevention Data Sheet 7-88 (Revised 2015): Ignitable Liquid Storage Tanks
- OSHA Standard 1910.164 (45 FR 60713): Fire Detection Systems
- HSE HSG176 (2015): Storage of Flammable Liquids in Tanks

Adding gas detection for another layer of protection

Any place flammable liquids are stored will present gas leak hazards, especially at the connection points of structures that move liquids into and out of a tank. Vapors can also collect in dikes around tanks. Since a combustible gas leak can be a precursor to an explosion or fire, gas leak detection can be considered the first line of defense against catastrophic events in hazardous FRT environments. Therefore, the most effective safety systems for FRTs combine both flame and gas detection.

Gas leak detection technologies sense and measure hazardous vapors. Common options include:

- Fixed-point detection of a combustible gas by electrochemical, catalytic or infrared technologies. The detector activates when it comes in contact with gases.
- Infrared detection along a line of sight. This method can detect combustible gas between two points at a range of over 100 meters.
- Acoustic detection using ultrasonic sensors that detect leaks based on noise patterns. Acoustic detectors can withstand extreme temperatures and are unaffected by fog, rain or wind.

Each of these detection technologies has benefits and limitations depending on environmental factors such as wind and rain, as well as factors related to a particular application, such as obstructions in a detector's field of view. Therefore, an optimal solution may involve using more than one type of technology and placing detectors in locations that maximize their effectiveness.

The resulting fire and gas safety system

To be useful, flame and gas detectors must be part of a system that can take actions based on detection data. In fire safety applications, this system is run by a controller that is NFPA 72 approved for flame and gas detection. In addition to providing real-time system status and diagnostics, the controller software allows programming and configuration of flame and gas detectors and other field devices.

In FRT applications, an effective controller may need to interface with and integrate a large number of individual flame and gas detectors, as well as fire suppression devices and notification devices. When necessary, this system can actuate audible and visual alarms and dispatch signals to start pumps, open deluge valves and notify authorities.



Spartan Controls Ltd., a leading provider of automation, valves, measurement and process control solutions in Western Canada, has installed over 650 Det-Tronics X3301 optical detectors on FRTs at major pipeline company facilities throughout the region.

Conclusion

Optical flame detection technology provides an attractive alternative to linear heat detectors for Zone 1 and 2 areas on FRTs. Besides eliminating installation and maintenance problems associated with linear heat detection, optical detectors — along with gas detectors in controller-run systems — can speed fire detection and help prevent a small flame from turning into a disaster.

Disclaimer

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About Det-Tronics

Det-Tronics is a global leader in fire and gas safety systems, providing premium flame and gas detection and hazard mitigation systems for high-risk processes and industrial operations. The company designs, builds, tests and commissions SIL 2 Capable flame and gas safety products ranging from conventional panels to fault-tolerant, addressable systems that are globally certified. Det-Tronics is a part of Carrier, a leading global provider of innovative HVAC, refrigeration, fire, security and building automation technologies.

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