SELECTING FIRE AND GAS SYSTEM SENSORS

Jesse Sumstad, Emerson, details the importance of using multiple types of sensors to ensure a robust safety system is in place on tank farms and transfer sites.

Safety at petroleum refineries and petrochemical plants is always of the utmost importance. Any incident that impacts production also has the potential to impact the larger supply chain. Designing safety systems that ensure protection from potential hazards caused by toxic, flammable, or combustible materials requires significant skill and planning. It also requires understanding of the capabilities and limitations of each group of fire and gas sensors available in order to decide which sensor is best suited to the safety task required. Selecting each sensor to build a safety system that is more than the sum of its parts means having the right information and understanding the risks posed by each section or element of a facility or transfer.

It should be noted that not only are the materials that are used in refining and petrochemicals hazardous, so too are the end products. A tank full of refined petroleum is still toxic and flammable, which means even at the endpoint of a production process, carefully selected fire and gas detection sensors will be needed to ensure the safety of personnel, the facility, and the environment.

Tank farms, which store liquids such as gasoline and diesel fuel, as well as pressurised liquified gases, such as propane, need to implement safety systems to send out alerts if a leak or fire is detected. Even vapours that can collect over stored materials in tanks can pose dangers if they escape.

Petroleum and petrochemical products stored at tank farms are there temporarily. They will need to be transferred to rail, truck or ship transport before reaching their final destination. There is the danger of gas or liquid escaping at each transfer point, posing a health risk to personnel in the area as well as a fire hazard.

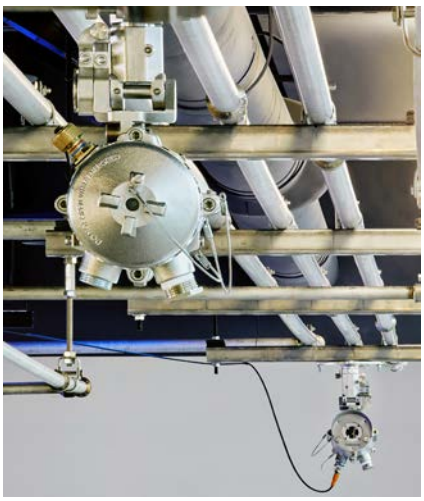

Figure 1. Emerson Rosemount™ open path combustible gas detectors installed.

Figure 2. Emerson Rosemount fixed point gas detector.

Looking closely at available sensors, it becomes clear that for a comprehensive safety system that considers all possible hazards, a one-size-fits-all approach is not the solution. This article provides an overview of available options and where those sensors are best suited within a facility.

Main detector types

A comprehensive safety system is built on four types of detectors. Each type is designed to address a specific safety concern in fire and gas detection and provide overlapping coverage.

Open path combustible gas detectors send a light beam from a transmitter to a receiver to detect combustible gases moving through the beam (see Figure 1). These detectors cover a wider area than a fixed-point detector and are therefore deployed like a perimeter fence around equipment and tank clusters. They are also subject to ambient air movement, which means it is recommended facilities deploy multiple units.

Fixed point combustible gas detectors use one of two types of sensor (see Figure 2). Catalyst bead sensors facilitate an internal chemical reaction in the presence of various gases, both hydrocarbon and non-hydrocarbon. Infrared sensors respond to the specific light wavelengths absorbed by the flammable gas. Both technologies depend on a cloud of gas drifting to the individual sensor in sufficient concentration to be detected. Fixed point detectors are usually deployed where there is a concentration of equipment and, therefore, multiple potential release points. Since ambient air movement affects where a cloud might drift, multiple units are typically distributed around target areas.

Ultrasonic gas leak detectors are tuned to detect specific sounds made by pressurised gas leaks in frequencies above the human audible range. As multidirectional detectors, these instruments can quickly respond to those specific sounds, pinpointing the source. Response can be immediate as there is no need to wait until enough gas has escaped to reach a concentration threshold. These ultrasonic detectors are commonly deployed where compressed gases are handled and stored in pressurised tanks.

Flame detectors are the next level of protection since they will detect a fire in progress. Flame detectors are designed to detect very specific wavelengths of light created by hydrogen and carbon-based combustion. They are deployed like surveillance cameras, often positioned above critical equipment, looking down to get a minimally obstructed view at a specific area of coverage (see Figure 3).

Designing the system

Knowing the types of detectors to install is only one step in building a robust safety system. A detector must be able to do more than just detect and sound the alarm. In many instances, it is of great value to have that sensor response trigger an action beyond alerting of a problem. When triggered, the device that contains the sensor should be able to independently shut down a pump, close a valve, trigger a suppression system, or activate a similar defensive mechanism. This combination of abilities is governed by safety standards such as NFPA 72, FM 3010 and UL 864. Each individual function can be tied together into a larger alarm and incident management system to ensure comprehensive responses.

Figure 3. Emerson Rosemount 975 flame detector.

A more comprehensive and appropriate response in the periphery of the main issue can reduce the risk of a cascading catastrophe.

Each detector must be considered on its own as well as within the larger context appropriate to the facility. A comprehensive safety strategy will dictate the placement and intended performance of each unit within the facility, which can be anywhere from a few detectors to hundreds depending on what high-risk material is located where.

Detectors on the market today are highly sophisticated instruments capable of also performing internal diagnostics and sending data via a digital communications link, such as WirelessHART®. Examples of what an effective design might look like for tank farms are explained in the following sections.

Building safety into process tank farms

Tank farms are not only for storing an end product awaiting transport to the end user. Many refining and petrochemical facilities have tanks that hold inventory – anywhere from a few thousand to millions of gallons – to ensure uninterrupted production even when deliveries are delayed.

Most inventory is liquid and stored in cylindrical tanks with fixed or floating roofs, whereas pressurised products such as propane are commonly stored in spherical tanks. In the past, tank farms, regardless of what they store, have experienced catastrophic fires due to overfilling, pipe failures, or operators opening the wrong valve.

Implementing a comprehensive system can dramatically reduce risk. A comprehensive safety system should include all types of detectors so that there are no blind spots or areas not seen by sensors.

Pressurised tank groups should have ultrasonic detectors in strategic positions to listen for leaks. Liquid and pressurised tanks should be surrounded by fences created by open path detectors covering the spaces between tanks. These should be positioned close to ground level because most hydrocarbon vapours and propane are heavier than air and tend to sink. Liquids from overfill incidents typically run out of vents, down the sides, and accumulate inside the tank's spill barrier berms. Valve and piping clusters represent multiple hazards across a small footprint. Fixed point detectors near the ground can spot these types of releases more quickly than other detectors. Flame detectors should cover all the spaces around and between tanks with overlapping views to provide redundant protection and avoid blind spots.

Transfer of product for transport

When adding transfer of product to tanker truck, rail car or even ships into the mix, the need for sensor coverage of the transfer area becomes even more critical. Transfer sites can be quite complex, with many valves and pumps clustered and active in a small footprint.

The potential for spills is significantly higher at transfer points than in other areas of the tank farm. Although, much of the equipment involved in transfers is designed with closure mechanisms to avoid spills and vapour loss, there is always the potential that these mechanisms may malfunction. If they do, they can quickly create dangerous situations.

Selecting the right sensor types for the transfer section of the tank farm can be a challenge because so much is packed into a small area, both in terms of equipment and activity; there are many moving parts. Sensor selection will depend on the type of product being transferred, though overlap of sensor fields is highly recommended.

Multiple units of fixed point detectors at strategic locations are recommended, as are open path detectors with beams parallel to paths to supplement coverage. Flame detectors are essential, but it can be tricky to decide where to place them because the transfer area sees heavy traffic. A spill or leak might be able to find an easy ignition source if other sensors do not detect the vapour or leak. Making sure the fire detection sensors overlap to cover areas behind and in between obstructions such as equipment and vehicles helps ensure the greatest possible coverage.

Wrap up

The past few years have shown the world how fragile supply chains can become when interruptions occur. The outward ripples impact other industries and, ultimately, the consumer. Avoiding incidents that impact the supply chain is one reason that adequate fire and gas sensor selection is an imperative part of a safety system.

Fire and gas systems protect facilities by reducing the impact of incidents; which means the equipment used in these systems has to be highly reliable. The disruption to the facility should a leak, or worse, a fire, occur is significant. Safety system device hardware and software must be certified to performance standards for maximum availability at all levels. This includes smart devices, which offer ready access to configuration and diagnostic information. T&T