DET-TRONICS

WHITE PAPER

Selecting fire and gas detectors for extreme environments:

Functional safety in harsh and remote locations



Liquid natural gas (LNG) facilities in the Russian Arctic. Drilling platforms in the swells of the North Sea. Pipelines that cross miles of heaving permafrost or blowing desert sands. These are some of the settings where industrial fire and gas detectors encounter extreme conditions and yet must perform accurately and dependably.

Start with high-risk processes, add combustible or toxic liquids and gases, and then place these hazards in far-flung locations and inhospitable environments. This is the real-world formula for industries' most challenging fire and gas safety system applications. The components in these functional safety systems must be designed to handle a wide range of external challenges, from temperature extremes to violent rain and sand storms to vibrating or shifting ground. At the same time, the control systems that manage the detection, notification and mitigation functions must perform without failures or false alarms, and often, without a human for hundreds to thousands of miles.



Figure 1: Heavy wind, rain or snow can lead to weather-induced fault conditions for flame detectors because infrared radiation is absorbed by water molecules. To minimize the accumulation of moisture or condensation on detector optics, look for IR detectors with lens heaters and device shielding (as shown on the Det-Tronics X3301 Multispectrum IR detector above).

Today's advanced fire and gas detectors and system controllers include special features for safe and effective operation in harsh and remote environments. Below is an overview of the performance features to look for when selecting functional safety equipment, plus some installation and operation tips for applications in extreme settings.

Flame detection and the role of optical technology

Optical flame detectors provide speed and accuracy of detection that thermal detector types can't, and today's optical flame detectors are designed to perform in a wide range of sub-optimal conditions. Advanced infrared (IR) detectors offer superior signal processing that minimizes the potential for false alarms caused by IR emitted from hot process equipment.

In addition to electronic design features, mechanical design options can also increase flame detection performance. Optical flame detectors can be fitted with weather shields that function like a hat brim to prevent rain and snow from collecting on the detectors' optical surfaces. Detectors can also be designed with lens heaters to melt snow and ice, or in humid conditions, to prevent condensation from forming and accelerate the drying process. (Figure 1)

Installation techniques can also help minimize the impact of precipitation on optical flame detector performance. Since detectors usually monitor processes at or below their level, users can aim detectors down 10–20 degrees.

This provides more physical protection for the optics and also facilitates natural removal of precipitation via gravity.

In areas where heavy rain is accompanied by strong winds, there is no physical way to prevent precipitation from accumulating on the detector's optics. Eventually, this accumulation will cause a significant reduction in the device's original detection range. Detectors equipped with a self-checking function can provide notification of a reduction in performance in the form of a fault. If this fault type occurs frequently at a site that experiences heavy windblown precipitation, some detectors allow users to adjust the time between automatic self-tests and increase the required number of consecutive failed tests (to allow the severe weather to pass) before a fault is triggered. An examination of the detector's event logs can help users determine the typical duration of an optical performance fault condition, as well as appropriate alternative fault settings.

Gas detectors for challenging environments

The ability to quickly and accurately detect leaks of volatile or flammable gas is critical, but again, extreme environments can challenge available gas detection technologies. For example, blowing sand can compromise an acoustic leak detector's performance by clogging its filter and/or damaging its sensor to the point of failure. In addition, problematic ultrasonic noise can be generated by high-velocity particles striking the sensor.

These desert environment problems can be minimized by proper design of the acoustic detector's particulate filter.



While desert locations for oil and gas processing can see extreme annual temperatures as high as 47 degrees C (116.6 degrees F) and as low as 12.8 degrees C (55.04 degrees F), blowing sand can be even more of a problem for the performance of functional safety equipment.

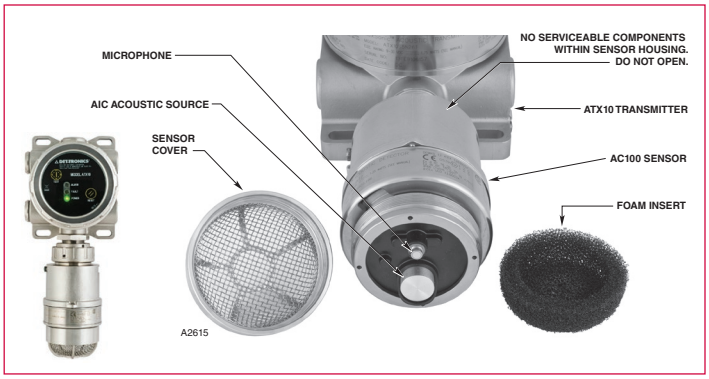

Figure 2: Acoustic gas leak detectors work by recognizing the unique sound "fingerprints" of various gases. However, the sound and impact of blowing sand particles can create nuisance ultrasonic noise and lead to possible fault conditions in windy desert environments. The Det-Tronics FlexSonic detector shown above uses a foam filter to eliminate ultrasonic noise due to particle impact with the microphone.

Filters with large pore sizes can effectively block most direct particle impacts without trapping sand and causing it to build up on the sensor. (Figure 2) Acoustic gas-leak detectors should be tested to MIL-STD-810G, Method 510.5, Procedure II, which applies to all devices likely to be exposed to dry blowing sand.

Shifting ground, a common issue for pipelines or processing plant installations in areas of permafrost, and vibration are environmental factors that can affect line of sight gas detector performance. In these settings, product specifiers should look for product features such as rigid mounting arms that minimize vibration, and optics with relatively large alignment tolerances.

Equipment standards for extreme environments

Both flame and gas detectors should be factory tested to ensure that they will operate reliably and not trigger false alarms or faults at extreme temperatures and/or during large temperature shifts. Detection components should also be rated to perform in a wide temperature range or tested by the detector manufacturer to verify their ability to meet specified temperature requirements.

As for detector housings, extreme external conditions call for packaging that can withstand knocks and jolts, as well as protect internal components in wet, dusty, acidic and caustic environments. Ruggedized stainless steel or aluminum construction provides optimal environmental protection.



Located above the Arctic Circle, Yamal is a ground-breaking project to develop the huge condensate gas fields in the Russian Yamal peninsula. Extreme cold and winds, long periods of darkness, snowfall that never melts, and fog and mist that accumulate and freeze on equipment combine to require high-performance technology such as the Det-Tronics flame and gas detectors specified for the application. (Photo originally used for the Yamal and Adjusting Territories Oil and Gas Investment Projects Report by Vostock Capital.)

Class I locations — and particularly those in extreme environments — call for detector designs that take into account the explosive and flammable potential of surrounding hazardous substances. These devices need to meet the fire- and explosion-specific standards established by organizations such as Factory Mutual (FM), Underwriters Laboratories (UL) and International Electrotechnical Commission (IEC), which require that equipment designs be certified to remain explosion-proof at the temperature range the manufacturer states the detectors can operate in. This means the detector housings must contain internal explosions so that hot gas and other byproducts cannot escape and ignite surrounding hazardous substances. For example, housings for explosion-proof detectors must be certified to ensure that they will not change in extreme temperatures, creating small gaps which may not contain an internal explosion.

Other third-party certifications confirm that detectors will hold up to harsh marine conditions such as on oil drilling platforms or on the decks of floating liquefied natural gas production units (FLNGs). Standards for fire and gas detection in these applications have more stringent environmental and electromagnetic compatibility requirements. Agencies accredited to issue marine certifications include DNV GL, American Bureau of Shipping (ABS), Lloyds' Register (LR) and the U.S. Coast Guard.

Planning for remote locations

Both offshore and onshore, extreme conditions and remote locations often go hand-in-hand, meaning that the flame and gas detection systems most severely tested by the elements are also those located in distant, hard-to-reach places. This makes it particularly important to specify durable, long-lived components for remote detection systems and also to keep plenty of spares at remote sites.

Another key consideration for remote detection systems is how the system will operate with few if any people

nearby who are knowledgeable about it. In cases like this, advanced communications can mitigate the downsides of remoteness. After receiving a leak, smoke or flame alarm from its component detectors, a remote detection system should be capable of notifying the appropriate personnel wherever they are located via an Internet connection. In addition, connected devices should have automatic self-test features that pull diagnostic information from the devices and make it available to remote personnel accessing the system.

Systems design — what about redundancy?

For flame and gas detection systems in remote locations, redundancy should also be considered based on the anticipated impact of a component's failure. While a system may be able to continue functioning effectively despite the failure of a system component, failure of the managing controller could render the system useless unless it includes a backup controller that can take over automatically in such situations.

In addition to redundant controllers, redundant detectors are sometimes deployed in remote facilities. A major rationale for using redundant flame detectors is to reduce the potential for false alarms that cause costly production shutdowns. This is done by implementing a "voting" scheme that involves installing multiple detectors in an area normally covered by only one. In this configuration, one fire alarm signal triggers notification of a potential threat and two (or more) fire alarm signals trigger executive action (shutdown and/or suppression).

Functional safety system certification

In addition to detector certifications, the overall fire and gas safety system should be certified by a third party to reflect the level of performance and reliability required by applications in extreme environments. Functional-safety-specific standards are set by organizations such as the IEC and the International Society of Automation (ISA).

Certification is a process that involves conducting an initial safety assessment, determining what actions need to be taken to create or upgrade the safety platform, and having the appropriate certifying companies and agencies evaluate the systems. The process also requires determining that components and sub-assemblies meet required codes and standards.

Arctic gas-producing regions, which see temperatures as low as –60 degrees C (–76 degrees F) and can be ice-bound for seven to nine months during the year, are isolated from oil and gas infrastructure and therefore demand equipment that operates reliably without human control.



Companies offering to certify products for functional safety are numerous and include organizations such as exida, FM, SIRA, UL and TÜV Rheinland. These agencies should be accredited for the specific standards used for product and/or systems certifications. It is up to the owner or operator of a functional safety system to investigate and select the proper hazardous location classification ratings, and performance and functional safety parameters that best address a facility or process's specific needs and objectives, including performance in extreme environments.

In summary

More and more, today's high-risk industrial processes are taking place in isolated and inhospitable corners of the globe. These settings demand the functional safety provided by fire and gas detection and hazard mitigation systems, and specifically, they demand detectors and control systems that are up to the extreme challenges posed by weather, environment and remoteness.

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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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