DET-TRONICS

WHITE PAPER

Selecting fire and gas detectors for extreme environments:

Functional safety in harsh and remote locations



Pipelines that cross miles of blowing desert sands. Processing plants that function in wide temperature extremes from day to night. Facilities located hundreds of miles from supplies or services. 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 should 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 ideally perform without failures or false alarms, and often, without a human for hundreds to thousands of miles.

Today's advanced fire and gas detectors and system controllers include special features for safe and effective operation in harsh and remote environments.

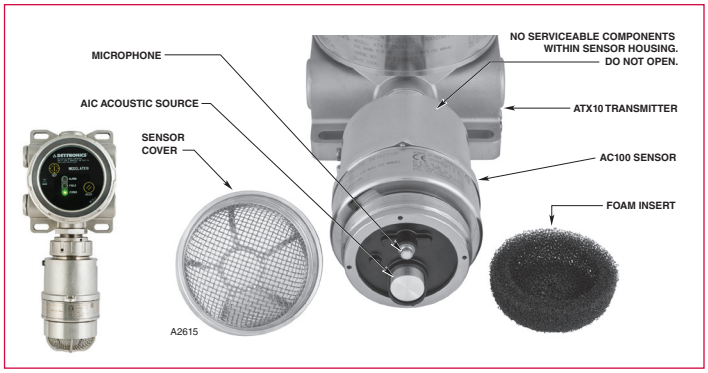


Figure 1: Acoustic gas leak detectors work by recognizing the unique sound "fingerprints" of various gases. However, the sound and impact of blowing sand particles can create nuisance ultrasonic noise and lead to possible fault conditions in windy desert environments. The Det-Tronics FlexSonic detector shown above uses a foam filter to eliminate ultrasonic noise due to particle impact with the microphone.

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.

Gas detectors for challenging environments

The ability to quickly and accurately detect leaks of volatile or flammable gas is critical, but 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. 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 1) 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.

Several environmental factors commonly found in desert locations can negatively affect the performance of line-of-sight gas detectors. These factors include vibration and shifting ground resulting from sandy soil, as well as the expansion and contraction of piping and foundations resulting from wide temperature variations. 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.

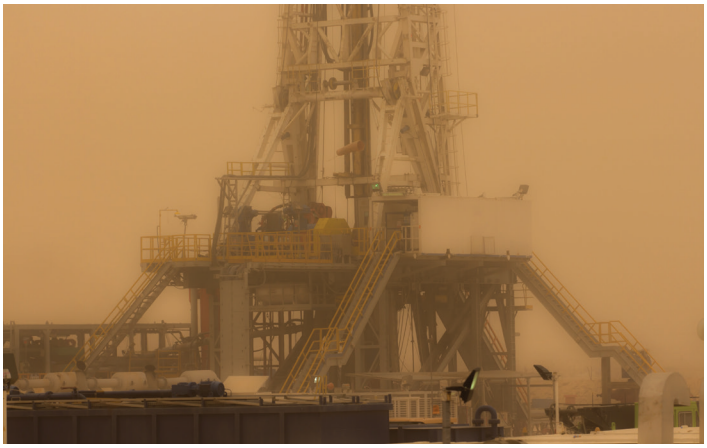
Flame detection and the role of optical technology

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 and "friendly" fires, such as process flares.

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 help prevent contamination from collecting on the detectors' optical surfaces. Detectors can also be designed with lens heaters for humid conditions, to prevent condensation from forming and accelerate the drying process. (Figure 2)

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, alone or combined with sand, 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.



While desert locations for oil and gas processing experience extreme temperatures, blowing sand can be even more of a problem for the performance of functional safety equipment.



Figure 2: Environmental protection accessories on flame detectors, such as the shields shown on the Det-Tronics X3301 multispectrum detector above, can help reduce maintenance requirements.

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 or caustic environments. Ruggedized stainless steel or aluminum construction provides optimal environmental protection.



Detectors installed in harsh desert environments should reliably perform across a wide range of temperatures, and their housings should be tightly sealed to protect sensitive components from harmful dust.

Class I/Zone 1 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 FM Approvals, Underwriters Laboratories 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 gas 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.

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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Adaptive Industrial Solutions
sales@adaptiveind.com
(877) 818-5009

det-tronics.com

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