WHITE PAPER

Flame detector requirements for extreme environments

Industrial flame detectors must perform accurately and dependably in the harshest conditions

Many of today's optical flame detectors offer excellent performance in terms of reliability and false alarm immunity. But what happens when these detectors are exposed to harsh conditions such as blowing desert sands, heaving permafrost or corrosive salt water?

If a flame detector can't cope with extreme environmental conditions, it's not going to live up to its performance promises. Flame detectors used in high-hazard applications must operate reliably and minimize false alarms, but they also need to perform in the most challenging environmental conditions. As components of functional safety systems, optical flame detectors 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 perform without failures or false alarms and, often, without a human for hundreds to thousands of miles.

No place for the ordinary flame detector

Start with high-risk processes, add in combustible or toxic liquids and gases, and then place these hazards in remote locations and inhospitable environments. These factors make tough operating conditions for any kind of equipment. To be successful, the most effective optical flame detectors require robust construction plus features that address these extreme weather challenges—thereby minimizing maintenance and avoiding fault conditions—while preventing catastrophic fires.

Flame detectors used in harsh environments should be factory-tested to ensure 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.

MEETING STANDARDS

Certification by Det Norske Veritas (DNV) to the Marine Equipment Directive (MED) requires equipment to withstand the harsh environmental conditions found in offshore applications.

The DNV/MED type approval for offshore includes:

- Temperature extremes
- Vibration
- Ingress protection from humidity and salt water

DNV is an independent certification body with the objective of safeguarding life, property and the environment, at sea and on shore. MED is the European directive requiring that gas and flame detectors installed in marine environments be tested to specific standards and deemed safe and certified for use in marine applications and environments.

Other standards for optical detectors include:

- ANSI/FM 3260, which specifies optical detectors for performance in terms of fuels detected
- NFPA 72®, which specifies response time and requirements for on- and off-axis detection

It is important that optical detectors be tested and certified for conformance to these and other standards when assembled in a "real-world" configuration, e.g., with weather protection in place.

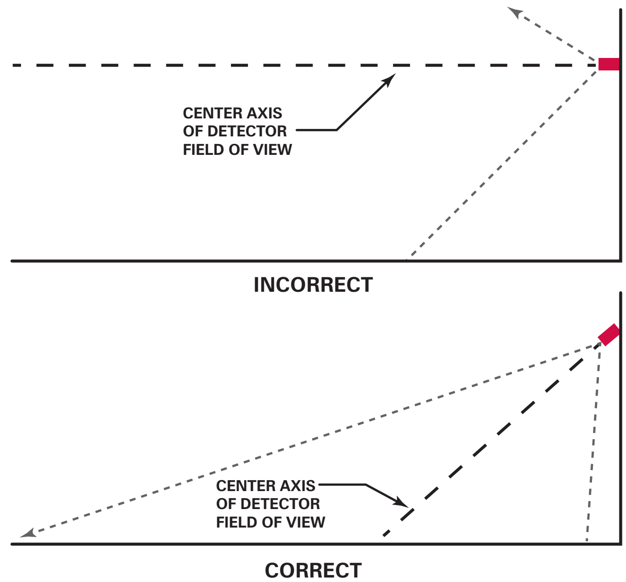
As for detector housings, extreme external conditions call for packaging that can withstand physical impacts as well as protect internal components in wet, dusty, acidic and caustic environments. Ruggedized stainless steel or aluminum construction provides optimal environmental protection.

Maintaining optimal capability under duress

In addition to electronic design features, mechanical design options can also increase flame detection performance in environments that include wind, rain and snow. Because Infrared Radiation (IR) is absorbed by water molecules, it is important to minimize the accumulation of condensation, rain and snow on the optics to reduce weather-induced fault conditions. Doing so will help ensure that optimal flame detection capability is maintained. 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.

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 on the Det-Tronics X3301 Multispectrum IR detector shown.

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 10–30 degrees. This provides more physical protection for the optics and also facilitates natural removal of precipitation via gravity.



Aiming optical flame detectors down

By aiming an optical flame detector down 10 to 30 degrees, the optics are more physically protected and precipitation is more likely to be removed naturally via gravity. In most applications, the detector is monitoring a process that is below or at the same level as the detector. Since the top of the X3301's field of view (FOV) is 30 degrees, the Det-Tronics detector can be aimed downward and still continue to monitor for potential fires above the center axis of the detector's FOV.

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 detector configurations.

More than one or potentially all of the measures may be required to optimize the detector's performance when it is installed in applications that experience extreme weather conditions.

Planning for remote locations

Both offshore and onshore, extreme conditions and remote locations often go hand-in-hand, meaning that the flame detection systems most severely tested by the elements are also those located in distant, hard-to-reach

Out here, lives depend on robust safety systems. Flame detectors must be up to the extreme challenges posed by weather, environment and remote locations, with features that enable operation without nearby technical support, such as frequent automatic fail-safe checks that can verify devices' flame detection capabilities.

places. This makes it particularly important to specify durable, long-lived components for remote detection systems and 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 fire 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 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).

Flame detection and the role of optical technology
Because flames in a refinery are typically fueled by hydrocarbons, using a multispectrum infrared (IR) flame detector provides unsurpassed flame detection of fires from hydrocarbon fuels. These hydrocarbon fueled fires produce heat, carbon dioxide, and other products of combustion—which is characterized by the emission of visible, UV, and IR radiation. Since optical flame detectors are designed to detect the absorption of light at specific wavelengths, this allows the detectors to readily differentiate between flames and sources of false alarms. These false alarms are often caused by randomly modulated infrared energy emitted from hot process equipment.

The Det-Tronics X3301 Multispectrum infrared flame detector meets the MED DNV offshore standards. It has been certified to withstand harsh environmental conditions in which equipment installed offshore must be designed to operate.

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.

In summary

More and more, today's high-risk industrial processes are taking place in isolated and inhospitable corners of the globe. If a flame detector can't handle the extreme environmental conditions it's likely to encounter, it's not going to meet current industry needs. These locations demand the functional safety provided by flame detection and hazard mitigation systems and, specifically, they demand flame detectors and control systems that are up to the extreme challenges posed by weather, environment and remoteness.

A multispectrum IR detector built for the harshest environments can provide more diagnostic data, increased detection coverage, excellent immunity to false alarms, faster response times and better flame detection performance than flame detectors that weren't designed and certified to operate in extreme environments.

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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