# Flame detector selection – Which one?

Which flame detector should I use? This is a common question when a fire protection engineer is looking to protect a high value asset or where fast detection is needed due to the escalation potential of a fire.

**Graham Duncan**

So, where do we start? All flame detectors have strengths and limitations, we therefore need to understand these in order to select the most appropriate technology for a given fire risk. In broad terms; the technologies can be categorised as Ultraviolet, Combination UV/IR, Single Frequency Infrared, Multi Spectrum Infrared and visual flame detection.

## Ultraviolet

Ultraviolet (UV) detectors are good general-purpose fire detectors as virtually all fires emit UV radiation. However, UV detectors are well known for their false alarm susceptibility to arc welding, X-raying, lightning, flare radiation, be it direct or reflected. Hydrocarbon films, such as those caused by oil lube sprays from gas turbines or diesel fuel, on the windows of the device render the detector blind; as can low concentration levels of solvents in the atmosphere. UV flame detectors are also prone to severe degradation by smoke.

UV flame detectors are rarely used today due to the wide array of false alarm sources and factors that can inhibit the device from working when needed.

## Single Frequency Infrared

Infrared (IR) detectors were introduced to alleviate the problems associated with UV detectors. They operate by detecting the heat element of a fire; analysing amplitude and flicker frequency of the flame. IR flame detectors solve a number of the false alarm problems associated with UV detection. They are not affected by hydrocarbon films; however, black body radiation does cause false alarms and water on the optical surface, attenuates the heat energy from a fire resulting in decreased sensitivity of the device. The vast majority of IR devices are designed to detect the product of combustion from a hydrocarbon fire—hot CO2 emissions and use a detection wavelength around 4.3 / 4.4 microns. This results in some devices, only being sensitive to hydrocarbon fires.

This type of device can reject transient or periodic sources of infrared radiation while remaining responsive to genuine fires. The approach cannot, however, reject infrared radiation associated with flare reflections or turbine combustion exhausts, and can result in false alarms. This detection also only allows for relatively short viewing distances even before desensitisation. Within its well-understood limitations, this is a reliable and robust technology.

▼ Oil and gas rig operating in harsh weather conditions.

Image courtesy of Micropack

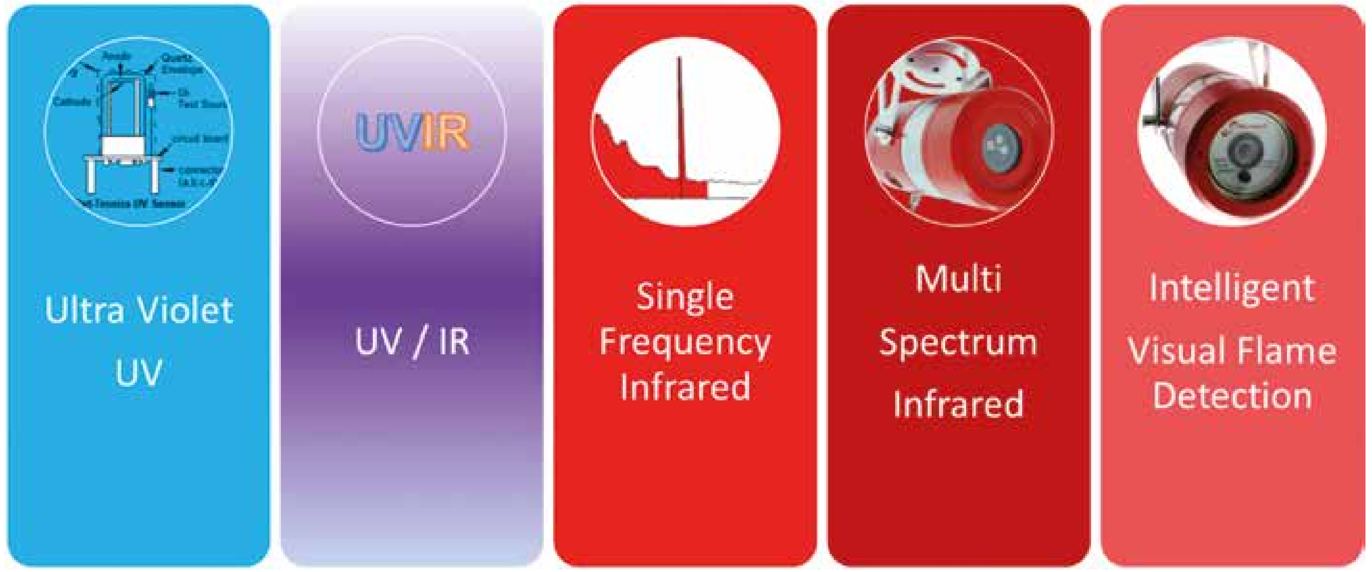


Image courtesy of Micropack

▲ Figure A – Flame Detector Technologies.

## Combined Ultraviolet Infrared UV/IR

UV / IR flame detectors are widely used in industry for their high levels of false alarm immunity, this is because the combined technologies have almost no false alarms sources in common. The limitation of using the combined technologies can also be significant as whatever interferant affects an IR or UV detector would affect the combined device. The UV section of the device is prone to contamination by oil mist and grime and will frequently indicate fault. In an enclosure fire, smoke is likely to 'blind' the UV section of the detector. UV/IR's also have the drawbacks of a single IR flame detector (false alarm to blackbody, blinding due to fog/ water) the technology is therefore best used in clean environments where detection distances are typically significantly less than 30m.

## Multi Spectrum Infrared

In the late 1990's additional IR sensors were added to the single frequency IR detector creating a new detector type called "Multi-Spectrum Infrared" (MSIR) or "Triple IR." These additional sensors, using what is known as "guard band" wavelengths were included to improve false alarm immunity and enable longer detection distances.

▼ Intelligent Visual Flame Detector installed aboard an FPSO.

Image courtesy of Micropack

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| Fire type / Inhibitor / False alarm | Combined ultra violet / infrared | Multi spectrum IR (hydrocarbon fires only) | Multi spectrum IR (hydrocarbon & hydrogen fires) | Intelligent Visual Flame Detection |
|---|---|---|---|---|
| Gasoline / n-heptane | | | | |
| Diesel Fuel | | | | |
| JP4 / Kerosene | | | | |
| Ethanol | | | | |
| Methanol | | | | |
| Methane | | | | |
| Hydrogen | Variant dependant | | | |
| Wood stack | | | | |
| Silane | | | | |
| Sunlight | | | | |
| Dust / Sand / Oil / Grease | | | | |
| Water | | | | |
| Arc welding | | | | |

Image courtesy of Micropack

Generally speaking MSIR detectors are suitable for the detection of hydrocarbon fires, as they monitor the hot CO2 emissions from fires, more recently some units include an additional sensor / wavelength looking for the presence of hot water vapour. These devices are also able to detect hydrogen fires.

MSIR devices appear less prone to spurious alarm from modulated sunlight and black body radiation although the sensitivity of this type of detector may be reduced, sometimes by a large amount, in their presence. Independent records of detector performance in the presence of false alarm stimuli, both with and without fire, should be available from all manufacturers. A good example of an independent performance standard comes from Factory Mutual, their FM 3260 "Approval Standard for Radiant Energy-Sensing Fire Detectors for Automatic Fire Alarm Signaling" can be used to rigorously tests products, the results of which are available from device manufacturers.

For design authorities, the data in the FM3260 report can be used to determine the effective viewing distance of a detector; it should be noted that this figure is usually significantly lower than the headline detection distance.

The use of multiple IR sensors / wavelengths has improved the false alarm immunity of a MSIR detector compared with a SFIR device, however the additional sensitivity it brings does lead the unit open to false alarms from arc welding, hot CO2 emissions from diesel engines or turbine exhaust as well as reflected flare radiation.

## Intelligent Visual Flame Detectors

Intelligent Visual Flame Detectors (iVFD) have been used since the late 1990's and were in particular developed to combat false alarms due to reflected flare radiation. iVFD detectors employ a video imaging based technique utilising a CCD array and advanced algorithms that process live video images for flame like characteristics. More recent developments use dual CCD arrays with one array being exclusively used for flame detection whilst the other offers a live video feed. Having stated this, it is a popular misconception that iVFD's are only used when a client wants to see a live video feed, in fact some iVFD's have no video output at all.

iVFD's monitor for bright burning fires, the limitation with the technology is that it cannot detect invisible or virtually invisible fires such as pure methanol, hydrogen and sulphur.

A major advantage of iVFD detectors is they cannot see hot CO2 emissions or the heat emanating from hot process; the technology therefore does not become desensitised and it does not false alarm due to the exhaust gases from gas turbines / diesel generators and black body radiation

In 2011, an independent review on loss prevention by FM Global (Ref 1) recommended that visual imaging flame detection systems be applied as the default technology for the following commercial and industrial applications:

- Outdoor, open areas such as oil rigs, oil fields, mining operations, and forest products
- Indoor locations such as industrial plants, boiler or other large vessel protection, turbines, and some clean/ chemical rooms

Table 1, summarises the strengths and limitations of the detection technologies discussed in this article.

## Summary

This article has discussed the strengths and limitations of a wide range of optical flame detectors used today.

When looking to recommend a flame detector it is essential that the spectral characteristics of the flame are matched to the detection technology. In addition, the environment in which the unit is to be used must be understood with regards to interferants (smoke, oil films, particulates, water) that will reduce detector sensitivity and false alarm sources (flare, exhausts, hot process). With this in mind, this article has discussed the strengths and limitations for a wide range of commonly used optical flame detectors.

**For more information, go to www.micropackfireandgas.com**

**References**
1 FM Global Property Loss Prevention Data Sheets 5-48.