Flame Detection

Introduction

There are two very distinct flame detection families that are used within the Oil and Gas Industry:

1. Radiation Flame Detectors

Consisting; Ultraviolet, Single Frequency Infrared, Combination UV/IR, and Multiple Frequency Infrared

2. Visual Flame Detectors

Consisting; Visual Flame

Radiation-type flame detectors collect radiation from the area under surveillance; sum the total radiation within the field of view; analysing the total intensity of the radiation and any flicker frequency that exists.

The second family; Visual Flame Detectors, are based on a near IR CCTV camera with flame detection recognition algorithms built into the detector. This type of detector is spatially aware; in that it analyses each area of interest within the field of view and determines if each area meets the criteria for fire. The visible radiation from each potential fire source is analysed individually.

Ultraviolet

Radiation-type, such as Ultraviolet (UV) detectors are good general-purpose fire detectors as virtually all fires emit UV radiation. However, UV flame detection is well known for its false alarm susceptibility to arc welding, X-raying and lightning. Seldom discussed are the factors which cause UV flame detectors to miss a fire. Hydrocarbon films, caused by oil lube sprays from gas turbines or diesel fuel, on the windows of the device render the detector blind. Even solvents in the atmosphere have been found to inhibit the device from responding.

As UV flame detectors are prone to severe degradation by oil and smoke they should not be used in most petrochemical applications. UV flame detectors should also not be used on sites where direct or reflected flare radiation is present. Figure 1 shows a typical UV flame detector footprint with appropriate desensitisation applied. Many operators do not allow UV detection to be applied for general application due to the drawbacks of the technology.

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 CO_2 emissions. 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. Figure 1 shows a typical IR flame detector footprint with appropriate desensitisation applied.

Ultraviolet Infrared UVIR

UV / IR combined detectors are generally not considered for duty across the industry as the use of the combined technologies, not only brings together the strengths of both, but also the limitations. 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. The detector also features the drawbacks of a single IR flame detector (false alarm to blackbody, blinding due to fog/ water) and, therefore, the detector is unreliable in detecting hydrocarbon fires. Figure 1 shows a typical UV/IR flame detector footprint with appropriate desensitisation applied.

Multi Frequency Infrared IR3

With the advent of Multi-Frequency detectors, guard bands were added to the 4.4uM IR sensor to reduce false alarms and increase the sensitivity. The signals from the sensors are correlated at either two or three optical wavelengths.

These devices may be less prone to spurious alarm from black body radiation although the sensitivity of this type of detector is also reduced, sometimes by a large amount, in the presence of blackbody radiation. This reduces the effective viewing distance of the detector and even then does not show the severity of desensitisation in certain cases (where the viewing distance can be reduced to only a couple of meters).

On many sites this type of detector has been very prone to disruption - fault, reduced sensitivity, unwanted alarm - by water/contamination in one or more of the three independent optical path(s) and reflected flare radiation. Micropack is aware of a large number of shutdowns caused by false alarm from this detection technology and operators should be wary when installing in certain areas - particularly where flare radiation and/ or hot surfaces may be present. Figure 1 shows a typical Triple IR flame detector footprint with appropriate desensitisation applied.

Visual Flame Detectors

Flame detector family type 2; Visual Flame Detectors, employ a video imaging based technique, utilising CCTV and advanced algorithms. The advanced algorithms process the live video image from the CCTV array and interpret flame characteristics.

This is a technology that provides a control room operator with real time images of each detector's field of view, therefore allowing a potential incident to be assessed and controlled from a safe distance, which in turn reduces the risk to personnel and reduces the risk of unwanted shutdown. The device operates in the near Infrared and uses extensive signal processing to detect and annunciate fires while rejecting the common sources of false alarm found within the oil and gas industry.

The emission of exhaust gases from gas turbines emit very strongly at 4.4µm; the prime detection wavelength for IR detectors; causing them to false alarm. As a visual flame detector is monitoring for bright burning fires visually, false alarm immunity is assured to hot CO_2 emissions.

Black body radiation, at certain high temperatures, emits strongly at 4.4um, which we learned causes desensitisation or spurious alarms with IR flame detection. The flame detection algorithms, and the wavelength at which visual technology operates at, ensures that the detector completely ignores this source of radiation and will not false alarm.

The limitation with the visual technology is that it cannot detect clean burning fires. This type of fire is present when Methanol, Hydrogen and Sulphur are burnt.

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

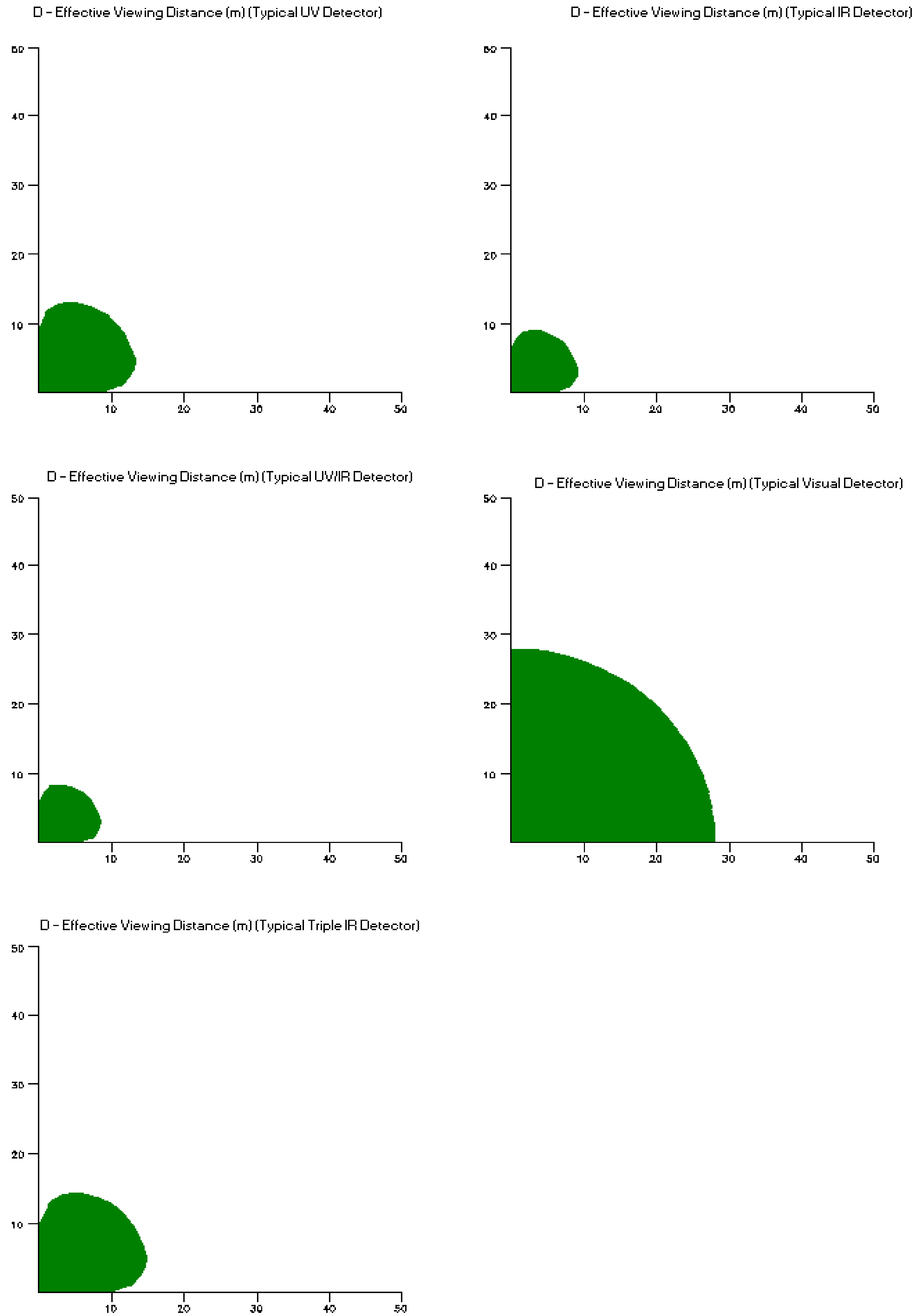
The study also recommends to use radiant energy sensing detectors to match the radiant emissions expected from the source to be detected, as required by the applicable occupancy-specific data sheet. Since each fuel emits unique spectra, not all detectors are capable of detecting all fuels. For example, the use of an IR3 to detect a methanol fire (special hazard).

Figure 1 shows a typical visual flame detector footprint with appropriate desensitisation applied.

Table 1—Summary of Flame Detection Technologies

Detector Technology	Suitable for General Use	Suitability for Special Hazards	Unwanted Response from Flare
UV	NO	YES (Match spectral emission of fire to technology)	YES
UV/IR	NO	YES (Match spectral emission of fire to technology)	YES
IR Single Channel	YES (Less likely to fail to danger, however, still prone to spurious alarm.)	YES (Match spectral emission of fire to technology)	YES
Multi Channel IR (IR3)	NO	YES (Match spectral emission of fire to technology)	YES
Visual	YES	NO (Will not detect fires with invisible flame)	NO

Figure 1 —Comparison of Effective Viewing Distance between Flame Detection Technologies



References:

1. FM Global Property Loss Prevention Data Sheets 5-48 January 2011.

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