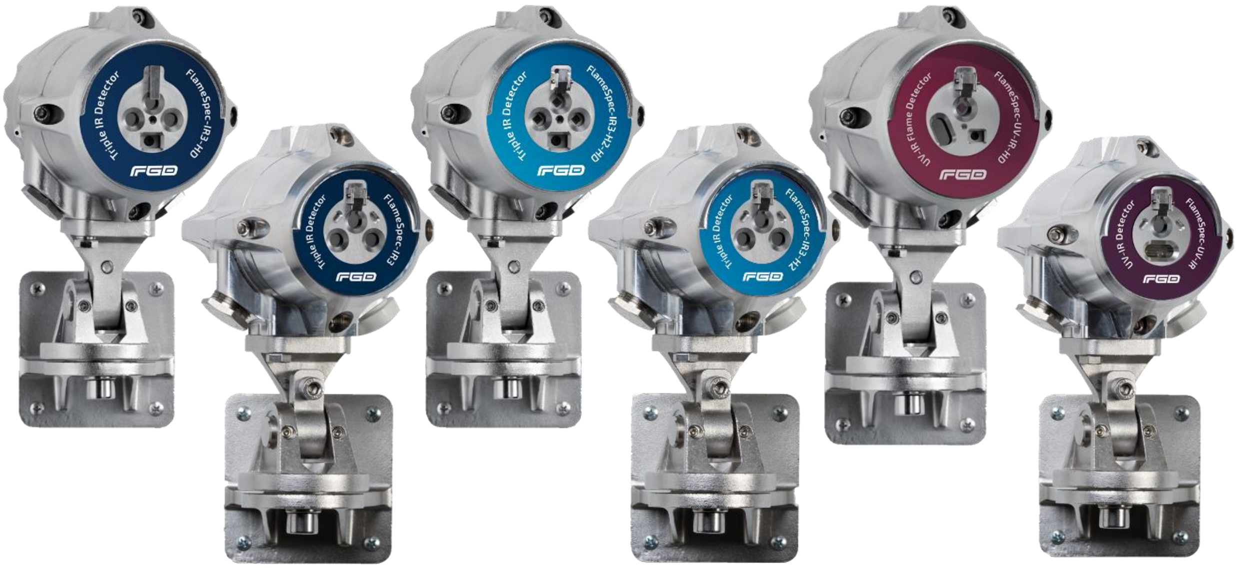
Technical Note

Fire & Gas Mapping Considerations



FIRE & GAS DETECTION TECHNOLOGIES INC.
Fire and Gas Detection Technologies Inc. | 4222 E. La Palma Ave. Anaheim, CA 92807
USA Tel: (+1) 714-671-8500 | support@fg-detection.com

1 Introduction

Fixed flame and gas detection systems are designed and installed to protect large and complex areas filled with process equipment from risks of combustible or toxic gas leaks, explosions, and flames. The fire & gas system performs three basic functions:

- Hazard detection
- Warn personnel
- Initiate Action.

For these systems to be effective, it is important that they offer a high likelihood of detecting the presence of any flame and gas hazards within monitored process areas. Determining the optimal quantity and location of flame and gas detectors is therefore critical to ensure the detection system's effectiveness.

2 Performance Target for Fire and Gas Systems

The process for F&G system design starts by the End User defining the risk and the assessment of a suitable 'detection target' for the zone (fire size or the size of the gas cloud) of interest. This allows the system Specifier to discuss the hazards present in terms of the damage it would cause, the escalation rate of any such event and the maximum level of damage that can be accepted by the process / end user.

For each area of concern, the Specifier must define the consequences to be prevented and the hazards that can lead to this undesirable situation occurring. The performance expectations for the F&G system must then be defined to ensure the event does not occur. In essence, the equipment and hazards are graded based on their escalation potential.

Once defined, this information along with the End User philosophy can then be used by the System Designers to define detector types, location, quantities, and coverage along with the system controls and outputs.

Many End Users categorize process areas based on the equipment and hazards containing flammable materials with category A being the highest risk and category C being the lowest. These categories are assigned a fire size for detection, with smaller fires needing to be detected in high risk areas and a "% coverage" target based on the size of fire to be detected. The "% coverage" should not be viewed as a mandatory requirement, rather it should be considered "desirable", considering the congestion and potential false alarm sources in any given process area.

Once the performance targets have been established, we need to determine the detection distance for the flame detectors.

3 What is the effective detection distance for a flame detector?

When considering detection distance, we need to understand that pushing a device to the envelope of its detection limits is not normally a good thing as there is a key trade-off between sensitivity and false alarm immunity. In hazardous process industries reliable detection and no false alarms are critical to production uptime and the selected detector sensitivity setting must reflect this.

Today FM 3260 and EN-54 part 10 are international standards for the performance of optical flame detectors. According to these standards triple IR flame detectors generally tend to be more sensitive (80 metres) than UV-IR flame detectors (30 metres), to a one-foot square n-heptane fire when used on the highest sensitivity setting the detector can employ.

When designing coverage, the detection range to the application's specified fuel should be considered with common false alarm sources and optical contamination present. If we also consider congestion in the field of view it is easy to understand that "perfect" device coverage is unlikely to exist. This means that detectors should be selected to detect the appropriate hazards as they occur on the facility considering:

- code and approvals requirements.
- contaminants (e.g., dust, dirt, sand, silicones, oil, or sea water spray);
- potential interferences (e.g., EMI/RFI, other gas constituents for gas detectors, welding arcs for fire detectors, sunshine for optical detectors).
- output signal compatibility with interfaces.
- technology robustness and proven reliability.
- local environmental conditions during normal and emergency situations (e.g., ambient temperature, vibration, effects of rain, snow, fog, and wind).

One major oil & gas operator proposes flame detection coverage as follows: "The flame sensor shall be used at an effective cone of vision between 60 and 90 feet (18.3 m and 27.4 m), even though most flame sensors can detect at a further range."

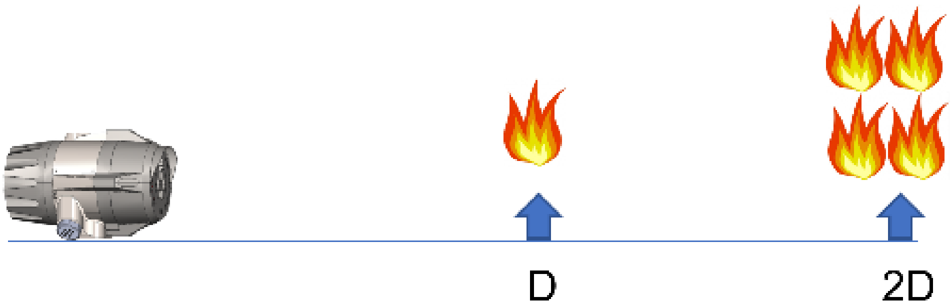
Indeed, if we look at the detection properties of two major manufacturers, we can see a good correlation between the above requirements and their factory default sensitivity. Furthermore, it becomes evident that major reductions in detector counts by using "ideal" detection limits or by changing from one detector manufacturer to another are not realistic.

		Manufacturer 1		Manufacturer 2	
Fuel	Size	Distance ft (m)	Response	Distance ft (m)	Response
n-Heptane	1 x 1 foot	98 (30)	2.2 s	100 (30.5)	7 s
Diesel	1 x 1 foot	79 (24)	3.9 s	70 (21.3)	4 s
Methanol	1 x 1 foot	75 (23)	1.2 s	70 (21.3)	6 s
Ethanol	1 x 1 foot	75 (23)	1.6 s	85 (25.9)	7 s

4 Inverse Square Law

It is important to understand that the detection distance is dynamic as it directly relates to the amount of energy being received by the detector, or put more simply, fire size. A small fire close to the detector can trigger an alarm just as easily as a large fire, like a flare, further away.

The detection distance is governed by the inverse square law, which in basic terms means if a detector responds to a 1 square foot n-heptane fire at 30 metres, it will also respond to a fire that is four times larger at double the distance (60 metres). Unfortunately, this calculation cannot be applied indefinitely as external influences, like, water vapour, cold CO2 and flame flicker also affect "detection."



By utilising the inverse square, we can see designers may be tempted to increase the target fire size to reduce the number of flame detectors needed. Although an acceptable technique, this does present a challenge as there is no credible verification that the design intent will be met. FM 3260 and EN-54 part 10 test detectors with a very modest size fire, 1ft² (0.09 m^2) n-heptane pan fire, (~40kW Radiant Heat Output [RHO]). This is why some oil & gas operators request test data to a major fire hazard. One such test requires uses a large fire (e.g. 1m diameter or 1m x 1m x 3m n-heptane pool fire) to see if the detector signals may be saturated.

5 Understanding false alarm sources

It is rare to have a flame detector installation that doesn't have potential false alarm stimuli present. Typical sources include flare stacks, direct and reflected sunlight, hot process, and engine exhausts, to name but a few. During maintenance work, detectors typically need to be isolated as additional sources of false alarm can be introduced, these include, X-raying, cutting, grinding and arc welding.

6 Summary

The design criteria has a major impact for the number of detectors needed an installation. In hazardous process industries, many End Users define the actions that will be taken in the event of an alarm, and this largely depends on the criticality and escalation potential of an installation. The initiated action is normally automatic, except where human action has been assessed for the facility and hazard type and can be demonstrated as being an effective part of the mitigation process. The actions typically range from alarm only, where human action is needed – perhaps by using a CCTV video feed for confirmation, to plant shutdown and suppression system / deluge discharge, where a voted detector configuration is needed. Detector voting uses a logic function, for example “2 out of N” (2ooN) to trigger, where “N” represents the number of detectors in fire zone. An alarm only configuration would typically use a single detector, without voting, to initiate an action.

The fundamental questions remain:

- What is going to burn?
- What size fire do I need to detect?
- What false alarm sources are present?
- What are the conditions at site? Hot, cold, dusty, salt spray, snow, etc.
- Is the flame detection technology suitable for all the above?

When proposing a design, it is a good idea to conduct a site survey, for existing plant, or to walk through a 3D model of a new facility, if such a design exists. When doing this, look for solid structures to mount the detectors, that covers the objects/area that need protection. Try to experience what the detector 'sees' taking into consideration the field of view of the detector. The detectors should be mounted looking down at an angle to prevent dirt, dust, and moisture from collecting on the windows and avoid potential false alarm sources in the cone of vision - such as flares, engine, or turbine exhausts.

These elements are important, but we also need to address another practical aspect of the installation - accessibility for maintenance purposes. This aspect should not be overlooked as flame detectors are usually mounted in elevated locations and the long-term operational aspects of the installation should be considered. This does however present a challenge for the designer as they are usually tasked with producing an optimised design, that essentially minimises the number of detectors used without consideration to access. It is quite probable that a less optimised detector layout, that uses existing structure with good access, would benefit the facility owner / operator from a maintenance perspective and that this may potentially improve facility uptime if it negated the need to construct scaffolding towers, for example.

Finally, when considering detection distance, do not increase device sensitivity to the envelope of its detection limits, reliable detection and no false alarms are critical to production uptime.