Using flame detectors for Zone 2 Hazardous Areas

In this article the fundamentals of Hazardous Areas are outlined and Flame Detector applications, split into Zone 1, Zone 2 and Safe Areas are discussed. This is not a definitive explanation of Flame Detector types or how they work, but a general dissertation and for this article and simplicity, reference is made to UV, UV/IR and Multispectrum Infrared (IR3) Flame Detectors.

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Today, with onshore industrial projects being closely scrutinised for cost, the choice of Flame Detectors can become a complex and time consuming process, but, with about 80% of onshore projects actually being in Zone 2 areas, the trend has been to purchase unnecessarily expensive, Explosion Proof Zone 1 Flame Detectors. While these are exceptionally suitable for Zone 1 applications, they are not cost effective for Zone 2 and until recently, there have been few suitable alternatives.

There are two predominant Flame Detector types in general use for industrial applications, there are Flame Detectors for Safe Areas and for Hazardous Areas. In many onshore Zone 2 applications, Zone 1 Flame Detectors are over-specified and Safe Area Flame Detectors have a low usage because Safe Area is defined as “an area in which an explosive atmosphere is not expected to be present”. However, there is also a growing use of Flame Detectors for Safe Areas, such as Airport Terminals, Train, Subway and Bus Stations, Sports Arenas, Atriums, Public Buildings, Shopping Malls and Exhibition Halls.

As noted, many onshore applications are for Zone 2 areas, so there is normally no need to use more expensive Zone 1 Flame Detectors. The initial cost saving can be significant, when a suitable a Zone 2 Flame Detector is selected. The cost of installation, maintenance and replacement parts is also much lower, resulting in a lower cost of lifetime ownership.

The options for flame detectors

Areas with potentially explosive atmospheres are divided into Zones, (according to the European, IECEx and ATEX standards) and Divisions (according to USA standards). Any equipment used in such areas must have an identification plate indicating in which Zone or Division the explosion protected equipment can be used. The Zone and Division classifications have one significant difference, in that Division 1 is a combination of Zone 0 and Zone 1. The definitions are almost equal for Zone 2/Division 2 and for Safe Areas. There are three approval methods for Flame Detectors for Hazardous Areas.

The Zone classification for ATEX/IECEx is as follows:

Zone	Hazardous Area Characteristics
Zone 0	Where ignitable concentrations of flammable gases, vapors, or liquids are present continuously or for a long period of time under normal operating conditions.
Zone 1	Where ignitable concentrations of flammable gases, vapors, or liquids are likely to exist under normal present continuously or for a long period of time under normal operating conditions.
Zone 2	Where ignitable concentrations of flammable gases, vapors, or liquids are unlikely to exist under normal present continuously or for a long period of time under normal operating conditions.
Safe Area	A Safe Area, (Non-Hazardous Area), is an area in which an explosive atmosphere is not expected to be present.

Explosion Proof: Sometimes there is a misunderstanding of what Explosion Proof means. The detector is not necessarily capable of surviving an explosion, but it is so designed, that the housing contains an internal explosion and does not vent an ignition source to an explosive atmosphere. Simply stated, this is done using flame paths, low energy electronics and reducing the internal free space to a level where the volume of any explosive mixture is insufficient to support combustion. All of this leads to an expensive product, the cost of which is more than justified for Zone 0/1 areas.

These Flame Detectors are designed for heavy-duty, industrial use, such Oil and Gas Exploration and Production, Pipeline and Compressor Stations, Refining, Processing and the Chemical industry.

Typical requirements are Zone 0/1 approvals using an aluminium or steel housing with Ingress Protection of IP65 minimum. Usually the sensitivity is adjustable with the highest being 60+m, based on a 33 x 33cm n-Heptane pan fire. Through the lens Self-Test, Heated Optics, multiple communication protocols, including 0-20 mA,, HART, Relays, Modbus, RS485 are standard as well as Fault Diagnostics, a Real Time clock, grounding lugs, SIL 2 certification, a -40°C to +75°C operating temperature and a heavy-duty swivel mount. Image/video verification is also available with some models as well as High Temperature versions.

Intrinsically Safe: The equipment and wiring must be incapable of releasing sufficient electrical energy, under normal or abnormal conditions, to cause ignition of a specific atmospheric mixture in its most easily ignited concentration. Consequently, Intrinsically Safe, (IS), Flame Detectors do not need housings to contain any possible source of ignition, as the electrical energy is so low, however, they do need to be installed with Zener Barriers for current limiting and special IS cable, which must be separated from high voltage cables both in the field, the control room and control cabinets. IS cable must also be inspected regularly and suffers distance limitations for cable runs, due to increasing capacitance and inductivity.

Non-Sparking (ATEX/IECEx) / Nonincedive (FM): A type of protection applied to an electrical apparatus such that, in normal operation, it is not capable of igniting a surrounding explosive atmosphere and a fault, capable of causing ignition, is not likely to occur. To prevent sparking on PCB's and critical electrical components, creepage and clearance distances need to be carefully addressed. Special coatings can be used to reduce arcs between conductors. The enclosure should be dust and water tight to avoid tracking across live circuits. Non-Sparking/ Nonincendive is very similar in concept to IS, but, the lack of expensive installation costs makes it a good choice for Zone 2 areas. Products must have approvals such as EN54-10 or FM3260 and ATEX or FM EX. A nonmetal housing is preferred, with a typical sensitivity of 35m, for a 33 x 33cm n-Heptane pan fire, as well as Self-Test, IP65 ingress protection and -25˚C to +70˚C ambient operating temperature.

Safe Area, (Non-Explosion Proof). These Flame Detectors have a relatively low price, but they do not meet the stringent requirements for industrial applications. Used mainly for indoor applications, (typically utility buildings, hospitals, atriums and some marine applications), they have no formal ingress protection. Construction is often an ABS plastic, injection molded enclosure and have a relatively low sensitivity. As many are designed to be used with loop power from a Fire Alarm Control Panel, they normally have low power consumption. These Flame Detectors typically do not have a Self-Test function and, as such, should not be used for Industrial and outdoor applications.

For the remainder of this article, we will use the Zone and Non-Sparking terminology for clarity.

In Figure 1, a typical Zone classification is shown. Flammable concentrations are continuously present inside the tank, which is rated Zone 0. The immediate area outside the tank, such as sealed flanges and manifolds, is classified as Zone 1.The remainder of the building is rated Zone 2. The wall of the building separates the Zone 2 area from the Safe Area. Much of the

Table 1: Cost of ownership Zone 1 and Zone 2 Flame Detectors

Cost Item	Flame Detector Type	
	Zone 1 Explosion Proof	Zone 2 Non-Sparking
Detector Purchase	Features and options required for high end applications.	Fully complies with features and options in mid-market applications.
Installation and Commissioning	Enclosure grounding, EX cable gland and restricted breathing cable required.	Ease of installation, EX cable gland included, enclosure grounding not required.
Maintenance	Rubber O-ring inspection, flame path inspection and enclosure grounding. Expensive Test Lamps.	Cost effective Test Lamp. Minimal maintenance.

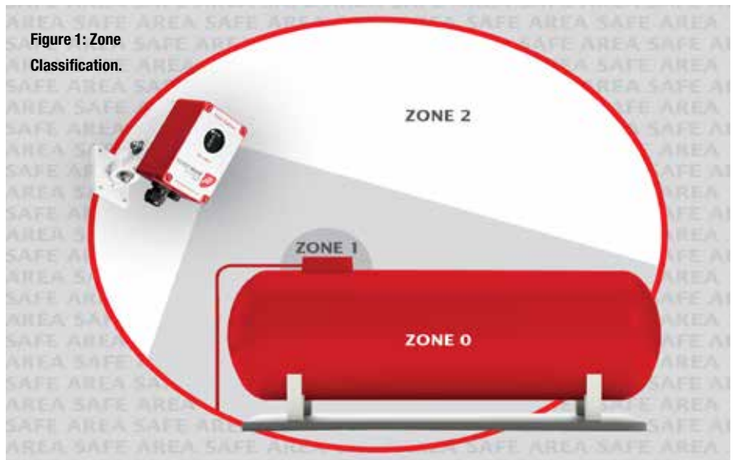
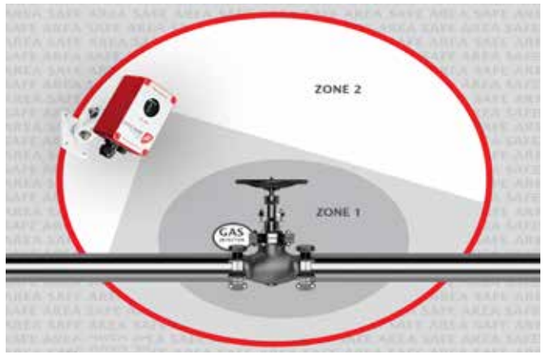


Figure 1: Zone Classification.



◀ **Figure 2: A Zone 2 Flame Detector monitoring a Zone 1 fire risk.**

area is Zone 2, however, a lot of Explosion Proof Zone 1 equipment is installed in Zone 2 areas. This is the basis of the claim that over 80% of all Explosion Proof Flame Detectors are mounted in Zone 2. Zone 2 Flame Detectors can be used for these applications and they can also be used for monitoring Zone 1 areas, as shown in Figure 2.

Many applications use Gas Detectors in concert with Flame Detectors. In Figure 2, there is a significant difference in the approach for using a Gas Detector and a Flame Detector. A Gas Detector detects diffusing combustible gases from a gas leak and must be mounted in Zone 1, close to any potential leak. Flame Detectors, which are "line of sight", should be mounted at a suitable distance to be able to monitor the area effectively within its Field of View. This allows Flame Detectors, in many applications, to be mounted in Zone 2 and monitor a fire risk located in Zone 1.

Choosing the right Flame Detector

As can be seen, there is an enormous choice for Flame Detectors, not just different types, (Ultraviolet, Ultraviolet/ Infrared or Multispectrum Infrared), but a myriad of manufacturers, housings, performance levels, ingress protection and approvals. It is important to choose the right tool for the job and unfortunately, there is a tendency today to "cut and paste" the last specification used, regardless of the application. Often end users are buying Flame Detectors that are over specified, resulting in increased costs of capital purchase and lifetime ownership. Table 1 illustrates the additional cost of ownership if the wrong Flame Detector is selected for Zone 2 applications.

For Zone 2 onshore applications, (discounting Explosion Proof), there are two options; Intrinsically Safe and Non-Sparking. As can be seen from Table 2, there are many potential applications for Zone 2 Flame Detectors.

Apart from performance and cost, a Flame Detector must be easy to install. The following "ease of installation" requirements are considered paramount.

- Grounding of the housing is not required.
- A cable gland must be included as a component of the Flame Detector housing
- No maintenance of the flame path should be required to complete the installation.
- Special cabling, (i.e. Intrinsically Safe), should be not required.
- No additional electronic equipment should be required to complete the installation.
- The permitted power consumption should be sufficient for powering a self-test.

As noted, although IS seems to be a reasonable choice, the additional cost of installation significantly increases the overall expenditure. Additionally, due to the communication options of IS Flame Detectors being limited to analogue outputs, this again is a disadvantage, especially if connection to local horns and beacons is needed.

Conclusion

As noted, more than 80% of all onshore industrial Flame Detectors are used in Zone 2 or Safe Areas. For applications for which Zone 2 Flame Detectors can used, is there any need to install expensive Zone 1 or IS Flame Detectors? Given the additional cost of using the other options, Non-Sparking is the superior choice for Zone 2 applications

Table 2: Typical applications for Zone 2 Flame Detectors

This table lists typical Zone 2 applications, however, it must be noted that Zoning is the responsibility of the Authority Having Jurisdiction and may vary from application to application.

- Ethanol and Methanol Processing, Hydrogen Plants and Storage
- Chemical Production Storage/Loading & Unloading
- Household/Industrial Waste Recycling Plants
- Chemical Waste Recycling Plants
- Tank Farms
- Engine Test Cells
- Power Plants
- Electrical Sub Stations
- Paint Spray and Powder Coating Booths
- Generator Rooms
- Machinery Rooms
- Power Transformers
- Oil and Gas Pipeline and Pumping Stations
- Aircraft Hangars
- Liquid Hydrocarbon, Chemical Solvent and Paint Storage
- Warehouses
- Aerosol Filling Lines
- Bus Parking Barns
- Fuel Service Stations
- Natural Gas and LNG Storage and Distribution
- Natural Gas Service Stations
- Truck Loading Racks
- Gasoline and Diesel Service Stations
- Hospitals, (Hazardous Gases)

For more information, go to www.sense-ware.com

References

1. Standard FM Class 3611 Nonincendive Electrical Equipment for use in Class 1 and 2, Division 2, and Class 3, Division 1 and 2, Hazardous (Classified) Locations
2. Standard IEC EN 60079-0 Explosive atmospheres - Part 0: Equipment - General requirements
3. Standard IEC EN 60079-7Explosive atmospheres - Part 7: Equipment protection by increased safety "e"
4. Standard IEC EN 60079-15 Explosive atmospheres - Part 15: Equipment protection by type of protection "n"
5. Standard EN54-10Fire detection and fire alarm systems - Part 10: Flame detectors - Point detectors
6. Standard FM 3260Approval Standard for Radiant Energy-Sensing Fire Detectors for Automatic Fire Alarm Signaling