# APPLICATION OF VISUAL FLAME DETECTION™

## TURBINE ENCLOSURES


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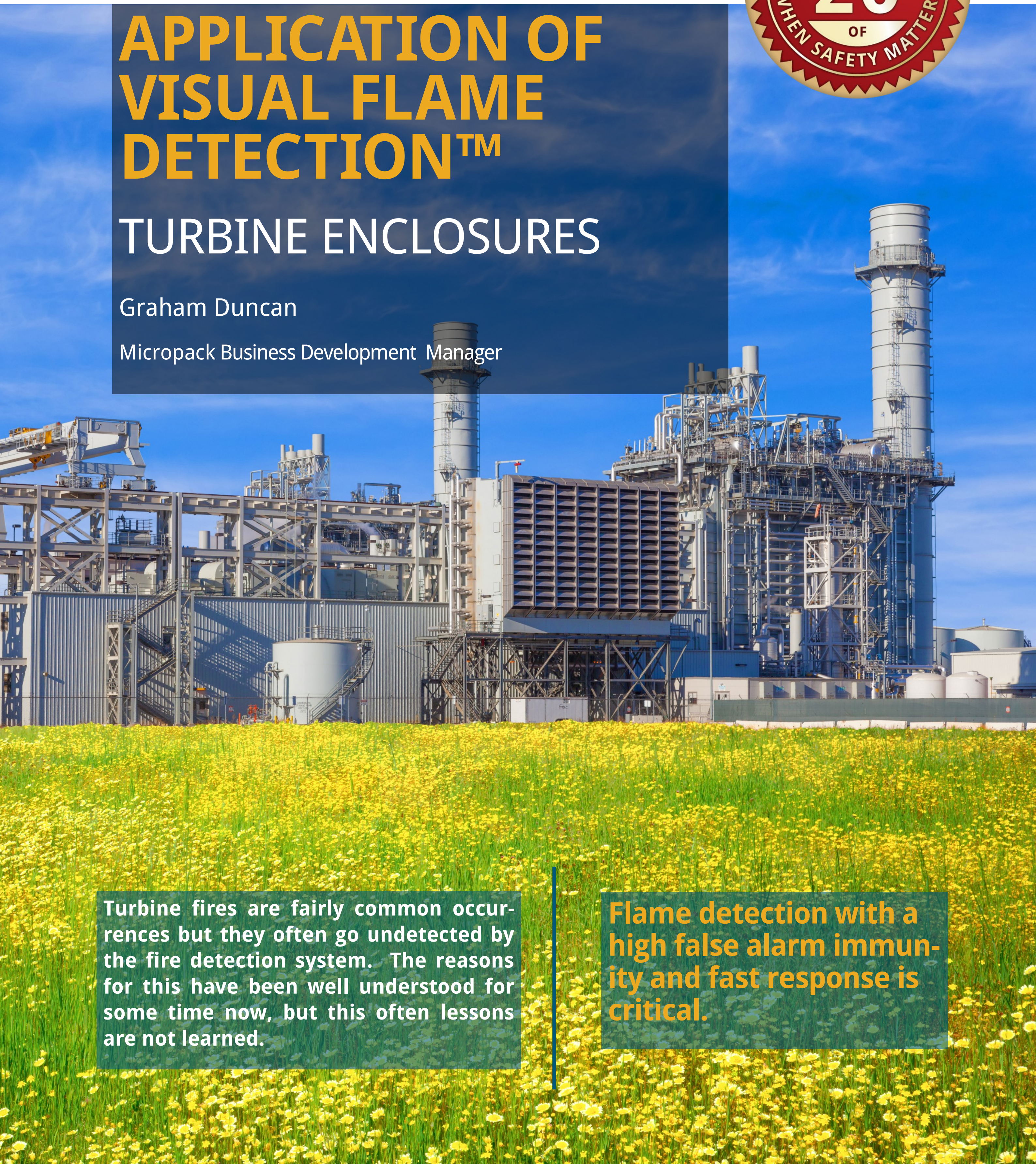

**Turbine fires are fairly common occurrences but they often go undetected by the fire detection system. The reasons for this have been well understood for some time now, but this often lessons are not learned.**

**Flame detection with a high false alarm immunity and fast response is critical.**

## Introduction

Micropack has extensive experience with Fire and Gas release events in Turbines and the F&G requirements for detection of these types of event. This document has been written to summarise the historical data relating to Turbine Enclosure F&G Detection Systems and detail the “evidence based practice” for recommendations on turbine enclosure fire detection systems.

## Fire and Gas Events

Turbine fires are fairly common occurrences but they often go undetected by the fire detection system. The reasons for this have been well understood for some time now, but this experience is rarely acted upon. To ensure the detection rate is increased, it is critical to ensure the detection employed is suitable for the application. In a limited number of instances, lessons are learned and detection systems are specified based on the hazard types. The reported performance of these systems has shown that the detection rate is far better. Gas turbine enclosures are fitted with gas detection, but it is known that there are significant numbers without flammable liquid detection. Flammable liquid detection in the form of oil mist detectors are fitted to some turbine enclosures usually in the enclosure exhaust duct. Oil mist detection would help improve the detection efficiency of flammable liquid leaks, both diesel and lube oil. Specifically it would provide an early warning of flammable liquid leaks.

## Fundamentals

In a typical turbine application there are three fundamental functions that the F&G detection system should perform;

1. Detection of fire inside the turbine enclosure.
2. Detection of external gas being ingested via the Turbine ventilation system.
3. Detection of fuel gas released within the Turbine enclosure.

## Underlying Causes of Fires and Explosions in Enclosures

Gas turbines are housed in enclosures and there are large areas of hot surfaces. Most turbines are dual fuel and run on diesel at least part of the time. Unfortunately oils (diesel and lubricating oil) have auto ignition temperatures (AIT) significantly lower than gas, and combined with the large hot areas in the turbine enclosures form a high risk scenario. The AIT of diesel and lube oils are ~240°C whereas methane is 530°C, and the external surface of a combustion chamber can reach ~200-400°C. If diesel or lube oil contacts surfaces at these temperatures, ignition will almost certainly occur. This is confirmed by the record of fires and explosions in gas turbines in the UKCS[1, 2]

Good practice is seen as fitting oil mist or vapour detection instruments into turbine enclosures exhaust ducts to provide early warning of oil leaks.

## Optical Flame Detection

Another source of fire could result from a fuel gas release and ignition within the turbine enclosure. In a typical turbine, due to the pressure of the fuel gas, it is nearly impossible to have small fires and rate compensated heat detection provides a cheap and reliable way of detecting such events. It is widely recommended that heat detectors are installed within the turbine enclosure and also in the enclosure ventilation exhaust ductwork where the hot gases from the fire will be transported to.

Optical Flame Detectors are often installed because they are most sensitive to flaming fires and provide greater area coverage.

**The turbine enclosure is a challenging and congested environment for optical flame detectors to operate therefore the technology employed must be suitable.**

## Radiant Flame Detection—IR / UV

A major hazard in the turbine enclosure is the potential for a high pressure release of lube oil. If a UV flame detector was employed in this application and the oil was to coat the lens, the oil would absorb the ultra violet light being emitted from any occurring fire and render it blind. These challenges have been well documented over the years.

IR Flame Detectors pose different challenges in that they are negatively affected by black body radiation from the hot equipment within the turbine enclosure. This has been known to cause certain brands of IR flame detectors to false alarm, whereas others will be blinded. IR flame detectors do provide a slightly quicker response to fuel gas fires than heat detectors, however, this benefit would be insignificant in terms of reducing damage in this type of event.

## Visual Flame Detection™

Visual Flame Detection™ Technology from Micropack can be employed to detect fires within the turbine enclosure, due to the fact that the technology is unaffected by the typical false alarm and desensitisation sources which affect radiation type flame detection; IR/UV/IR3. Blackbody radiation caused by the hot machinery will not cause a false alarm or desensitise visual based flame detection technology. Water on the optics will have a minimal effect.

The benefits of installing a Micropack FDS301 inside the turbine enclosure are listed below:

- Live video image of turbine enclosure
- Not affected by black body radiation (hot machinery)
- Less affected by dirt/grime/oily deposits on the lens
- High temperature rating +85°C
- Pre and post alarm video recording of the event onto an on-board micro-SD card

## FM Global Recommendations

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In 2011, an independent review from FM Global[3] recommended that visual flame detection systems be applied as the default technology for the following 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).

## Summary

In summary the fire types that can be encountered in a typical Turbine Enclosure can be detected by Oil Mist Detectors, Rate Compensated Heat Detectors and Visual Flame Detection applied and mapped correctly.

## References:


1. Gas turbine hazardous incidents; A review of the of UK Onshore and Offshore installations. Roger C. Santon c/o Health and Safety Laboratory
2. Accident statistics for fixed offshore installations units on the UK Continental Shelf 1980–2005 Research Report 566 HSE Books 2007
3. FM Global Property Loss Prevention Data Sheets 5-48 January 2011.


## Author


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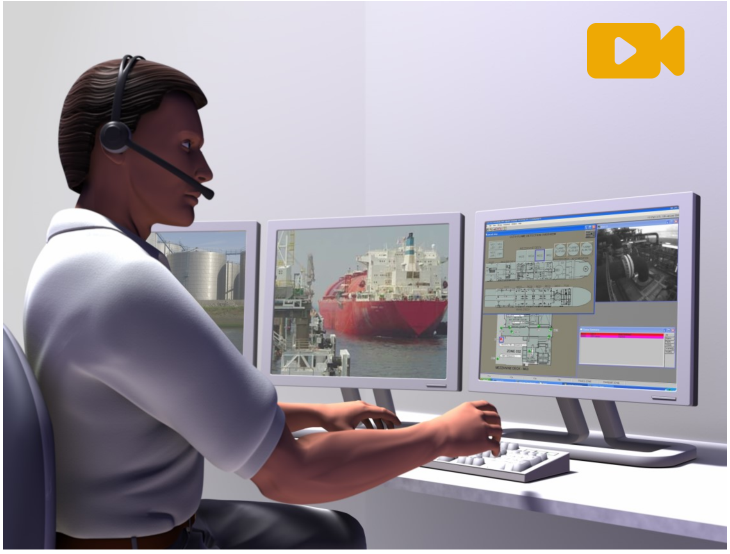
## 6 reasons to use Visual Flame Detection™ in Turbine Enclosures



FDS301 Visual Flame Detector—Operator Live Video Feedback

**When Safety Matters.** Visual Flame Detection™ will provide a fast response to fuel gas and lube oil spray fires.

**Challenging environment.** Where other technologies would either false alarm or miss fires, Visual Flame Detection™ is unrivalled in its false alarm immunity and flame detection capability.

CERTIFIED · exida · IEC 61508 · SIL 2 CAPABLE

**Safety Integrity Level**

Certified as SIL 2 Capable by EXIDA

**Go further with confidence.** On-board micro-SD card in every unit capable of recording any occurring fire. Lessons could be learned from this video and preventative safety measures introduced.


**Live Video Feedback.** Incorporating a colour camera in each unit, the FDS301 offers a cost effective combined flame detection and CCTV solution.

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**When compliance is critical.** Visual Flame Detection is recommended specifically by FM for use in turbine enclosures.

MICROPACK FIRE & GAS

# FDS301 TECHNICAL SPECIFICATION

## Environmental

| | |
|---|---|
| Operating Temp | -60°C to +85°C (-76°F to +185°F) |
| Storage Temp: | -60°C to +85°C (-76°F to +185°F) |
| Humidity | 0 to 95% RH non-condensing |

## Operating Voltage

24Vdc Nominal – (18 to 32 Vdc Range)

## Power Consumption

6 watts minimum (no heater), 10 watts typical, 15 watts maximum (with heater)

## Speed of Response

~7 seconds (Typical)

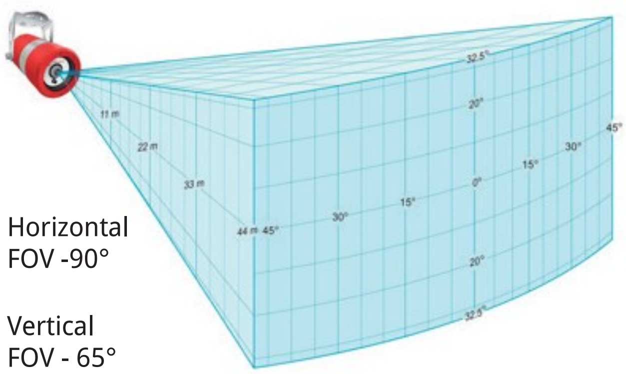
## Flame Sensitivity

| Fuel | Fire Size | Distance |
|---|---|---|
| Methane Jet Fire | 0.9m (3ft) plume | 30m (100 feet) |
| Ethanol | $0.1m^2$ (1sqft) pan | 25m (85 feet) |
| n-Heptane: Pan Fire | $0.1m^2$ (1sqft) pan | 44m (144 feet) |
| n-Heptane: in direct sunlight | $0.1m^2$ (1sqft) pan | 44m (144 feet) |
| n-Heptane: in modulated sunlight | $0.1m^2$ (1sqft) pan | 44m (144 feet) |
| n-Heptane: modulated black body | $0.1m^2$ (1sqft) pan | 44m (144 feet) |
| n-Heptane: Arc welding | $0.1m^2$ (1sqft) pan | 44m (144 feet) |
| n-Heptane: 1000watt lamp | $0.1m^2$ (1sqft) pan | 44m (144 feet) |
| Gasoline Fire | $0.1m^2$ (1sqft) pan | 44m (144 feet) |
| JP4 | $0.36m^2$ (3.8sqft) | 61m (200 feet) |
| Ethylene Glycol | $0.1m^2$ (1sqft) pan | 15m (50 feet) |
| Diesel | $0.1m^2$ (1sqft) pan | 40m (130 feet) |
| Crude Oil (heavy fuel oil) Pan Fire | $0.25m^2$ (2.7sqft) | 40m (130 feet) |
| Silane fire | 0.61m (2ft) plume | 13m (42ft) |

## Enclosure

| | |
|---|---|
| Dimensions: | 100 Diameter x 200 Length Overall (mm) |
| Material: | LM25 (Red epoxy), 316L stainless steel |
| Entries: | 1 – M25, ¾"NPT (Variants on Request) |
| Weight: | 2.5kg (LM25) or 6kg (316L) |

## Field of View




## Outputs

Relay contacts - alarm and fault
Current source 4-20mA
RS485, HART
Live colour video – PAL and NTSC

## Certification

ATEX : II 2 G Ex db IIC T4 (FM07ATEX0033)
Factory Mutual : 3260 (3029978)
IEC 61508 : SIL 2 (MP 080203 C001)
IECEx FME 07.0002
Class 1 DIV 1 GROUPS B,C,D,T4
Class 1 Zone 1 AEx/Ex d IIC T4
EN54-10 (VdS)

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