LNG LEAK DETECTION BY INFRARED THERMAL CAMERA
INSTALLATION AT FOS-CAVAOU TERMINAL

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ABSTRACT

The 2001 Toulouse accident consequence has lead to toughen the French regulatory frame for industrial risk management. Nowadays, two independent safety barriers are required to suppress the worst scenarios that are taken into account by the urban planning program. Consequently, the Fos Cavaou terminal is to implement a second safety barrier for LNG leak detection. The Fos Cavaou terminal already uses linear and punctual LNG leak detection systems. Other standard systems available on the market had been reviewed but their implementation had an impact on the Terminal's day to day operation and on its maintenance. The selected solution as second safety barrier is a zone monitoring system, making possible the detection of a major LNG leak by thermal difference identification between the ambient conditions and the cold liquid or gas release. In case of leak, infrared thermal imaging cameras linked with a central system and a dedicated software will launch a number of automatic trips. Hence, any failing equipment/segment will be identified and isolated from the rest of the plant. Infrared thermal imaging cameras are to be implemented along the major LNG lines of the plant. Compared to punctual detection systems, Infrared Thermal Imaging Camera allows to monitor long piping segments, at a lower cost. The cameras will not interfere with day to day operation and maintenance and they can be installed on any kind of piping support (racks or pipeways). To avoid noisy and false alarms, experiments and field operation feedback is needed to feed the specifications for infrared thermal imaging cameras installation and configuration.

CONTEXT

In 2001, a huge explosion occurred in the fertilizer factory “AZF” in the French city of Toulouse. The accident caused the death of 29 people (28 inside the plant, 1 outside) and seriously wounded 2500 people. The whole factory was destroyed and two thirds of the city's windows were shattered.

After this tragic accident the French Authorities decided to strengthen the regulation in two ways:

- Making the safety criteria tougher in order to get the permit for building and operating new establishments.
- Managing the land-use planning in the vicinity of the existing establishments to protect efficiently the population around the site.

These measures were introduced by an act passed in 2003 called “Risk law” (loi Bachelot). The new act applies to the establishments that could lead to major accidents e.g. classified as SEVESO.

For the SEVESO establishments the new regulatory framework required to carry out the safety reports on the basis of a probabilistic approach of the risks. Henceforth, all potential accidents leading to significant effects on the site have to be studied, whatever their likelihood.
Nevertheless the new methodology accepts not to take into consideration very unlikely accident scenarios if they fulfill certain stringent conditions:

- the risk level associated to the scenario is equal or less than $10^{-5}$/y and,
- the risk level remains equal or less than $10^{-5}$/y when the barrier concerned by the higher level of reliability is removed.

**CONSEQUENCES OF THE NEW REGULATION ON LNG RECEIVING TERMINALS LOCATED IN FRANCE**

For the LNG receiving terminals in France as a result of the new rules, applicable to SEVESO establishments, the installation of a redundant, automatic and fully independent emergency shutdown system is become required along the LNG pipelines and especially the unloading line(s). Otherwise the major scenarios of flash fires coming from a full bore rupture of pipe or a very large leak has to be taken into account with a duration of leakage of at least 30 min. This time is assumed by the French administration to be necessary under certain circumstances to manually activate the shutdown.

As Elengy terminals were equipped with a unique barrier using traditional techniques (gas, cold or flame detectors) a change in the emergency shutdown system became necessary.

A review of the different techniques available on the market was carried out and resulted in the choice of a second barrier using infrared thermal cameras. Fos Cavaou terminal was designated as the first site to experiment this innovative solution.

**INSTALLATION OF A NEW DETECTION SYSTEM AT FOS CAVAOU TERMINAL**

The system, installed at the Fos Cavaou terminal, is designed to detect major LNG leaks e.g. leaks having a potential impact outside the periphery of the terminal.

The detection is performed through a set of infrared thermal cameras installed along the major LNG lines from the unloading berth to the regazefiers. In this way the cameras can monitor a broad area representing more than 900 linear meters.
Implementation of cameras on the site

These cameras are combined with an image processing software. The principles adopted at Fos Cavaou terminal are mentioned below. They aim at ensuring efficient detection and to reduce the risk of spurious detection:

- For each camera controlled field, a size of “area affected by abnormally low temperatures” is defined. This surface area is computed through a number of pixels which is representative of the dimensions of the phenomenon we want to detect. As a result the triggering of the safety measures is subject to the expanse of the cold area detected.
- Zones of the controlled fields can be neutralized by the image processing (for example sectors of sea or sky).
- A detected leak has to be confirmed within 10 seconds to be taken into account.

Trials of leaks with Nitrogen (In blue area affected by low temperatures)  Image generated by a thermal camera
The device interfaces with the Safety Instrumented System (digital control system) of the terminal. A confirmed leak detection automatically triggers the emergency shutdown in the affected section (unloading, send-out, or both) cutting off the fluid transit and isolating the facility from the rest of the terminal.

ADVANTAGES OF THE THERMAL CAMERAS AND FIRST FEEDBACK

The system has several advantages. First of all it ensures a reliable image day and night, whatever the atmospheric conditions (rain, fog, smoke,…). Then it does not interfere with day to day operation or maintenance activity as the cameras are mounted high up on supports (see the pictures below ) and they are set only to detect significant leaks.

The camera offers three different focal lengths to find the required angles and depth of field and monitor up to 100 linear meters of pipe. Thus, 23 cameras can monitor all pipes.

The reliability of the detection is based on the appropriate setting of sensitivity to analyze contrasts and white level (thermal image) which are potentially affected by external conditions (sunlight and shadows, vehicles, birds, staff, …). The first months of operation have showed that the system was functioning properly. After the period of trial and adjustment it has been successfully connected to the Safety Instrumented System of the terminal and subsequently no spurious alarms has been observed.

Cameras installed on a metallic supports at Fos Cavaou terminal