# Explosion of an additive tank in a oil and bitumen refinery

May 18, 2002

**Dunkerque [Nord]**

**France**

**Explosion**
**Refinery**
**Bitumen additive**
**Storage tank**
**Inerting**
**Decomposition**

## THE INSTALLATIONS IN QUESTION

The refinery has been located on the Port of Dunkerque since the early 1950s.

The establishment, which employs 260 people, produces base oils, bitumen and derivative products from atmospheric residues and hydrocracking residues from petroleum refining units.

It features an industrial blast-type bitumen production facility and a paving asphalt and polymer bitumen production unit that uses a mixture of bases and specific additives.

The bases and additives are stored at the site prior to use.

## THE ACCIDENT, ITS BEHAVIOUR, EFFECTS AND CONSEQUENCES

### The accident:

At 3.30 pm, an explosion occurred in a bitumen additive tank located in the bitumen tank zone. The roof of the recipient was blown off and landed nearby. A fire developed with flames reachi heights of up to 10 meters. The internal contingency plan was pu into action. The personnel, having been alerted by the explosion, brought the fire under control in 10 minutes using 2 fire nozzles.

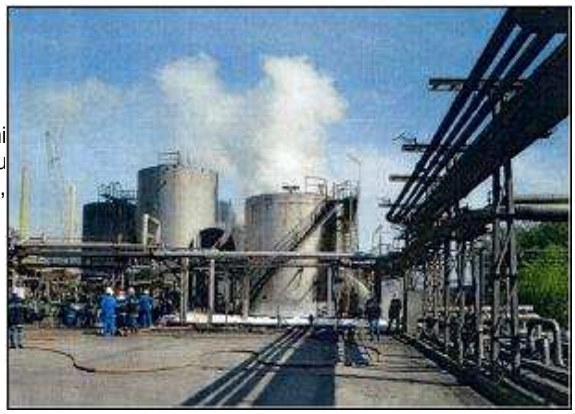

Photo DR

Storage zone

Photo DR

Roof of the tank

The public firemen did not have to intervene upon arrival. The prefecture informed the Classified Installations Inspectorate at 4.40 pm. A press release compiled by the sub-prefecture was sent to the regional press the same day.

## The consequences:

The accident claimed no victims and property damage was limited, except for the tank itself.

Property damage was limited to the tank itself, and the operator evaluated the corresponding damage to be less than 0.5 M€.

At the time of the accident, the wind was not blowing in the direction of the local residents, but toward the docks. The quantity of material lost in the fire is estimated to be 1 m³. The residual materials remaining in the tank were transferred to another recipient, prior to being eliminated in an external industry as the product had become unusable as it had become mixed with firefighting foam.

Particularly, active orders for the product were cancelled following the accident as the storage tank involved was used to store this type of additive on the site. The lack of product did not however jeopardize normal operation of the remaining installations as it was only required for a small part of the site's production activity.

## European scale of industrial accidents:

By applying the rating rules of the 18 parameters of the scale made official in February 1994 by the Committee of Competent Authorities of the Member States which oversees the application of the 'SEVESO' directive, the accident can be characterised by the following 4 indices, based on the information available.


The parameters that comprise these indices and the corresponding rating method are available at the following address: www.aria.ecologie.gouv.fr

Level 1 attributed to the amount of 'dangerous materials released' expresses the limited effects of the explosion of the tank (parameter Q2).

The property damage evaluated by the operator justifies the level 1 rating attributed to the "economic consequences" index (parameter €15).

# ORIGIN, CAUSES AND CIRCUMSTANCES OF THE ACCIDENT

The tank that caught fire contained an additive used to manufacture bitumen and consisted of 2 polymers with a high flashpoint. A storage capacity of 185 $m^3$ (diameter: 6 m – height: 6.5 m) it had a storage capacity of 140 tons of product. At the time of the incident, the tank was nearly full.

The tank was heat lagged and equipped with a mixer and heating coil to maintain the additive at a uniform temperature of 150°C (below a certain temperature, the product becomes too viscous and cannot be transferred or pumped). In terms of safety equipment, the tank was equipped with a temperature indicator (with just one reading possible, at the equipment console), a nitrogen inerting system and vents. The tank was associated with a retaining catchpit having a volume greater than 185 $m^3$.

Subsequent inquiries showed that the 2 polymers, which made up the additive in question, could decompose at a temperature below that of the storage temperature. The first decomposes into a substance having a flashpoint less than 50°C and into a highly flammable monomer with a flashpoint below 0°C. The second can release highly flammable gases.

The origin of the accident was due to the slow decomposition of the additive's 2 components that could, in the presence of air, produce organic peroxides or other substances liable to ignite spontaneously. These components, stored over a long period of time (there was little additive movement in the months preceding the accident), accumulate a large amount of static electricity. Nitrogen flushing was insufficient to prevent air from entering the tank.

## ACTION TAKEN

Following the accident and on the Inspectorate's proposal, the prefect signed an emergency order requiring the operator to respect the following provisions:

- Submittal of a detailed accident report within 8 days (products, storage conditions, the circumstances of the accident, an initial hypotheses relative to the causes of the accident…),

- The submittal of a detailed report within a period of one month concerning the causes of the explosion and the proposal of measures to prevent it from reoccurring,

- Immediate suspension of the establishment's procurement of additive until the measures stipulated have been implemented.

Following the examination of the various elements submitted by the operator, the Inspectorate proposed to the *Prefect* that continued use of the additive storage tank, for which product procurement had been suspended, be contingent on the implementation of the following additional safety devices:

- Automatic temperature control (with shut-down at high temperature threshold) to prevent the thermal degradation of the polymer regardless of storage duration,

- A device for continuous measurement (direct or indirect) of product temperature, with "high level" alarm in the control room,

- A continuous mixer motor current meter, with remote malfunction alarm in the control room,

- A nitrogen inerting system based on a pressurisation slaving and control system,

- A device for continuous measurement of the tank's gaseous atmosphere, with "low level" alarm in the control room,

- A valve type vent system preventing the influx of air, or other system providing equivalent guarantees (pressure/vacuum valve with explosion trap, …)

After having installed the equipment requested, the operator resumed storing additive at a temperature lower than that used prior to the accident.

## LESSONS LEARNED

The frangible roof prevented the opening of the tank's shell and massive product leakage.

The examination of the causes of the accident highlighted insufficient risk analysis and malfunctions or insufficiencies with several pieces of equipment: automatic temperature control and mixer operation and temperature control devices, nitrogen inerting and associated devices (vents, pressure measurement of the gaseous atmosphere...).

Certain information could be applied to other storage containers, the operator made sure that no other product stored on the site was capable of thermally decomposing under current storage conditions. The operator also catalogued the flammable liquid storage containers equipped with a flushing type nitrogen inerting system and a vent and/or a gauge well with the same characteristics as the damaged additive tank, in order to install additional safety devices.