Explosions occurring in a bituminous materials depot

May 3, 1994

Portet-sur-Garonne (Haute Garonne) France

Explosion
Hydrocarbons
Storage (fixed)
Building works
Hotspots
Victims

THE FACILITIES INVOLVED

The site:

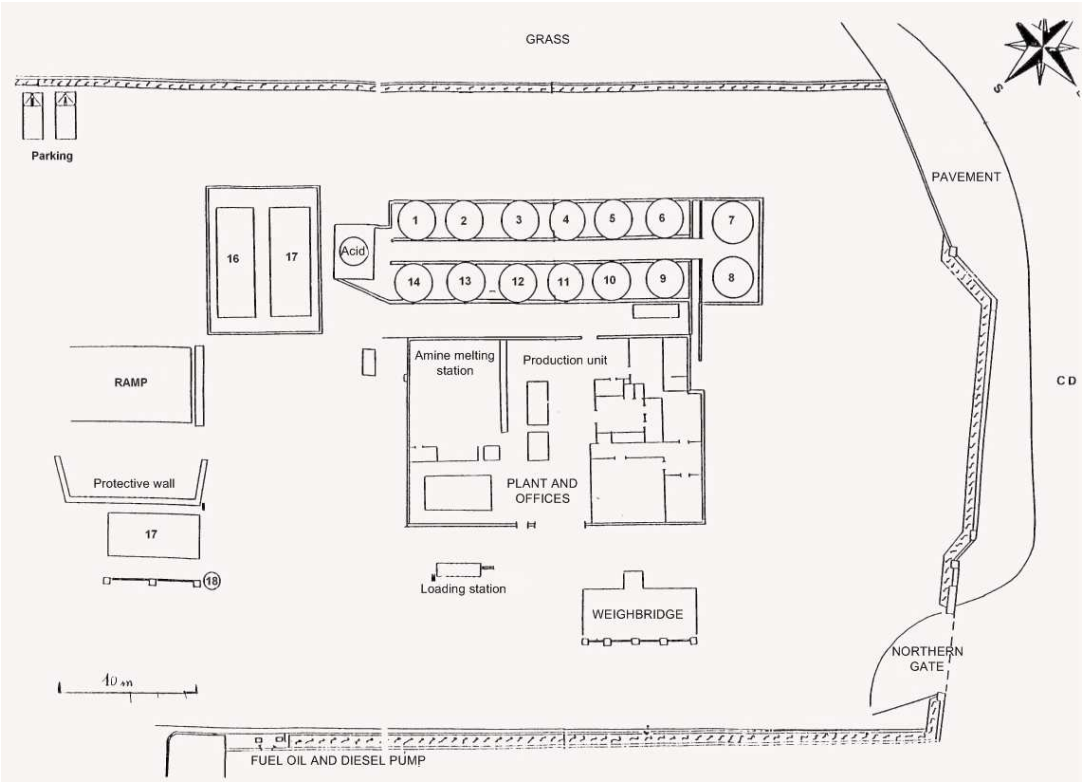
The company, specialised in the public works industry, was operating in the town of Portet-sur-Garonne an asphalt emulsion production plant, which also served as a logistics platform for construction vehicles assigned to jobsites throughout the Haute-Garonne department (south-western France).

The site was set up in 1970 on a 1.5-ha parcel and comprised the production facility, an emulsion storage and delivery zone, a cold mix plant, a mechanical maintenance shop, a fuel distribution station, materials depots and office buildings for both technical and commercial units. The site was located in the vicinity of a commercial area, whose businesses included a supermarket at a distance of 100 m and an automobile accessories store 30 m away.

The involved unit:

The aboveground depot of liquid asphalt materials consisted of 14 vertical tanks laid out in 2 parallel rows and 2 horizontal tanks that had remained empty for several months prior. A hydrochloric acid tank had been installed adjacent to the depot. This 14-tank configuration had been designed to store emulsion (featuring a mix of 60% bitumen and 40% water in 9 of the tanks), water (1 tank), flux oil (1 tank) and "cut-back 0/1" (i.e. a mix of liquefied bitumen with a 40% kerosene concentration - 1 tank).

The vertical tanks were equipped with a guardrail on their cover around the manhole; moreover, they featured a 100-mm diameter vent shaped like a gooseneck, yet without any flame arrester, along with an opening for horizontally passing cables. The tanks were also fitted with internal steam heating coils, fed by a boiler that at the time of the accident was turned off. The "cut-back 0/1" tank heating system was not intended to be used.



THE ACCIDENT, ITS CHRONOLOGY, EFFECTS AND CONSEQUENCES

The accident:

For several weeks leading up to the accident, company employees had been installing walkways and railings between the various tanks, for the purpose of improving access to each tank cover.

On Tuesday May 3rd, the "cut-back 0/1" tank, positioned at the beginning of its row of tanks, contained 18 tonnes of liquefied bitumen (accounting for half its capacity). The product had been delivered 5 days beforehand, at a temperature of 60℃. The second tank in the row, intended for storing pure bitumen, had been empty for several weeks but not yet cleaned or degassed. The first tank in the adjoining second row carried flux oil (incorporated into the bitumen as a softening agent).


Photo: DRIRE

Around 2:30 pm, two company employees were installing a walkway between the covers of the "cut-back" and oil tanks. They were apparently using a trimming machine near the "cut-back" tank vent when a violent explosion of the tank vapour space occurred, hurling the tank some 20 metres off its base and the 2 employees 30 metres from their location. The liquefied bitumen, which had spread to the surrounding area, caused a fire and, within 5 minutes, an explosion of the adjoining non-degassed, empty bitumen container, which was thrust some 10 metres onto the roof of the neighbouring facility. The tank broke at the level of the shell-bottom junction.

The hydrochloric acid tank melted due to the heat generated. Acid mixed with hydrocarbons overflowed on the site all the way to the entrance parking lot, and the retention basins were destroyed by the blast of the explosion; moreover, a small amount of the spill polluted the sewer network.

Traffic was stopped on the street leading to and from the shopping centre adjacent to the site. Local residents and shoppers, as well as all bystanders, were evacuated. The fire also ignited a row of trees planted on the property line (due to the thrust of the cut-back tank); the emergency response team arrived quickly on the scene to extinguish the blaze.

Consequences of this accident:

The 2 employees working at the site of the explosion were killed instantly.

Besides the 2 exploded tanks plus the melted acid container, 12 other tanks were damaged, 5 of which superficially (thermal insulation); the retention basins also experienced major degradation. The roof on the nearby production plant sustained damage, primarily due to the impact of the bitumen container, and 7 company vehicles were destroyed by fire on the parking lot.


Photo: DRIRE

The European scale of industrial accidents:

By applying the rating rules applicable to the 18 parameters on the scale officially adopted in February 1994 by the Member States' Competent Authority Committee for implementing the "*SEVESO*" directive on handling hazardous substances, and in light of available information, this accident can be characterised by the four following indices:

The parameters composing these indices and their corresponding rating protocol are available from the following Website: http://www.aria.developpement-durable.gouv.fr

The "1" value ascribed to the "Hazardous materials released" index indicates that explosions occurred (parameter Q2: with a quantity of explosives in TNT equivalent < 100 kg).

The "3" score for the "Human and social consequences" index reflected the deaths of two employees (parameter H3).

The "2" rating attributed to the "Economic consequences" index stems from the amount of property damage sustained, appraised in 1994 at 5 million francs (parameter €15).

THE ORIGIN, CAUSES AND CIRCUMSTANCES SURROUNDING THE ACCIDENT

Investigators working at the scene found 2 trimming machines as well as a pair of goggles near the body of one of the victims; also, lying on top of the flux oil tank were welding rods, a fire extinguisher, miscellaneous tools and an electrical extension cord for the trimming machines. A welding machine was discovered at the foot of the tanks. Based on the onsite works previously performed on other tanks, the working procedure for installing walkways between the two tanks entailed the following:

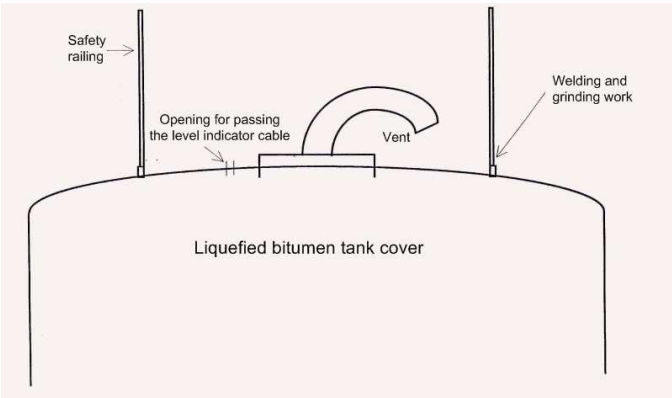
- Use of the trimming machine to cut an opening on the existing guardrails along the walkway alignment
- Welding of an angle beam onto these guardrails in order to attach the walkway
- Welding of the walkway railings
- Bolting of the walkway.

No facility manager could indicate, in the testimony released, the actual works conducted by the 2 employees at the time of the accident. The risks of fire and explosion had not been examined by the Hygiene, Safety and Working Conditions Committee when the decision was made to install the walkways, and moreover no specific safety document regarding such operations had ever been written. A manual issued by the company's head office was circulated, but it did not include the precautions to be taken when using equipment capable of creating sparks or hotspots. The safety guidelines posted near the materials depot and emulsion production plant did not explicitly state that it was prohibited to be in the vicinity of installations with a flame or devices capable of generating sparks or hotspots, even though such preventive measures were listed in prescriptive form in the Prefecture's order authorizing facility operations.

No risk analysis was carried out prior to undertaking these works and instructions to the 2 employees were strictly verbal. Both victims would have been advised only orally to take necessary precautions with respect to the risks of contact with inflammable vapours; the flux oil tank vent had been obstructed by a wet rag. In addition, on the "cut-back" tank vent, a 6-m long hose had been attached using adhesives so as to divert vapours towards the container bottom.

The flammability characteristics of the "cut-back 0/1" tank, as a 1st-category inflammable liquid (i.e. 21℃ < FP < 55℃), were not accurately known by the facility operator; the safety fact sheet available in the plant manager's office, besides failing to comply with regulatory models, did not mention the flash point value. The last delivery order (dated 5 days prior to the accident) indicated that the product had been transported under conditions of a 2nd-category inflammable liquid (i.e. 55℃ < FP < 100℃) and delivered at a tempera ture of 60℃, thus exceeding its flash point.

The initial inflammation was likely caused by a spark or hotspot created by works on the walkway, which in turn ignited a vapour space outside the "cut-back" tank. These vapours were able to "form" either at the end of the hose, or at the hose-vent junction (had the hose not been perfectly sealed), or at the tank cover opening designed for instrumentation (level measurement cable). Subsequent to inflammation of the vapour space within an unconfined volume, the flame would have penetrated into the tank, thereby triggering the explosion and ejecting the tank.



The second explosion, occurring once the "cut-back" thrown underneath the tanks had fully ignited, would have been caused by inflammation of the vapour space inside the bitumen container either by flames spreading near the vent (a phenomenon analogous to the 1st tank) or by internal overheating of the vapour heating pipes by means of heat conduction from the fire.

ACTIONS TAKEN

The administrative enquiry was conducted by the Classified Facilities Inspector's Office in close collaboration with the legal expert appointed by the examining magistrate, the local gendarmerie and the assigned Labour Inspector.

Noncompliance with both the labour code and classified installation legislation was reported. The Prefect suspended activity at the asphalt materials depot by virtue of a decree issued on June 1st, 1994 and withheld authorization to resume operations until completion of a safety report. A penal suit for involuntary homicide was brought against the plant manager and subsidiary executive. The Toulouse Court of First Instance, in its June 9, 2004 ruling, acquitted the two defendants.

Subsequent to the accident, the site operator adopted the following measures:

- ✓ Installation of a new depot with a total capacity of less than 150 tonnes of emulsion,
- ✓ Compilation of a safety manual with both general and specific guidelines for nationwide dissemination,
- ✓ Organization of a four-day training course for 200 staff members.

The facility was definitively closed on October 5, 2007.

LESSONS LEARNT

This accident reinforces the need for precise knowledge of the characteristics of all products used or handled during company activities, particularly regarding inflammable liquids. The safety data sheet constitutes an essential document for understanding and appreciating the risks of fire and explosion relative to certain products. In the present case, ignorance of the flash point for liquefied bitumen had tragic consequences. It is necessary however to ensure that this sheet has been properly completed and remains relevant over time, given that the type of product and hence its properties are capable of evolving as a result of production process modifications.

The accident also highlighted the strong correlation of facility works with accident occurrence, especially with respect to organizational and human factors. The determinant factors for ensuring effective risk management during onsite works include: a preliminary analysis of risks specific to the given installation; design of corresponding prevention measures (featuring detailed descriptions of the works scheduled, technical safeguards implemented, a written set of procedures and guidelines applied, burning permit approval); thorough preparation of all onsite tasks (e.g. tank drainage and degassing); well-adapted training and risk advisory provided to all parties; and a close works monitoring effort.

More generally speaking, this accident has underscored the need to develop in companies a real safety-oriented culture that involves both executive staff and company personnel, with the aim of modifying behaviour of the various risk management actors.