

Explosion of an underground solvent storage tank during a maintenance operation

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Saint-Sulpice (Tarn)

FRANCE

Explosion
 Explosive atmospheres
 Maintenance
 Subcontracting
 Organisational and human factors

THE ACCIDENT AND ITS CONSEQUENCES

-  A contractor at an upper-tier Seveso plant was cleaning an underground tank so that it could be filled with a different product. The tank was located in an outdoor area comprising 12 horizontal underground multi-compartment tanks, each having an overall capacity of 60 m³ (nominal compartment capacities of 10, 15 and 35 m³) and containing flammable liquids (solvents or petroleum products). Cleaning began at 8:30 a.m. At 9:55 a.m., an explosion occurred in the 35 m³ compartment containing ethyl acetate.



Damaged pipes

The force of the explosion sent the tank's cover as well as tools and debris flying across a distance of several metres. The contractor's two employees suffered severe burns. The visible property damage was limited to empty pipes used to transfer solvent, which received slight damage from falling objects. The explosion cut off the plant's electricity supply, in turn shutting off its computer system and the automated systems used to monitor equipment on the underground tanks.

The operator administered first aid to the two injured employees (absolute emergency), immediately called emergency services, initiated its internal emergency plan, and notified nearby businesses. A large number of first responders (30 gendarmes, 56 firefighters from the Departmental fire service (SDIS), and 14 vehicles) were quickly mobilised.

Departmental fire service halted railway traffic between the towns of Albi and Toulouse and set up a 500 m safety perimeter around the site. The gendarmerie halted road traffic. The director of a primary school located 700 m away implemented the school's safety plan and ordered pupils to shelter in place. Other schools in the town followed suit.

Departmental fire service tested the air around the tank and across the site with an explosimeter. Once finding that there was absolutely no risk of explosion, it inerted the tank by filling it with water. After doubts had been dispelled by rescue service and the Emergency Support Unit (CASU) of the French National Institute for the Environmental technology and Hazards (INERIS) issued its opinion about the risk of secondary accidents occurring in the tank's other compartments, the prefect lifted the containment restrictions and reopened road and railway traffic at 12:00 p.m.

THE ORIGIN AND THE CAUSES

The explosion was sparked by the combined presence of both an explosive atmosphere (ethyl acetate concentration between its LEL and UEL [2%; 11.5%]) and an ignition source. Ethyl acetate has a flash point of 4°C.

When the accident happened, the manhole cover on the tank's compartment had been resting on a tripod and the contractor's employees had inserted a hose in the tank to begin emptying it.

The findings of the legal investigation under way are not yet known, but the following assumptions have been made:

- regarding the presence of an explosive atmosphere, the employees failed to do three things to ensure that no flammable fumes were still present in the manhole: (i) they did not obstruct the flanges on the manhole to limit fume emissions before opening it; (ii) they did not extract fumes from the manhole vent pipe; and (iii) they did not test the atmosphere in the vent pipe with an explosimeter. And yet, these points are specified in the operator's prevention plan and procedure.



Manhole cover

- regarding the presence of an ignition source, the employees failed to take the necessary precautions to limit the associated risks: (i) they did not connect the manhole to earth; (ii) neither the hose used to drain the tank nor the steel tools found nearby were certified for explosive atmospheres; and (iii) they opened the manhole with an unsuitable item of lifting equipment that may have produced impact sparks.

These immediate causes reveal the following organisational and human root causes:

- **Training / identification of risks:** contractors who lack sufficient knowledge of the risks involved and who do not follow basic safety instructions;

- **Procedure and instructions:** the procedure did not ensure that degassing and cleaning of tanks containing flammable liquids are performed safely; the safety actions and safety checks required at each step in the procedure were insufficiently clear and specific; and the procedure did not sufficiently take into account recommendations from technical guides for this type of operation (INRS guide);
- **Organisation of inspections:** the operator failed to prepare and supervise the operation: it does not have a contractor accreditation process; there were no supervision hold points in the procedure; a number of basic requirements for ensuring safety during the operation were not mentioned in the prevention plan (contractor accreditation, equipment compliance, weather conditions...); and a safety inspector was not involved in the process despite being set out in the prevention plan;
- **Conception of installations/ergonomics:** the access to the tank was uneasy (it was necessary to go through a small and isolated door and to step over several pipes). Such conditions could have played a negative role during the sub-contractors' intervention.

FOLLOW-UP ACTIONS TAKEN

In the evening after the accident, and following a proposal by the inspection authorities for classified facilities, the prefect signed an emergency-measures decree:

- barring the operator from emptying or filling the 12 underground flammable-liquid tanks or transferring their contents to the packaging area until the level gauges and leak detectors on the tanks were once again operational;
- barring the operator from cleaning or inerting any of the flammable-liquid tanks until the supervision and maintenance procedures had been revised;
- requiring the operator to visually inspect or check the integrity of the affected tank's compartments and its pipes.

A legal investigation of the operator and its contractor was launched. All the parties involved were questioned by the gendarmerie, with the inspector of Directorate for the Environment, Development and Housing (DREAL) assigned to the site interviewed as a witness. Using feedback from the accident as a basis (focus on the change in the tank cleaning and degassing operations), DREAL and the Regional Directorate for Enterprises, Competition Policy, Consumer Affairs, Labour and Employment (DIRECCTE) investigated the actions implemented by the operator.

LESSONS LEARNT

1° An effective means of reducing risk at the source

The fact that there were no consequences off the site shows that the use of underground tanks to store flammable liquids is effective in limiting effects following an explosion.

2° Collaboration among authorities is essential

Information shared among the inspection authorities, rescue service, emergency support unit of INERIS, and DIRECCTE was valuable in understanding and analysing the accident. The inspection authorities' visit in the presence of DIRECCTE made it possible to finalise the drafting of the order on emergency measures and identify when the tank instrumentation system failed (this information had not been provided by the operator at the time of the accident). By working together on this accident, which involved aspects relating to France's environmental and labour codes, DREAL and DIRECCTE were able to put forward consistent proposals.

3° Too many grey areas in the accreditation of contractors

The obligations imposed on operators of upper-tier Seveso facilities with regard to contractor training and qualification remain difficult to ascertain unless there is a prevention plan between both parties. The prefectural order authorising the plant's operation called for the creation of a contractor accreditation procedure (which, following the accident, was found to be nonexistent). However, depending on the sector, not all upper-tier Seveso facilities call on certified contractors (MASE-UIC). The issue of contractor certification at high-risk sites remains unresolved.

4° DREAL's role in the criminal prosecution case

The criminal investigation conducted by the gendarmerie raises the question of the role of the inspection authorities for classified facilities in the post-accident investigation. Although DIRECCTE followed the criminal procedure as an expert, DREAL's inspection authorities were merely questioned as a witness. They therefore did not have access to all the information in the case or to the depositions filed by the parties involved.

5° Progress achieved through feedback

The media coverage of the accident acted as a catalyst for the advancement of ongoing files. The operator's highest level of management stepped in and leveraged this feedback throughout Europe (presentation of the case made to all its European sites). In France, it distributed to all its sites a prevention plan template designed specifically for the maintenance and degassing of flammable liquid tanks. It also developed requirements for the qualification of contractors that conduct these operations and defined mandatory supervision hold points.

The investigation revealed that the explosimeter used by the contractor was not designed for detecting ethyl acetate. Both rescue service and the operator wondered if their own explosimeters were compatible. Lastly, the contractor discontinued its flammable-liquid tank degassing operations.