Sudden opening of a crude oil tank bottom

12 January 2007

Ambès (Gironde)

France

Sudden rupture
Wave effect
Hydrocarbon depot
Crude oil
Water and soil pollution
Facility ageing
Prevention/protection/ intervention measures

THE FACILITIES INVOLVED

The site:

The facility is a depot for oil and petroleum products: crude oil, domestic fuel oil, diesel fuel, gasoline, etc. The site comprises 28 tanks and its total capacity equalled 283,000 m³ at the time of the accident; moreover, the facility is connected to three pipeline installations and contains two wharfs. Facility operations are required to comply with a permit authorisation protocol for public utility easements ("upper-tier *SEVESO*") and are regulated by prefectural order adopted March 9, 2006.

The depot is located along the banks of the Garonne River in the vicinity of a marshland around its northern boundary, in an area containing what are known locally as "*jalles*" (pits and swampy channels).

The involved unit:

The accident occurred within the crude oil depot, at the level of tank no. 1602 (built in 1958 and containing a floating roof); on the day of the accident, the facility was storing roughly 12,000 m³ of light crude oil.

THE ACCIDENT, ITS CHRONOLOGY, EFFECTS AND CONSEQUENCES

The accident:

During the afternoon of January 11, 2007, a small leak was observed in the retention chamber of tank no. 1602. Since draining the tank required positioning supporting legs to hold the floating roof, the operator planned on performing this step the next day for safety reasons. In the interim, water was poured into the bottom of the tank via the bleed valve in order to limit the amount of oil leaked.

On January 12, 2007 at 8:00 am, a portion of the tank bottom broke and 12,000 m³ of crude oil spilled in a matter of a few seconds.

The earthen dykes were able to mechanically withstand the wave effect. However, 2,000 m³ of crude oil overflowed and spread on the ground and roads both in the immediate area around the depot and outside the site.

The Internal Emergency Plan was activated. The surfaces of crude oil spill at the level of the retention basins were covered with foam (170 m³ of emulsifier were used) so as to prevent ignition and contain the emanation of hydrocarbon and hydrogen sulphide vapours.

The authorities proceeded by: evacuating 12 employees from adjacent businesses, setting up a safety perimeter, closing the Garonne to nautical activities and the local road at the site periphery to vehicle traffic.

Air quality measurements were conducted by requesting site personnel as well as members of the neighbouring population to carry a passive badge monitor.

The products that spilled into the gutters and retention basin were channelled towards the site's settling pond and then transferred into empty storage tanks. Approximately 6,000 m³ of product were pumped in this manner.


DR

Consequences of the accident:

This accident had no direct impact on human health.

The air quality measurements recorded on January 12 by emergency service personnel indicated that the lower explosivity limits had not been reached at any point in the storage facility. A hydrogen sulphide (H_2S) odour could easily be detected up to several kilometres downwind from the site and necessitated wearing masks at the depot. The crews subsequently called to repair the faulty tank needed to be equipped with self-breathing apparatuses. Since emission concentrations at the site periphery remained limited, it was possible to terminate the evacuation period for local residents after a few hours. From the outset, H_2S concentration beyond the site boundary was below the average exposure value. January 15 marked the date when H_2S content fell to zero at all measurement points.

Benzene concentrations recorded on January 12 equalled 2.4 mg/m³ at the level of the tank and 0.4 mg/m³ near the settling pond, for an average exposure value of 3.25 mg/m³. As of January 18, benzene contents had dropped below the detection threshold.


DRIRE Aquitaine


CEDRE

Most of the 2,000 m³ of oil spilled outside the basins was confined within site boundaries. A substantial percentage of this volume quickly reached the stormwater ditches and then by gravity flowed into the settling pond, thus triggering the immediate shutdown of pumps used for discharging pond water into the external environment, although 100 m³ did get released before pump shutdown:

- 50 m³ flowed into "*jalles*" (pits and swampy channels) located to the east of the site, where the oil polluted 2 km of ditches and infiltrated deep enough to reach the water table.
- To the west, another 50 m³ reached the Garonne River at the beginning of the flood tide period. For the most part, the oil slick remains enclosed along the river's right bank, yet it was rising at the time because of the flood-tide condition. Iridescence could be observed all the way to the *Pont d'Aquitaine* Bridge 12 km upstream. When the tide changed, the oil slick shifted downstream and reached the site of the "*bec d'Ambès*" (confluence of the Garonne and Dordogne Rivers).

To the south, the oil also spread over the ground and small roads, contaminating down to deeper layers, then crossed departmental highway no. 10, at which point it was largely contained by a parapet running parallel with the Garonne. A small quantity nonetheless seeped through and slightly contaminated the upper part of the riverbank at this location.

On January 13, traces of the spill were observed more than 20 km downstream of the depot as well as on the Dordogne River. The succession of tidal movements exacerbated the level of pollution over some 40 km of riverbanks on the Garonne, Dordogne and Gironde. The most heavily fouled 10-km stretch was found on the right banks of the Garonne and Gironde.

A few soiled birds were sighted at the time of the initial waterway inspections, yet the local ornithological protection association notified of the incident by the Prefecture did not indicate the presence of any significant impact on bird populations. The death of several coypu was also announced. In the pits ("*jalles*"), the traces found suggest that wild boars actually waded through oil dispersing drops as they continued along their path. Nonetheless, environmental groups and hunting associations did not report any exceptional impact on local wildlife.

The operator proceeded with pollution cleanup measures under the supervision of CEDRE (Centre for Documentation, Research and Experimentation on accidental water pollution).

A total of 13,000 m³ of fire water containing emulsifier were stored at the depot and then underwent onsite an activated sludge type treatment by means of extended aeration.

Moreover, closure of the oil storage sector forced a crude oil extraction company to cease operations of oil wells at its Parentis Lake site (in the Landes, south-western France), whose output passes through an oil pipeline to be stored in tanks at the Ambès depot. Operations at the wells would be partially resumed a few days later, by introducing a road-based logistics organisation for transferring oil to other storage centres in the region.

The European scale of industrial accidents:

By applying the rating rules applicable to the 18 parameters of 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 the information available, 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: www.aria.developpement-durable.gouv.fr

The "quantity of hazardous materials released" parameter Q1 received a 4 rating since nearly 11,000 tonnes (12,000 m³) of easily-inflammable, light crude oil were released when the tank split (22% of the upper *Seveso* threshold of 50,000 tonnes).

The "human and social consequences" parameter was rated 2 as a result of the need to evacuate neighbouring residents for over 2 hours (H7 parameter).

The parameter addressing environmental consequences was given a 4 rating given that 42 km of riverbanks and "*jalles*" were polluted and necessitated a special cleaning effort or decontamination steps (Env 14 parameter).

Economic consequences were rated 5 due to operating losses, estimated at over € 50 million (€16 parameter).

THE ORIGIN, CAUSES AND CIRCUMSTANCES SURROUNDING THE ACCIDENT

A number of critical questions were raised over both the corrosion phenomenon and the influence of the tank's unconsolidated bed on the overflow.

The most recent inspection of tank no. 1602 had been performed on February 27, 2006, while the bottom had last been inspected on April 3, 2006; the inspection method applied was a 100% scan of the bottom according to the magnetic flux loss protocol. The accident report indicated: thickness losses of between 20% and 50% over the central part, losses of 20%-80% on the periphery, and a likely 2-year life span for the tank bottom.

Seals were verified on 10% of the tank welds without any defects being detected.

Repairs were carried out and controlled following this inspection step.

ACTIONS TAKEN

Onsite measures implemented:

Subsequent to the accident, emergency prefectural orders issued January 13 and February 5, 2007 prescribed the following:

- Suspension of all crude oil tank operations
- Application of the initial emergency measures (tank drainage, crude oil pumping, etc.)
- Special monitoring of the piezometric impact
- Study of the pollution impact and planned treatment procedure
- Analysis of accident causes, evaluation of tank inspections, measures adopted to limit the probability of such an event recurring.

The foam blanket was kept in place on depot retention basins for about 2 weeks (approx. 170 m³ of emulsifier).

In order to guarantee personnel safety, the cartridge respiratory mask became mandatory gear for all site technicians during one month after operations began. A medical check-up (blood and urine tests) was performed by the occupational physician on everyone working at the depot to ensure the complete absence of adverse health effects.

Pollution cleanup efforts:

Aerial, nautical and pedestrian surveying steps were organised on a daily basis for the first five days following the accident; this monitoring served both to assess the situation (50 m³ of drifting oil spill and 40 km of fouled riverbanks) and to define intervention strategies for the Garonne, Dordogne and Gironde Rivers. The consensus priority was to stop the transfer of pollutants offsite. On January 12, major pumping operations got underway on the departmental road, in tubes and in drains. The stormwater ditches were plugged using mounds of dirt. In conjunction with this effort, oil dispersants were spread. Waterway traffic, which had been halted for a while, was reopened during the day so as to accelerate stirring of oil in the water column.


CEDRE

The "*Gascogne*" buoy tender, equipped with a weir skimmer and a tank, was mobilised although the device encountered difficulties in removing oil from the water due to strong currents and the oil spill expanse.

Absorbent strands were set into place by the coast guard at all wharfs in the affected zone in order to recover the drifting oil. These absorbent strands, along with a floating dam and later on an improvised dam, were installed in front of stormwater outlets, where salting-out tends to occur.


CEDRE

The pollution control boat, a craft capable of sailing through very shallow waters and fitted with side baskets for collecting floating waste in Mediterranean ports, began the dynamic recovery process on residual streaks of pollutants and floating waste. Its efficiency would be enhanced by lining the bottom of the lateral baskets with absorbent material.

On January 19, it was ultimately decided to build cofferdams on the banks of the Garonne using a backhoe loader at all the points where the stormwater is discharged at the level of the site. These facilities were designed to set up an accumulation pit that could be continuously monitored and pumped dry as often as necessary; they were rebuilt after every tidal movement of a strength capable of weakening the structure.


CEDRE

On January 20, a specialist company began the first-stage cleanup on the riverbanks, i.e.: collection of plates and plugs, recovery of macro-waste both fouled and clean (to avoid subsequent contamination).

The tracking and maintenance of absorbents (which serve to remove pollutant quantities rinsed by the river from its banks) at the level of the site, along with the collection of residual floating matter by the pollution control boat and first-stage containment efforts on the banks, continued until January 25.

Cleanup operations were suspended on the 25th due to snowfall and then came the weekend. Efforts resumed on January 29 and were definitively stopped on January 31 as regards physical collection efforts and on February 7 for the monitoring and maintenance of absorbents by the pollution control boat.

It was not considered beneficial to proceed with a second-stage cleanup of finer debris and pollution along the Garonne riverbanks, zones that were difficult to access, hazardous, sensitive to excessive human presence and exposed to a heavy dose of "natural cleaning" by the river. In addition, nautical surveying conducted by the CEDRE Centre on January 13 and 24 indicated that a quick rinse had been applied to the contaminated flora: the 10 km stretch least affected by the spill had already undergone a natural "cleaning" on January 24.

Findings from the March 6 survey showed that only 10 km were still polluted and moreover that the flora had started to grow back on the riverbanks. On April 5, the remaining linear stretch of pollution had been reduced to 3 km on the right bank of the Garonne. A final survey, undertaken on July 3, revealed the presence of just three small clumps of polluted vegetation in front of the depot. Since that time, no further reconnaissance operation has been carried out.

The "*jalles*" cleanup effort mobilised a total of 40 individuals for 2 weeks during the preparation phase and then another 40 for a 6-month period to oversee implementation; this operation consisted of:

- Reopening of former routes to enable access for pump trucks
- Pumping of the largest accumulations using four-wheel drive sewer cleaning trucks
- Installation and maintenance of absorbent strands and improvised dams to avoid propagation during precipitation events
- Bush clearing of all riverbanks in "*jalle*" zones to free access for cleanup teams
- Systematic soil protection using farm tarps and geotextiles for the entire set of operations
- Selective collection of floating pollutants either with skimmers or by hand
- Coarse cleaning of "*jalle*" riverbanks by means of scraping, rinsing with a fire hose and raking polluted vegetation
- While waiting for the "*jalles*" to dry, installation and replacement of absorbents in order to collect dripping pollutant at the riverbanks due to the effect of temperature rise
- Once the "*jalles*" had dried, final scraping of the riverbanks and riverbeds over a few sectors, followed by scarification for the purpose of speeding biodegradation
- Continuation of "*jalle*" monitoring activities (with replacement of absorbents and a more durable presence of improvised dams), as a step to control eventual repeat wintertime contamination, especially via the ground left untreated inside the depot area
- Tracking of water and sediment contamination throughout the 2007-2008 winter season.

Cleanup measures both onsite and offsite are still under discussion (as of June 2009), including: soil excavation, water table treatment.

Measures adopted at the regional level:

Following this accident, all operators of inflammable liquid storage facilities were requested, by administrative memorandum, to:

- Summarise the conclusions and recommendations issued by oversight bodies regarding tanks and the measures taken
- Establish an emergency procedure governing the protocol adopted in the event of leak detection on a tank
- Stipulate procedures for managing effluent in the case of a crisis (gutters, retention basins, etc.)
- Conduct an updated study on the wave effect.

Measures adopted at the national level:

A nationwide action plan with respect to verifying hydrocarbon tank bottoms was launched for 2008.

LESSONS LEARNT

Feedback from this accident has yielded three areas for further reflection and examination:

Organisation:

The accident analysis demonstrated that the introduction of tank leak control procedures would serve to better anticipate pre-crisis reactions subsequent to discovering product leaking from a tank.

Operators must obviously have access to immediate expertise and be prepared to make a quick decision regarding tank drainage in order to mitigate the consequences associated with sudden tank opening to the greatest extent possible.

Prevention:

The full analysis of accident causes, once the legal evaluation has been completed, will produce the entire set of measures capable of reducing the probability of this kind of opening.

The following points merit consideration:

- Control system efficiency
- Tank bed: better design for the next generation of tanks, improvement of existing tanks.

Protection:

This accident initiated a discussion on the need for a tertiary confinement barrier (with tank walls and retention basins serving as the first two barriers), thereby enclosing the depot and making it possible to contain eventual overflows at the site itself.

Such a regulation could incorporate:

- Limiting the probability of occurrence of spills into inflammable liquid storage zones
- Generation of a worst case scenario for the purpose of devising the appropriate technical measures to adopt.

Analyses could also be conducted in order to identify whether or not this type of accident could arise at facilities storing materials other than inflammable liquids. The environmentally hazardous products and toxic products not covered by the regulation relative to pressurised equipment have still not been addressed in the national regulation on 10-year inspections of storage tanks (Ministerial order dated November 9, 1972).