Hydrocarbon leak on a pipeline

18 September 2001 and 09 February 2002

Lucciana – [Haute-Corse] France

Accidental pollution
Pipeline
Hydrocarbons (Fuel oil)
Soil pollution
Corrosion
Surveillance and contingency plan
Easements

THE FACILITIES CONCERNED

The facility

The industrial facilities are located in the town of Lucciana. The operation of these facilities requires the use of pipelines transporting liquid and liquefied hydrocarbons. This is in particular the case of the electrical power plant located inland to which a 8,000 m³ intermediate depot is associated, located in a littoral zone, which is used as a buffer during fuel deliveries.

THE ACCIDENT, ITS CHRONOLOGY, EFFECTS AND CONSEQUENCES

The facility:

The thermal power plant was commissioned in 1973, and the hydrocarbon pipeline used to supply the littoral depot with fuel was commissioned in 1975.

After delivery by sea, the hydrocarbon pipeline allows the heavy fuel oil (FO2) and the light fuel oil (FOL) to be transferred from the plant operator's intermediate depot near the littoral boundary to the power plant depot located 7.5 km inland; the pipeline is buried at an average depth of one meter. As a general rule, it remains continually filled with light fuel oil (FOL) between two transfer phases.

The pipeline is made of 5.56 mm-thick steel and has a swing diameter of 100 mm. With a total length of 7,430 meters, the pipeline consists of 12-meter linear sections welded end to end. It is coated in a casing of 3 mm thick synthetic resin which is bonded to the metal, then by 5 cm-thick polyurethane foam and finally by a casing similar to the first. Its operating pressures are 40 bar under normal operation and 90 bar under forced operation. The pipeline was tested at 102 bar at the time of its commissioning and ten-year inspections.

The product transfer procedure from the intermediate depot to the plant is as follows:

- light fuel oil (FOL) is transferred at 70°C at 10 bar for 4 hours in order to heat up the walls of the pipeline to prevent setting points,

- transfer of the product heated (FO2) to 85°C at a n initial pressure of 40 bar; the pressure is lowered to 36 bar during the transfer operation when the temperature of the pipeline walls stabilises,

- pumping of "cold" light fuel oil (FOL) in the pipeline for flushing at 20 bar

- FOL "filling" of the pipeline at zero pressure between two transfer operations. In reality, the pressure of the pipeline on the littoral side (at the location of the accident) is approximately 2 bar. This static pressure is due to the difference in elevation between the plant and the littoral (fluid column).

The transfer operations are performed by site personnel near the intermediate depot and operate it under contract. When its depot is filled, the Plant has approximately 20 to 45 days of production autonomy depending on the energy demand.

The accident of 18 September 2001

This incident involves a leak of heavy fuel (FO2) and heating fuel which occurred on the connecting pipeline between the seaside petrol station and the power plant, during one of the power plant supply operations intended to replenish the on-site fuel stock.

The consequences

Heavy fuel was noticed approximately 600 meters from the hydrocarbon depot, in a corn field along the departmental highway, along the pipeline route.

The results of the investigations conducted by the operator revealed the following points:

- Soil pollution by heavy fuel in top soil,
- Soil pollution by light fuel (FOL) limited to underground sandy areas; this pollution was contained in the sandy layers by the massive presence of compact peat,
- Occasional pollution of the underground water table in a restricted sector likely to migrate.

The operator estimated the volume of infiltrated FOL at approximately 400 m³, in addition to the volume already extracted (250 m³). Nevertheless, it appears somewhat difficult to make this estimation without precise knowledge of the duration of the leak.

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 3 is attributed to the dangerous materials released (Q1) on account of the estimated volume of 650 m³ of light fuel oil released which is similar to heating oil.

The accident of 09 February 2002

On 9 February 2002, at around 3.15 pm, a farmer informed the shift personnel that there was heavy fuel in his field approximately 2 kilometres from the plant.

The first visual inspection of the pipeline did not help determine if the cause of the leak was due to corrosion problem or external aggression. It was noted, however, that the farmland located alongside the pipeline was inside the zone supposedly covered by easements. In addition, the pipeline markers had been moved.

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Level 1 is attributed by default to the dangerous materials released (Q1 parameter) since the quantities of light fuel oil spilled are not know.

ORIGIN, CAUSES AND CIRCUMSTANCES OF THE ACCIDENT

The accident of 18 September 2001

The monitoring and contingency plan was put into action and the following measures were taken:

- The pipeline was filled with water at zero pressure,
- Extraction of the liquid part of the product on the surface,
- Search for the leak,
- The polluted area (approximately 250 m3) was stripped and stored in an oil tight area.

In addition to these initial measures, the operator of the power plant carried out operations to mark out and contain the polluted area by installing eight core samples and three piezometres.

A programme to inspect the perforated tube was implemented at its location that included:

- Visual inspection,
- Chemical analysis,
- Micrographic examination
- Microanalysis examination with an electronic probe.

Chemical analysis was used to confirm that the steel analysed corresponded to the grade of the material used in the construction of the pipeline.

The micrographic examination conducted near the leak in the pipeline showed a significant loss in thickness as well as several corrosion spots. Ripped material was observed at the location of the perforation. Numerous corrosion craters in a zone outside the penetration were also seen.

In addition, the presence of oxides on the external wall and on the edges of the rip possibly indicates that the leak was not recent.

Finally, the micro-analyser/electric probe examination of the oxides on the external wall of the pipeline near the perforation revealed the presence of chlorides.

These investigations enabled the operator to conclude that the pipeline gave in after a significant loss of thickness located in the zone having widespread corrosion caused by chlorides on the external wall due to the presence of brackish water. The brackish water comes from water table variations, particularly under the influence of the "salt wedge" (the rise of salt water into the water table). Moreover, the pipeline further deteriorated due to the absence of the cathodic protection whose operation was stopped between 1975 and 1993 (cable disconnected).

The accident of 09 February 2002

The monitoring and contingency plan was put into action and the following measures were taken:

- The pipeline was filled with water at zero pressure,
- The polluted area (approximately 10 m3) was stripped and the heavy fuel from the intermediate depot was stocked in an oil tight 8,000 m3 retaining pit,
- Search for the leak.

ACTION TAKEN

The accident of 18 September 2001

After the replacement of the defective tube, the transportation of heavy fuel oil resumed under strict surveillance.

The 7,430 metres of pipeline was inspected. The method retained involved searching for faults using leakage currents as the pipeline layout does not allow the passage of a leak control tool. This method revealed 17 faults on the "upstream" sector between the littoral and the intermediate depot, and 9 faults on the "downstream" sector, between the intermediate depot and the power plant.

It was then decided that the pipeline was to be checked (trenches, thickness measurements, metallurgical examinations, etc.) as a priority based on the extent of the fault.

Monitoring of the soil and underground water pollution was performed by the department in charge of policing the area.

In addition, the power plant operator hired an engineering firm to conduct the following operations:

- Soil clean-up operations while maintaining the pipeline in operation,
- The decontamination of materials stocked and their disposal after treatment,
- Clean-up of the water table.

The accident of 09 February 2002

The investigations conducted revealed limited surface pollution of approximately 2m². The first piezometre was installed to check the presence of a water table and any possible pollution.

Repair operations similar to the ones following the 18 September 2001 incident were carried out on the pipeline.

Moreover, the inspection authorities ordered the operator to speed up investigations. The examination of the defects detected between the littoral boundary and the depot were stopped due to the upswelling of the brackish water.

The operator thus began its search inland on 22 February 2002 by digging trenches near the power plant.

The following points were developed during the manual digging operations:
- Degradation of the pipeline's position markers,
- Mechanical deterioration of the covering,
- Decreased tube wall thickness (two series of ultrasound measurements)

A hydraulic test was carried out on 1 December 2004 as part of the ten-year inspection. The increase in water pressure caused a new perforation in the pipeline a few hundred metres downstream the location of the accident of 9 February 2002.

The perforation in the pipeline during the test is also due to the insufficient thickness of the tube following corrosion. A study conducted bears out the assumption of the upswelling of the brackish water. The containment of humidity while installing the thermal insulation has also been raised.

After repair, a new test was successfully carried out at the end of January 2005.

On 28 March 2007, a technician detected new leak on a pipeline at 200m from the thermal power plant in Lucciana during a transfer operation between an intermediate storage site and the power plant. This incident is once again linked to the loss of external thickness due to corrosion. The prefectoral order on 17 April 200 required the maximum

service pressure of the pipeline to be brought down to 60 bar. The re-commissioning of the structure was also subject to a new hydraulic test that was carried out successfully on 13 April 2007 by an accredited body.

In October 2007 following a road project, 800 m of pipeline were replaced by factory assembled tubes in thermal insulation plants. The inspection authorities ordered the operator to carry out a detailed study on the sections of pipelines that were removed.

LESSONS LEARNT

The operator integrated the elements available to repair new leaks as part of its spare parts management system. Especially problems related to containment of humidity while installing the tubes was taken into account by procuring factory assembled tubes in thermal insulation plants.

The most recent version of the surveillance and contingency plan (updated November 2004) includes regular inspection of easements by checking the positions of terminal markers along the length of the pipeline. Finally, within the scope of better information relative to underground structures at risk, an interdepartmental SIG ("Système d'Informations Géographiques", geographic information system) is currently being set up. This systems aims to provide civil engineering firms with information on easements related to underground pipelines and electrical lines via the towns.

This accident highlights the special attention to be paid during the construction, operation (see cathodic protection), surveillance and maintenance of pipelines carrying dangerous materials whose disruption could have serious environmental, material and human consequences.