Derailment of a train transporting hydrocarbons

13th January1993

La Voulte-sur-Rhône – [Ardèche]

Fire
Explosion
Tank-wagon
Gasoline
Axle
Victims
De-pollution

THE ACCIDENT, THE SEQUENCE OF EVENTS, ITS EFFECTS AND CONSÉQUENCES

The accident

On January 13th 1993, around 23h30, 7 wagons containing 80 m^3 of gasoline derailed at the exit from a tunnel to the South of la Voulte-sur-Rhône (07). A violent fire was started. The locomotive driver succeeded in distancing the rest of the train. The sudden opening of the ring die of a wagon caused an explosion and a ball of fire 15 to 20 minutes later. Streams of burning hydrocarbons poured onto the lands reaching the closest houses situated some 20 metres below the tracks and generated a series of explosions in the sewers. Iron drain covers were projected 15 metres into the air, one of them was found 20 metres away and 10 metres up on a roof. A parked car was projected against a wall. The thermal radiation was sufficient to set fire to a house and a meadow at 100 m from the tracks. The fire was brought under control at the end of the morning following the intervention of 250 firemen..

Of the seven derailed wagons, four had spilled their load on account of the major damage that they had suffered (opening of the ring die, stripping of the bottom valve, puncturing of the ring die, tearing along 1/3 of the length of the wagon at the level of the lower generator). The integrity of the tanks of the three remaining wagons remained intact.

Source : BARPI

Source : BARPI

The consequences

Human consequences

The driver of the train and two local inhabitants suffered superficial burns, 3 other people presented fractures and various contusions resulting from their precipitate flight before the flames.

A protective perimeter of 600 m was set up and 1 000 people were evacuated in the middle of the night.

Around a hundred people were re-housed during the de-pollution work which lasted more than four months.

- **Environmental consequences**

The hydrocarbons trapped in the subsoil constituted the major element of the pollution caused by the accident. 300 m³ were released from the 4 damaged tank wagons.

Roughly 200 m³ had burned or vaporised during the explosions, while flowing into the drainage network and during the course of the ventilation operations.

A quantity estimated at 100 m³ polluted the subsoil and 8.5 m³ reached the aquifer.

Only 20 m³ were recovered following the emptying of those of the wagons which still contained residual quantities of hydrocarbons..

Agricultural wells were polluted and 2.6 ha of land was contaminated..

The consequences of the accident were aggravated by the presence of housing. A road lined with buildings and oriented towards the site of the accident thus channelled part of the flaming gasoline. The transfer of the gasoline to the sewers also provoked a fire and explosions in a rainwater pumping station located at 250 m from the site of the accident. The destruction of the pumping equipment of the station, by limiting the release, however, allowed for the avoidance of pollution of the Rhône.

- **Material consequences**

15 houses were destroyed, 15 vehicles were burned and the pumping station was out of action.

The rehabilitation of the site and the indemnification of third parties and the stricken commune represented, according to the estimates of the transport company, a global cost close to 70 million 1993 francs(13.6M€ 2006) of which 15 MF (2.8 M€ 2006) just for the reconstruction of the urban rainwater pumping station, and the de-pollution works cost 5 MF (0.9 M€ in 2006).

European scale of industrial accidents

In using the scoring rules of the 18 parameters on the scale which was made official in February 1994 by the Committee of Competent Authorities of the Member States in application of the 'SEVESO' directive, the accident can be characterised, in taking into account the available information, by the four following indices:

The parameters comprising these indices and the method of scoring can be found at the following address:: http://www.aria.ecologie.gouv.fr.

The level 2 of the index relating to "dangerous substances released" is explained by the pouring out of 300 m³ of gasoline (parameter Q1).

The 1 000 people who were evacuated for more than 3 hours explain the level 3 of the index of 'human and social consequences' (parameter H7).

The level 3 of the 'environmental consequences' index is due to the fact that at least 2.6 ha of polluted land had to be subjected to decontamination (parameter Env 13)

Finally, the rehabilitation of the site, costing an amount of 70 million francs (10.6 M€ ECU 1993) justifies the level 6 of the index of 'economic costs (parameter €18).

THE ORIGIN, THE CAUSES AND THE CIRCUMSTANCES OF THE ACCIDENT

The 2 enquiries that were conducted concluded that the derailment followed the breaking of an axle on one of the wagons from over-heating of one of its axle boxes. Traces found on the wooden sleepers and on the ballast showed that the damaged wagon had continued on its course with the train for 300 m before leaving the rails while crossing points located some 100 to 150 m before the site of the derailment.

THE MEASURES TAKEN

- **Rehabilitation of the site**

The rail transport company and the commune quickly requested the help of a specialised firm to evaluate the consequences of this accident and assigned to this firm the management of the de-pollution operations.

The first measures taken involved the securing of the site by cleaning, rendering inert the drains by pumping them out and ventilation of the hydrocarbons (3000 m³/h). An inventory was taken of the inspection points and checks were made for the presence of inflammable gas. Examination of collection points permitted the identification and the rapid elimination of pockets of floating hydrocarbons.

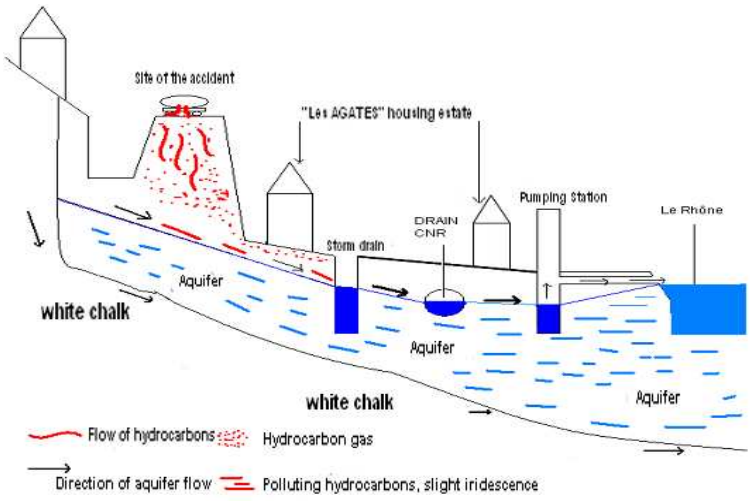
In a few hours, 16 piezometers were drilled. In 4 days, 110 samples were taken in the aquifer and 250 measurements for "gas" were made in the ground. These checks gave a glimpse of the pollution level, nonetheless the "gas" checks in the subsoil were continued daily for a week. In cases where abnormal values persisted, the sensitive areas were ventilated and de-polluted. As from the 18th January 1993, 5 wells (∅ 1 200mm) were dug to lower the layer.

The shallow layer (1 to 4m) was vulnerable, but no trace of floating hydrocarbons was detected over a control network comprising 36 sampling points. Only 4 of the 5 wells located at 40 m downstream from the site showed very slight traces of pollution. There was no odour in the water and the pollution could only be detected by laboratory analysis. The drinking water catchment for the commune upstream was not threatened.

Pollution was present in the embankment carrying the railway (1,1 ha). The great heat generated by the fire caused a partial de-gassing of the subsoil. According to the first "gas" measurements taken, the soil was only affected to a depth of 1 m. Samples of gas at greater depths subsequently defined the depth of the soil contaminated.

The subsoil of the urbanised zone was also affected over an area of 1,5 ha from the base of the railway embankment for a distance of 80m. Within this zone, points with heavy concentrations of hydrocarbons were identified (levels exceeding the maximum measuring capacity of the instruments of 2 500 ppm). The drains facilitated the transfer of pollutants but a CNR *(Compagnie Nationale du Rhône)* drain functioned as a "hydraulic barrier" at the base and along the railway embankment and limited the run-off of the layer of hydrocarbons. During the de-pollution work, this system which drained the floating hydrocarbons allowed for the recovery of part of the hydrocarbons above the pumping station.

The zone in which were found the highest concentrations of hydrocarbons benefited from the experience of "venting" acquired following the accident at Chavanay in December 1990 when 250 to 300 m³ of gasoline penetrated the soil and polluted a surface area of 2 ha of land. Installed at the North and the South of the polluted lands, the two drainage networks allowed for the recovery of hydrocarbons by creation of a depression in the ground (ΔP=250 mb). The polluting products recovered were incinerated in a catalytic bed oven. This arrangement was completed by a second hydraulic barrier (line of wells in a depression) installed at the Eastern border of the zone.



Four months after the accident, roughly 98 % of the gasoline spilled into the subsoil had been recovered. During this period, three types of action were undertaken:

- placing the local inhabitants in safety;;
- evaluation of the hydrocarbon pollution;
- de-pollution of the site.

Initiation of measures designed to limit the delay and cost of de-pollution.

THE LESSONS LEARNED

Since 1993, following the analysis of this accident, a body charged with the transport of dangerous substances was created within the railway company, with the following missions:

- following in real-time of individual wagons (in mixed traffic) and of entire trains,
- handling of incidents and accidents: the role of advice and information concerning accidental events occurring during transport in order to make intelligent use of public emergency services.

Above and beyond questions linked to the implementation of first aid measures, the question rapidly arose as to the limitation of the extension of the pollution of the subsoil and the drainage network with hydrocarbons. The bodies concerned, (commune, railway company and administration) were confronted with the urgent necessity to take decisions to evaluate without delay the extent of the pollution, the potential gravity of the actual and potential consequences, as well as to initiate measures to prevent the propagation of the hydrocarbons while:

- responsibilities were not clearly defined
- no estimate of the duration or the cost of these measures was available. .

As regards the experience gained which could be transposed to classified installations, it should be remembered that:

- the massive and uncontrolled spillage of inflammable volatile liquids in a drainage network can create major risks for persons, assets and the environment
- the gravity of potential consequences from this type of accident necessitates urgent intervention with means to limit the propagation of the spillage and then the rapid initiation of means of evaluation and re-absorption of the pollution

Accidental spillage linked to transport or the using of dangerous materials within industrial plants and their propagation in the drainage network merit examination in risk analyses and should be taken into account in the emergency plans.

Further information on comparable accidents:

- Accident at Chavannay (Aria n°2438) ;
- Accident in Zurich (Aria n°5073) ;
- Accident in Lausanne (Aria n°5515).