

## Water pollution after an explosion in a chemical plant

June 8, 1988

**Auzouer-en-Touraine – [Indre-et-Loire]  
France**

Explosion  
Chemistry  
Silicone oil  
Alcoolate  
Organisation  
Firefighting water  
Victims  
Water distribution  
Convictions

An explosion resulted in an immense fire in a chemical plant. The highly polluted firefighting and cooling water made its way to the Brenne, Cisse and Loire Rivers. Two hundred thousand inhabitants of Tours and the surrounding region were deprived of drinking water for several days.

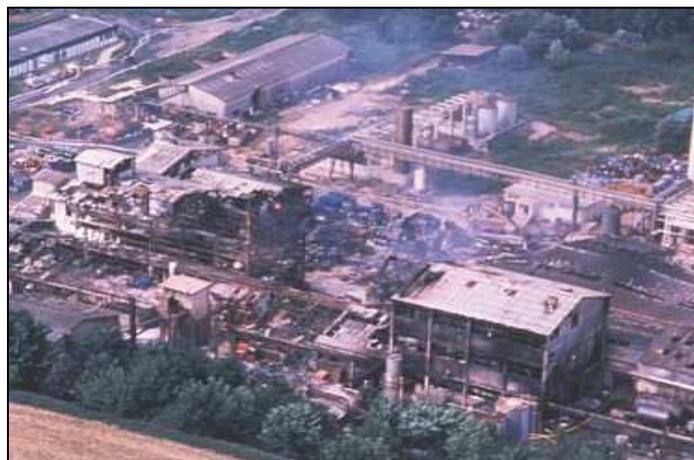


PHOTO: SDIS

PART OF THE PLANT THE DAY AFTER THE  
ACCIDENT

### THE INSTALLATIONS IN QUESTION

Since 1952, the plant has operated on 6 ha of property located along the banks of the Brenne River. The company employs 150 people, including 20 executives and 15 foremen, and produces 800 specialty chemical products essentially intended for the textile or plastics transformation industry.

The site is divided into several production and storage sectors and does not have a large retaining capacity. The numerous chemical products are stored anarchically, although in relatively small quantities.

## THE ACCIDENT, ITS BEHAVIOUR AND CONSEQUENCES

### The accident:

- **During the night of June 8th**, only a foreman and 9 employees were present at the plant. Having been on the job for only 6 months and assigned to his workstation just recently, and alone, an operator was in the process of manufacturing a silicon and additive-based waterproofing product. The plant had been performing this synthesis for a long time, but the procedure had recently been modified and the order in which the reagents were to be added was not specified. The operator loads 800 kg of oil into tank 1702 on the 1st level, begins heating up the reactor, goes down to the ground floor to pump the alchoolate (reagent) and notices a sort of fog coming from tank 1702, while he was climbing up to the 2<sup>nd</sup> level to fill a water tank. At around 3 am, the decomposition of the silicone oil resulting from the sudden and uncontrolled addition of very basic alchoolate resulted in an explosion after hydrogen had formed.
- A local resident sounded the alarm. The nearest emergency response centres were informed, except for the professional firemen in the city of Tours. The initial resources employed at 3.20 am had no effect on the fire which involved 500 tons of miscellaneous products in the zone concerned, including a large quantity of alcohols.
- The fire expanded in both surface area (3,000 m<sup>2</sup>) and intensity and generated a thick cloud of toxic fumes (nitrogen oxides, ammonia...) which required the evacuation of 200 local residents at around 4 am. The high temperatures facilitated the decomposition of the stored chemical products. The concentrations of HCN, CO, NOx and halogens were taken, and only traces of CO and NOx were detected.



Photos: SDIS

- Firefighting resources were reinforced by a pump-and-tank wagon, 4 large nozzles and foam monitors supplied by 2 synthetic emulsifier trucks from the Tours airbase. The fire was brought under control around 6.15 am.
- Part of the firefighting and cooling water, containing a high percentage of toxic elements, spilled over and flowed directly into the Brenne (Cat. 2 river) via 2 outlets that were not identified at the start of the rescue operations. The Brenne is an tributary of the Cisse, which itself flows into the Loire.
- Another part of the effluents was channelled via the site's wastewater network to 3 buffer tanks from which, during normal operation, are directed to the plant's treatment station. Throughout the entire operation, the effluent lifting pumps remained in operation and progressively filled the treatment station's 600 m<sup>3</sup> homogenisation pond, while the water normally charged from the day before are discharged by the station. Upon completion of operations, a power outage caused the lifting pumps to stop operating while the pond was  $\frac{3}{4}$  full. When the operator put the treatment station back into operation 3 hours after the fire was extinguished, toxic effluents were again released for a period of 7 hours (approximately 630 m<sup>3</sup>).
- The releases polluted roughly thirty kilometres of the Brenne, Cisse and Loire Rivers. The operator was unable to provide a precise indication of the stocks and, following the fire, issued an unverifiable list of a hundred or so products, some toxic or flammables, that were destroyed in the accident (phosphorous oxychloride, hydrocyanic acid, resins, polar solvents...). The most dangerous compounds released into the river system were essentially organic (cyanide-containing products, pentachlorophenols, and miscellaneous phenolic derivatives) although sediments revealed significant quantities of chrome, mercury, magnesium and aluminium. The concentration of certain toxic materials such as the cyanide-containing products explain the animal and vegetable mortality reported in both rivers.

- Analyses on water taken from the Loire showed a high COD (chemical oxygen demand), high conductivity and traces of cyanide. The pollution in the river required the shutdown of the drinking water reservoirs located 30 km from the plant for a period of 8 days, affecting the city of Tours and several other communities. The drinking water requirements for the 200,000 people in the area are estimated at 45,000 m<sup>3</sup>/day.



Source DR

**Distribution of drinking water in Tours**

### The consequences:

- The operator, who was conducting the manufacturing operation roughly ten meters from the equipment, was severely burned when the reactor exploded. He was hospitalised for 6 weeks and unable to return to work for 6 months. Two firemen were also seriously injured and 15 members of the rescue team were intoxicated (CO) during the intervention.
- The releases sterilised 23 km of the Brenne and 5 km of the Cisse including the total destruction of fish (at least 20 t), bacteria, aquatic invertebrates and certain vegetables (algae and bryophytes). Dead mammals (rats, coypus...) and ducks were also observed along the 2 rivers. No animal mortality, however, was noted along the Loire.
- At the financial level, the accident was rather costly for both the company and the community, particularly regarding the relatively inexpensive preventive measures which could have prevented it:
  - ✓ Cost for the company: 53 MF: damage to buildings and production resources, operating costs (8 MF), maintenance costs...
  - ✓ Creation of a supervisory and health care position in the plant: 1.1 MF/year.
  - ✓ Preventive measures implemented by the operator after the estimate, estimated at 3.8 MF: water retaining dike, access, sludge treatment, personnel protection...
  - ✓ Overall cost for the community: 49 MF, including:
    - Damages paid to employees (partial unemployment): 2.4 MF
    - Government and Services: 7 MF
    - Territorial communities: 12.8 MF
    - Private sector: 18.8 MF
    - Damage to the environment: 6.7 MF.
- Finally, the indirect effects of an accident cannot be underestimated. The environmental image of the Loire River was damaged, particularly in terms of its recreational possibilities. The national and international press focussed on the Loire and the city of Tours.

## 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 Auzouer-en-Touraine accident can be characterised by the following 4 indices, based on the information available.

Dangerous materials released		<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Human and social consequences		<input checked="" type="checkbox"/>					
Environmental consequences		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Economic consequences		<input checked="" type="checkbox"/>	<input type="checkbox"/>				

The parameters that comprise these indices and the corresponding rating method are available at the following address: <http://www.aria.ecologie.gouv.fr>

Owing to the lack of data concerning the quantities of substances released during the accident and classified according to the 96/82/CE 'SEVESO 2' directive (notably hydrogen and ammonia), the "dangerous materials released" index (parameter Q1) is rated 1 by default.

As the effects of the explosion were not characterised and broken window distances were evaluated at less than 330 m, the index relative to the quantity of explosive substances involved in the explosion (parameter Q2) is given a level 1 rating.

The 200,000 people deprived of drinking water for 8 days explains the level 6 rating of the 'human and social consequences' index (parameter H8). As the accident seriously injured one employee and slightly injured 17 rescue personnel, the indices relative to parameters H4 and H5 reached levels 1 and 2, respectively.

The 30 km of water pollution explains the level 4 rating for the 'environmental consequences' index (parameter Env14).

And finally, 49 MF in damages outside the establishment account for the level 5 rating of the 'economic consequences' index (parameter €17).

## **ORIGIN, CAUSES AND CIRCUMSTANCES OF THE ACCIDENT**

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According to the Inspection services (Labour and Classified Installations Inspectorate), the explosion was caused by an incorrect mixture in the reactor. With a poorly regulated and acidic pH, the mixing-in of a new product to silicone oil results in the release of H<sub>2</sub> or sodium hydride which spontaneously ignites when it comes in contact with air. The operation reproduced under laboratory conditions by the plant, did in fact result in an explosion.

## **ACTION TAKEN**

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### Technical actions

Following the accident, solid and liquid wastes were destroyed and the surface waters decontaminated. The cost of these operations is estimated at 10 MF (1.5 M€). The operator reinforced its prevention and protective equipment resources and improved management and emergency plans.

## Legal action

- The charges made against both the company's President and Technical Director, who was in charge of the Auzouer facility, involved the following offences:
  - ✓ the release of substances toxic to fish (art. L232-2 and L232-4 of the Rural Code),
  - ✓ involuntary injury leading to an inability to return to work for 3 months (art. 319 and 320 of the Penal Code),
  - ✓ Labour Code offences concerning the layout of facilities,
  - ✓ and against the establishment's Director, infractions of the Labour Code concerning the insufficient amount safety training given and interfering with the operation of the CHSCT ("Comité Hygiène, Sécurité et Conditions de Travail", Committee for Hygiene, Safety and Working Conditions).
- According to the judgment of 01/13/92:
  - ✓ the President was sentenced to a one-year suspended prison sentence and a 120 KF (18.3 K€) fine,
  - ✓ the Plant Manager was sentenced to a 6-month suspended prison sentence and a 60 KF (9.1 K€) fine,
  - ✓ the damages to be paid jointly to the civil parties was approximately 800 KF (122 K€), including:
    - 300 KF (45.7 K€) to the departmental federation of fishing and fish farming associations,
    - 250 KF (38.1 K€) to the Supreme Council for Fishing,
    - 132 KF (20.1 K€) to the local fishing association,
    - 80 KF (12,2 K€) in all to environmental protection associations,
    - 10 KF (1.5 K€) to the syndicate and to a national professional federation, owing to the "direct damage resulting from the downgraded image of the chemical profession as a result of the accident, and the indirect damage as a result of the clear violation of safety requirements".

The judgement stipulated that an additional expert assessment be conducted in order to evaluate other damages for which the amounts are not indicated above.

- Concerning the context and pre-accident circumstances, responsibility for the accident essentially falls upon the serious insufficiencies within the organisation and management of the installations:
  - ✓ insufficient "safety culture": the Court found that only 6% of the investments between 1987-88 were dedicated to safety and the environment and considered it to be an obvious sign of "lack of motivation";
  - ✓ inadequate training of the new operator: a 2-day training program in theory and a 4-month on-the-job training period with the previous operator are considered insufficient;
  - ✓ no night time supervisory staff present: the Court noted that a single OHQ (Operational Headquarters) level supervisor was likely to provide assistance between 1 am and 5 am. The Court considered the President's "inability" to require operational supervisors to perform night watch duties to be a significant fault;
  - ✓ inadequate operating instructions: the Court cited the "disorder" and the insufficiently clear definition of the manufacturing sequence, and noted nearly illegible handwritten notes regarding safety-related information;
  - ✓ faulty safety instructions: the lack of the material safety data sheet for the product appended to the operating instructions demonstrates a misunderstanding of the CHSCT recommendations for this particular aspect;
- The liabilities relative to the aggravation of the consequences associated with the intervention are as follows:
  - ✓ the liabilities concern the irrational restart of the treatment station, considered to be another fault committed by the operator. In addition, he will not benefit from attenuating circumstances associated with the difficulty encountered in the diagnosis and decision-making process during the intervention,
  - ✓ the firemen were discharged of any liability on the amount of water used and the spillage conditions, and their actions were considered justified given the disorder among the installations and the need to cool down the anarchical storage of flammable products near the unit on fire. The operator is thus completely liable for the improper management of the installations.

- Application of ICPE legislation:
  - ✓ as there was not a report documenting the disregard for certain technical specifications, no charges based on a violation of ICPE legislation could be upheld by the Court. Only the damages involving fishing and fish farming (Rural Code) could thus justify legal proceedings. The justified requests for damages by certain communities, manufacturers and consumer and farming associations of the valley, disturbed by the restriction in water usage, were purely and simply rejected.
  - ✓ concerning the disregard for the provisions of the Prefectoral Decree of 09/18/75 and 12/12/86, the Court did not directly hold the Government responsible for neglect in the application of ICPE legislation. It nevertheless highlights "the manufacturer's failure to act for nearly 13 years, most likely encouraged by the patience of a Prefecture having little interest in coercion".
  - ✓ Tribunal applied art. 22.1 of the Act of July 19, 1976 (art.5 of the Act of Aug. 03, 1985) relative to the disclosure of the judgement, following the "particularly negligent behaviour of the accused".

## LESSONS LEARNED

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Generally speaking, the establishment disregarded safety obligations in favour of immediate profitability. While having exemplary results in terms of innovation and external trade, the company neglected control over its production and the resulting risks. These deficiencies appear to be associated with the low number of upper management, which was rather standard for a small-to-medium scale industry, and not for financial reasons. The new procedure used by the operator featured numerous insufficiencies, for example (products to be added listed in the inappropriate order, role and control of the pH poorly described...).

- Relative to the intervention:
  - ✓ as urban telephone network had become rapidly saturated, communications had to be via radio;
  - ✓ the site's emergency plan did not adequately account for the numerous chemical products present at the site, and proved to be unusable given the circumstances and was not initiated;
  - ✓ the rescue team's lack of resources (individual protective and penetration equipment, high-power intervention means...) made them initially helpless against a fire fuelled by a large quantity of alcohols. They had to wait until the reinforcements arrived (pump-and-tank wagon, 4 large nozzles, 2 emulsifier trucks) to bring the blaze under control;
  - ✓ the lack of anticipation on the part of the emergency services (management, training in staff techniques, exercises...) and a 1 to 2-hour delay in bringing the resources up to steam;
  - ✓ the supply of firefighting water was limited and deteriorated following the rupture of a pipe in line with the fire making 3 fire hydrants unavailable;
  - ✓ the drainage channel likely to lead a pollution directly or not to the natural environment were not rapidly identified, the outlets were blocked off less than an hour later.
  - ✓ atmospheric pollution devices were not immediately available (12 hours late), while on the contrary, information for monitoring water pollution was excessive. Hundreds of "water analyses" (local laboratories, water distributing lessee companies, DDA...) were conducted without any real coordination which would have ensured better use of the resources available and coherent information from the various entities involved;
  - ✓ the restart of the installations associated with the damaged installations must be carefully monitored. There were at least 2 peaks in the water pollution; in the morning during the intervention and in late afternoon following the deliberate release by the plant's water treatment plant;
  - ✓ the overestimation of the value of the physico-chemical analyses and the difficulty in evaluating the risks associated with the pollution of a tributary of the Loire lead the municipality of Tours to opt for the precaution principle even without evaluating the intermediate solutions. Stopping water distribution for 8 days for more than 200,000 people appears disproportionate compared to the actual health hazard, although was useful in reassuring the population.
  - ✓ Communication with the population and the media was properly controlled by the municipal services. As the logistics worked properly, this episode may be considered to be an example of successful crisis management although not a model case.