

Fire and explosion in an industrial chemical plant

18th October 1981

Villeurbanne – [Rhône]
France

Fire
Explosion
Warehouse / Chemicals
Flammable liquid
Sodium chlorate
Victims
Detection

THE INSTALLATIONS CONCERNED

Installation concerned

The chemical plant was installed in 1967 in the buildings of a former foundry. In 1976, following the acquisition of another company, it extended to cover an area of 13 000 m² of which 9 000 m² are covered. The environment has become increasingly urbanised since its installation.

The company operates as a wholesale distributor of chemical products for sale to retailers and individual clients, who can come to supply themselves directly on the spot. It is one of the largest operators on the national level in its category. There is considerable diversity in the range of products stored: acetone, methyl alcohol, gasoline, fuel oil, white spirit, turpentine essence, solvent based paints, liquid polishes, stain removers, various cleaning products, garden products, , phyto-sanitary products, sodium chlorate..

It is estimated that a volume of 33 000 litres of flammable liquids are held in inventory (acetone, alcohol, fuel oil...) at the moment of the accident, the warehouse also contained 15 t of paints and products for the treatment of wood, plus over 14 t of sodium chlorate.

The administrative situation

As regards the regulations relating to installations which are classified in terms of environmental protection, the company was only known for having a gasoline depot with a volume of 10 000 l in an underground tank which had been declared.

However, the enquiry following the accident revealed that 3 depots or workshops were subject also to the requirement of a declaration:

- Alkaline chlorate depot ;
- Flammable liquid depot in open air;
- Accumulator charging workshops..

THE ACCIDENT, ITS UNFOLDING, ITS EFFECTS AND ITS CONSEQUENCES

The accident

It is difficult to be precise about the time that the fire started (between 0h30 and 1h in the morning) on account of the absence of any security rounds and fire detection systems.

The alert was given towards 1h20 in the morning. The fire was then visible from outside the buildings. The fire services arrived within the following minutes. Around 1h30, a first explosion occurred while the police and safety services were commencing the evacuation of the neighbouring buildings,. This incited the inhabitants of the quarter to evacuate their residences spontaneously. At 2h10 a second, very powerful explosion occurred, accompanied by numerous projections of stored products and materials, in particular of the metal beams which supported the roofing of the buildings. Around 2h15,

two further explosions of lesser importance occurred. Around 3A.M. the fire-fighting services had the fire, which now extended to most of the buildings, under control.



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The consequences

Human consequences

A young woman of 19 years was killed at 250 m from the site of the fire by one of the metal beams, certainly projected by the second explosion.

An elderly person suffered from a very serious leg injury by another beam

Eleven other people, including two police officers and two firemen were lightly injured by falling material projected by the explosion or suffered from respiratory problems.

Material consequences

- The site of the chemical plant

The buildings of the industrial chemical plant were almost completely destroyed by the fire and the explosions. There remains nothing on the presumed site of the chlorate depot and the ground has been indented by 50 cm. There only remains skeleton walls and a mass of metal profiles (roof beams and shelving)

Losses are estimated at 17 million francs (MF 1981) of stocks (5,6 M€ 2006), 6 MF (2 M€ 2006) of materials and buildings, as compared with forecast sales of 115 MF for the year 1981 (37,7 M€ 2006).



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- In the environment

The fire ravaged the buildings of a company sited next to the industrial chemical plant. Further away, the environment was principally affected by the effects of the second explosion (blast and projectiles) essentially experienced in the South and East sectors.

Windows were blown out of around 150 apartments, blinds were also damaged and inside doors and partition walls torn out. One building had to be condemned after the accident. A few windows were also blown in buildings situated 200m from the site.

The surroundings to the South and East were « bombarded » with very diverse projectiles when the second explosion took place. The lawns of a group of educational buildings a hundred metres away and the balconies of the closest apartment buildings were covered with debris. Some projectiles were found more than 200m from the presumed site of the explosion.

Among the projectiles were found 1kg and 5kg pots of sodium chlorate, more or less burned out, 5l cans of white spirit or which some are intact, flasks of washing-up liquid or "Javel" water (an aqueous solution of sodium hypochlorite also containing sodium chlorate), aerosol cans, Cardboard cartons of garden products, metal beams of an estimated weight of 45 kg coming from the roofing of the buildings found up to 120 metres from the site. Some of these had been blasted over 8 floor buildings.

Projectiles also damaged cars parked in the streets surrounding the plant.

European scale for industrial accidents

By using the rules for quoting the 18 parameters on the scale formalised in February 1994 by the Committee of Competent Authorities of the member states for the application of the 'SEVESO' directive, the accident can be characterised by the 4 following indices, taking into account the available information..

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

The parameters of which these indices are composed and the methods of quotation are available at the following address: <http://www.aria.ecologie.gouv.fr>

The level 3 indicated as the index relating to dangerous substances relates to the loss or ejection of 14 t of sodium chlorate ($Q_1=14 \text{ t} / 200 \text{ t} = 7\%$), a product classified as an oxidising agent under the SEVESO directive (parameter Q1)

The deceased person (parameter H3) and the 8 injured members of the public (parameter H4) explain the level 4 in the index "human and social consequences".

Finally the material damage to the establishment, estimated at 6,14 M€ (inn 1963 ECU) explain the level 3 for the "economic consequences" (parameter €15).

ORIGIN, CAUSES AND CIRCUMSTANCES OF THE ACCIDENT

The origin of the **fire** could not be established with certainty. However several hypotheses have been put forward:

- Criminal act (responsibility for the fire was claimed in an anonymous telephone call) ;
- Act of negligence or ill-will;
- Electrical fire (the latest report of the examination of the installations indicated a correct electrical installation) ;
- Spontaneous combustion of product stored (several unstable chemical compounds of mixtures were present in the warehouse);
- Accident.

No element of proof is available to confirm any of these theories..

The origin of the **explosions** can be explained by the presence of flammable liquids and of sodium chlorate:

Explosion due to flammable liquids.

The heat generated by the fire was sufficient to liberate the flammable liquids (melting of plastic containers and rupture under intense pressure of metal containers) the boiling point of acetone is 58°C, that of alcohol is 78°C, that of white spirit is situated between 135 and 205°C creating an over-pressure in the contents and thus liberating an explosive atmosphere ignited by the fire.

Explosion due to chlorate

Chlorate can decompose in an explosive fashion under the effect of heat or shock. A mixture of chlorate and combustible materials can also explode when exposed to a flame.

The second explosion, the most powerful, took place in a space which contained at least 6 tonnes of sodium chlorate 11 m³ of flammable liquids in various types of containers, plus wax in the form of table candles. It is probable that the destruction of some of the packaging of these, during the first hour caused the mixture of chlorate and flammable liquids to create an explosive compound.

THE STEPS TAKEN FOLLOWING THE ACCIDENT

Change of the site

The company abandoned the Villeurbanne site to move to a nearby industrial zone.

LESSONS LEARNED

The respect of obligations prescribed by the decrees applicable to installations classified as being subject to declaration would doubtless made it possible to reduce the consequences to the environment. The enquiry held by the inspectorate of classified installations will demonstrate major shortcomings as regards respect for elementary safety rules contained in the "standard" decrees and, in particular:

- For chlorate depots "the space designated for the storage of chlorates will contain no flammable liquids, compressed gases, concentrated mineral acids or finely powdered combustible materials"
- For depots of flammable liquids « flammable liquids must be stored in non-flammable recipients"
- For the battery charging workshop: « The workshop should be put to no other use. In particular is forbidden to store there a depot for combustible materials »

In the absence of any watchman's rounds, of any fire or smoke detection systems, alarms or automatic extinguishers, the fire easily spread throughout the warehouse, fed by the combustible materials present. (cardboard packaging, palettes...).

The destroyed establishment had grown through the years to reach a level of activity incompatible with the age of its buildings and the density of its environment..

A report of the general inspectorate of the environment concluded that "On a national scale, this situation does not appear to require any profound modifications to the regulations governing classified installations (only a few adaptations and, for sure, the adoption of a limit in the matter of sodium chlorate storage are advised), but a programme of information addressed to the professions concerned, in the forefront of which are the circuits of chemicals wholesalers, either classic or cooperative, who, while being in a small minority as compared to the volumes of products distributes, probably includes the majority of the establishments in which security is insufficiently taken into account».