Fine chemistry
Cyclohexane
Utilities / Compressed air / Inerting
Human factor
Post work acceptance inspection
Victims
Organisation
Sub-contractor
Expert evaluation

# Explosion and fire in a facility

November 6th, 1998

# Neuville sur Saône – [Rhône] France

## THE INSTALLATIONS IN QUESTION

### The site

Located in Neuville-sur-Saône north of Lyon and on the banks of the Saône river, the plant synthesises active pharmaceutical materials:

- corticoids (from bovine bile up until 1998, and since by synthesis of soy sterols),
- antibiotics (ketolide),
- insecticides (deltamethrine).

The company employs 1,000 individuals and is certified by the SEVESO directive (2nd amendment). In its environment, two 400 and 600 m urbanisation control zones were implemented, due to the presence of an ammonia storage facility, and a PPI ("Plan Particulier d'Intervention", emergency response plan) perimeter of 2,100m.

The plant must deal with numerous odour problems, which have generated complaints from local residents.

### Installation concerned

The building involved in the accident was used for the synthesis of corticoids from bovine bile. It has been vacant since 1988. It now houses the partial synthesis of a promising antibiotic. The clinical tests on small quantities are terminated and the need to continue with product qualification tests, performed on industrial installations, justified the overhaul of the building.

The antibiotic is synthesised in 9 steps followed by a distillate treatment to remove an odorous component, dimethylsulphide; the residue is then packaged for destruction. This treatment does not enter into the fabrication cycle and the operation is conducted in a 8m³ reactor (GG01), by oxidising the dimethylsulphide with hydrogen peroxide in an acidic environment. The explosion occurred in this reactor. The plant must handle numerous odour problems and the resulting complaints from neighbouring residents.

## THE ACCIDENT, ITS BEHAVIOUR AND CONSEQUENCES

### The accident

On November 6th, the treatment of the cyclohexane-rich distillate was almost finished following oxidation in a nitrogen atmosphere, neutralisation of the reactive environment, final inspection, then clearing of the lines with nitrogen. At 6:15pm, not long after the nitrogen valve was opened, an explosion occurred. Audible over several kilometres, the explosion shattered reactor equipment (blowout diaphragm, manifolds, etc.) and the windows of the 500 m² facility. The POI ("Plan d'Organisation Interne", internal contingency plan) was initiated. The internal fire-fighters manage to control an incipient fire in 15 minutes. An operator serious injured by a falling electrical cabinet died a few hours later, and 2 employees were injured (ankle burns and eardrum trauma) and 12 other individuals indirectly injured were examined as a precaution. Despite the noise of the explosion, no consequential damage to the environment was observed.

## The consequences

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## 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.


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

The cyclohexane involved in the accident represents less than 0.1% of the corresponding Seveso threshold (200 t – highly toxic for aquatic organisms), which equals level 1 of the "dangerous materials released" index according to parameter Q1 (Q1 < 0.1%).
As the effects of the explosion had not been characterised and windows were broken at distances less than 300 m, parameter Q2 was given a rating of 1.
The overall "dangerous materials released" rating is thus 1.

Three parameters are involved in determining the level of the "Human and social consequences" rating: H3, H4 and H5.

- Parameter H3 is rated as level 2: 1 employee killed (H3 = 1 death).
- Parameter H4 is rated as level 2: 2 employees seriously injured (H4 between 2 and 5 employees injured).
- Parameter H5 is rated as level 2: 12 employees examined as a precaution (H5 between 6 and 19 employees injured).

As a result, the overall "Human and social consequences" rating is 2.

# ORIGIN, CAUSES AND CIRCUMSTANCES OF THE ACCIDENT

The implementation of a new manufacturing process in the existing facility required certain modifications to be done. These modifications were carried out during the summer of 1998 and concerned primarily the connection of the equipment in place to fluid pipe networks and notably the nitrogen networks. In this respect, the factory has 2 networks, the first operating under 3.8 bar for reactor inerting and, the second, referred to as "purge nitrogen" operating under 3 bar. It is the latter that was to be used, for the first time, to purge the reactor where the accident occurred.

During the legal inquiry, the expert, upon following the pipelines, discovered that the connection had not been made on the "purge nitrogen" factory network, located on a rack outside the facility, but to the compressed air network.

The accident occurred during the rinsing of the tank containing cyclohexane (combustible), after the blowoff valve connected to the compressed air network (oxygen carrier) had been opened. The hypothesis proposed is that the energy required for ignition was provided by the agitation or the transfer of 2 non-miscible liquids (cyclohexane and water), one of which is inflammable and non-conducting and thus easily charged with static electricity (Klinkenberg experiment).

## ACTIONS TAKEN

### Technical actions

The operator took the following measures after the accident :

- withdrawal of the deodorising treatment,
- organisation of a workgroup to determine the deficiencies in the qualification procedures and to improve them,
- better identification of pipework (all plant pipelines are painted),
- analytic inspection of the absence of oxygen (oxygen meter).

### Administrative actions

The regulated activities practised in the new fabrication process were identical to those for which the facility had already received authorisation and the volumes involved were similar if not less. In terms of regulations, the new fabrication process was thus placed under the jurisdiction of article 20. The day of the accident, the operator had not completed its modification dossier, and thus it had not been submitted to the Prefecture. The Inspectorate drew up a report. The dossier has since been submitted and the facility has been in limited operation since March, under coverage of an additional prefectorial decree.

### Legal action

Two years later, the inquiry conducted following a judicial inquiry implicated 3 companies and lead to the indictment of 14 individuals.

## LESSONS LEARNED

The proper execution of modification operations performed by an external company must be checked by 2 procedures :

- The first, entitled "qualification of installations or IQ" consists in a dry-run acceptance testing, to check that the modification is in compliance with the specifications of the reference dossier. This verification was conducted by the sub-contractor who did not detect the connection error (pipes on the rack not colour-coded).
- The second, entitled "operational qualification" in the presence of the fluids which will actually be used. This verification was conducted by the factory. Care was taken to ensure that the reactor's purge nitrogen connection was under pressure, although the fluid type was not verified.

The accident is thus the result of insufficient verification of the proper execution of works.