

Explosion for a mixing operation in a multi-purpose plant

June, the 8th, 1999

**Wuppertal
Germany**

Fire
Polyvalence
Potassium Carbonate
Potassium Hydroxyde
Thermal runaway
Human factor
Organisation
Urbanisation

THE INSTALLATIONS IN QUESTION

The site :

The incident took place in an installation producing a variety of products for crop protection in a small quantity of 10 – 30 tons per months and proving new products and new operating procedures. It showed typical characteristics of a multi-purpose plant. All components could be interconnected any way and used for several productions.

The plant was subject to license according to German Federal Immission Control Act. Due to the quantities of hazardous substances at the installation in amounts that exceeded upper tier threshold limits the extended obligations of German Ordinance on Incidents had to be fulfilled by the operator. A safety report has been drawn up. The establishment is located in a valley amidst a residential district and crossed by a public means of conveyance, strictly speaking a suspension railway.



Source : Autorité de Rhénanie du Nord-Westphalie

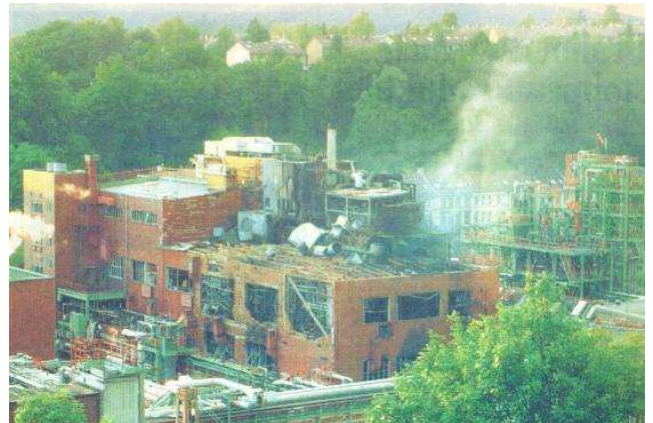
THE ACCIDENT, ITS BEHAVIOUR, EFFECTS AND CONSEQUENCES

The accident

On the 8th of June, 1999, 500 kg potash was filled into a 4 m³ stirring reactor. After that reactant A solved in a solvent (together 1.600 kg) was added in a metered form. After activating the stirrer the content of the reactor was heated up to 90°C.

At 16:30, two employees standing not far from the reactor suddenly heard a loud hiss and alarmed by this immediately ran away in the direction of the fire door.

At the same moment the reactor exploded. The pressure wave grasped the two employees who were injured considerably. In the following of the explosion a fire occurred.



Source : Autorité de Rhénanie du Nord-Westphalie

The consequences :



Source : Autorité de Rhénanie du Nord-Westphalie

The two employees staying in the room where the explosion occurred suffered heavy injuries especially the drumheads bursted. Four other employees of the multi-purpose plant, three employees of other departments and two members of the establishment fire brigade were injured respectively had to be investigated providently at the hospital.

The first two employees had to stay in the hospital for several weeks. Three of the injured employees were attended ambulatory and the six others were dismissed after check-up.

Outside the establishment 91 persons were notified with complaints concerning breathing passages or injuries by glass fragments and had to be attended ambulatory.

A lot of dwelling houses suffered partly considerable damages especially because a lot of windows were smashed by the blast. The establishment was devastated in a circuit of 200 m around the place of explosion. A contact line of the railway was pulled down.

Echelle européenne des accidents industriels

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.

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"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" 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 type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

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

Considering the effects of the explosion (the complete destruction of the establishment in a radius of 200 m), one can estimate that broken windows could be found a radius greater than 330 m around the explosion. Parameter Q2, the "dangerous materials" index, is thus given a rating of 2.

The accident resulted in 2 operators seriously injured (parameter H4) and 91 individuals outside the establishment who were cared for on site (parameter H5). Owing to this last parameter, the "human and social consequences" receives a rating of 5..

ORIGIN, CAUSES AND CIRCUMSTANCES OF THE ACCIDENT

Two expert bureaus got the job to find out the reasons of the accident. A few days later due to the evaluation of circumstances and interviews with the employees the reason was found out. It was a substance confusion during feeding the reactor. Instead of potash the employee had filled potassium-hydroxide into the reactor.

The ordered packing drums with potash were provided correctly. An employee by mistake took a stillage of potassium-hydroxide from supply area and brought it to the reactor. Maybe the similarity of the labels „potash“ and „potassium-hydroxide“ on the drums in foreign language was the reason. The employee who had to fill the content of the packing drum into the reactor by using the man hole recognized the mistake. He told his foreman that something was wrong with the packing drum but the foreman ordered him to fill in the packing drum as planned.

The evaluation of operation recordings showed that after activating the stirrer and beginning of heating there were no remarkability ascertainable over a longer period. Then suddenly the temperature was rising in such a steep manner that after a few seconds the reactor failed. The speed of the runaway reaction was so high that the plant personnel could not interfere effectively. Furthermore, the opening of the safety valve was too slow.

ACTIONS TAKEN

The establishments fire brigade arrived immediately at the location where the explosion had taken place. At 6.45 p.m. the fire was unter control and at 7.23 p.m. it was extinguished.

The laboratory truck of North Rhine-Westfalia State Environment Agency arrived at 6.20 p.m. and started immission control measurements in respect of hazardous substances. Only for chloric acid gas there were higher values of 0,5 ppm which were distinctly below the German MAK-value of 5 ppm (MAK = German Occupational Health and Safety Threshold Limit). As a result no hazard for the public due to hazardous substances had been recognized.

After the explosion the public in the neighbourhood was called to close the windows. Due to broken windows, not everyone was able to comply with this advice. For several hours the operator was not able to term the substances released.

LESSONS LEARNED

The destroyed plant wasn't rebuilt. So the incident didn't entail consequences to this plant. The consequences of the accident led to the company's decision to displace the production of corp protection products to another location far away from any residential districts (> 1000 m).

Meanwhile the competent authorities began to consider the problem of substance and product confusion in multi purpose plants intensively and to reflect upon the measures necessary from a new point of view.

The company itself planned a complex multi purpose plant for corp protection products at another location where the residential districts are so far away that in case of an accident no consequences for the public could occur.

Therefore obviously the competent authorities paid attention to lessons learnt from this accident in the license procedure of that new plant.



Source : Autorité de Rhénanie du Nord-Westphalie

Up to the day of the accident the operator only applied house-keeping measures to fight the problem of substance and product confusion. From his point of view after the accident there was no reason to change this procedure on principle. Only better house keeping measures as a non-hierarchical 4-eye-priniple was taken into account. The competent authorities are convinced that only house keeping measures to prevent substance and product confusion do not correspond with the state of the art in safety technology. From the competent authorities point of view additional a

technical identification system like a barcode system for example with technical interlock has to be installed. In this case each packing drum will get a plain machine readable code. The code on the packing drum shall be read automatically immediately before filling the substance into the reactor.

The feeding devices as metering valves, metering screws and so on should be interlocked by process control system in a way that feeding is only possible after reading the expected code. The competent authorities are sure that the accident presented above would not have taken place, if such a technical identification system like that described above had been used.

During the lapse of the licensing procedure a lot of controversy discussions between the operator and the authorities concerned had taken place. As a final result the new plant will get a technical identification system without interlock in addition to the improved house keeping measures suggested by the operator.



Source : Autorité de Rhénanie du Nord-Westphalie