IMPEL NETWORK

European Union Network for the Implementation and Enforcement of Environmental Law

MINISTERE DE L'AMÉNAGEMENT DU TERRITOIRE ET DE L'ENVIRONNEMENT

Meeting - LYON, June 2000 , 6th and 7th

« LESSONS LEARNT FROM INDUSTRIAL ACCIDENTS »

ICPE / IMPEL Inspectors

Thanks

We do thank the participants to the meeting for their presentations and their contribution in the achievement of the following synthesis.

The participants' names are presented below in the order of the presentation in the document.

- Monsieur Dominique VANDERSPEETEN (DRIRE Franche Comté)
- Monsieur Fiorenzo DAMIANI (ISPSL- Italie)
- Monsieur Norbert WIESE (Land Rhénanie du Nord –Westphalie)
- Monsieur Claude DELMAS (DRIRE Midi Pyrénées)
- Madame Caroline TAIN (DRIRE Nord-Pas-de-Calais)
- Monsieur Yves LIOCHON (DRIRE Bourgogne)
- Monsieur Bill HAZLETON (HSE-Royaume-Uni)
- Monsieur Bo WENDT (Environnement Ville de Bastad)
- Monsieur Christian PELLIGAND (DRIRE Ile-de-France)
- Monsieur Patrice CHEMIN (DRIRE Haute-Normandie)
- Monsieur Jean-Philippe BERNARD (STIIC)
- Monsieur Christian SALEMBIER (DRIRE Rhône Alpes)
- Messieurs Philippe DUMORA et Alain SOUCHAUD (DRIRE Poitou Charentes)
- Madame NAYLOR (DSV du Morbihan) et Richard MEMBRIVES (DRIRE Bretagne)
- Monsieur Pascal HERITIER (STIIC)

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Introduction

Presentation files of the accidents

9 Leak of refrigerant gas in a food factory
Coldwater Seafood in Grimsby (United Kingdom)
November 11th , 1998

10 Leak of a toxic agent
Construction of the Hallandsäsen Tunnel (Sweden)
From April 1993

11 Overflow of petroleum products in a depot
CIM in Grigny (91)
September 7th , 1999

12 Rupture of a phosphoric acid storage tank
Grande Paroisse SA in Rouen (76)
April 23rd , 1999

13 Leak of hydrochloric acid in a storage facility
Aventis Company in Villeneuve-la-Garenne (92)
May 12th , 1999

14 Fire in a aerosol container wharehouse at a chemical plant
Sico Company in Saint-Egrève (38)
July 13th , 1999

15 Outbreak of fire in a silo of an agricultural cooperative
Lusignan (86)
June 29th , 1999

16 Spontaneous combustion of animal meal
Plouisy (22) and Cléguer (56)
July 20th and August 29th ,1999

17 Accident on a cooling shroud of an oven loading chute at a domestic waste incineration facility
Tiru in Saint-Ouen (93)
July 22nd , 1999

Annexes

1 Accidents involving the incineration of DW / CIW and similar cases

Study achieved following participants' demand for IMPEL meeting, June 6th and 7th 2000.

2 Accident reporting :

First information French form, presented for the meeting.

Introduction

Opening speech for the 2000 edition (June 6th and 7th)

Opening speech for the 2000 edition

Philippe LUCAS

Chef du Bureau de la pollution industrielle des eaux,

des carrières, des industries minérales et métallurgiques.

First off, please excuse Marie-Claude Dupuis who was not able to join our assembly today and who asked me to represent her.

It is a great pleasure for me to **open the 2000 edition** of these annual meetings dedicated to accidents and feedback. This is the sixth seminar of its type. Again this year, and in accordance with the procedure initiated last year, our European counterparts will also be participating within the framework of the IMPEL programme and I am happy to welcome them today, on behalf of myself and on behalf of the Regulated Facility Inspectorate. This increased participation can only contribute to enriching our exchanges and discussions.

As a reminder, **the IMPEL network** is, literally, the "European Union Network for the **Imp**lementation and **E**nforcement of Environmental **L**aw". The network was created in 1992 in order to encourage the exchange of information and the comparison of personal experience, and to facilitate a more coherent approach as regards the implementation, application and monitoring of environmental law. Within the SEI, Annick Bonneville is in charge of France's participation in this programme. She will be present tomorrow and will be able to answer any questions that you may have and may provide you with any further information about the programme.

And now let's get to the heart of the matter and introduce the presentations which will follow. Certain programmes will be presented by inspectors of different countries. It is my hope to reiterate the recent **community regulatory modifications** which will most certainly soon lead to a change in our practices.

First off, at the international level, **the SEVESO 2 directive** further reinforces certain points: the implementation of a major accident prevention policy for "lower threshold" establishments and **safety management systems** for "upper threshold" facilities is one, but certainly not the least. In broad terms, it clearly relies on data supplied from feedback.

As a reminder, **a management system** integrates safety into the establishment's general system of organisation, breaking it down according to the traditional lines of the company's management (personnel management, the identification of risks under normal and critical situations, inspection of the correct implementation of the system, as well as practical rules with the identification and correction of deviations, emergency situation planning, …).

These requirements of the directive were transposed into French law: the first texts of the French Ministry of the Environment (modification of the nomenclature, order and bulletin decree) were signed between December 1999 and May 2000.

If everything is not new, it is clear that more systematic, further developed and better organised work is now requested in the field of safety management. This includes the revision of the classification method with the introduction of the cumulative rule as well as the lowering of certain thresholds which broaden the field of application in relation to the former directive: in this manner, a larger number of establishments will be concerned.

In order to achieve this type of approach, all intervening parties, operators and inspectors in charge of inspecting installations must particularly rely on passed experience: past incidents and accidents comprise one of the most tangible and often extremely rich sources of information.

Of course, this information is acquired through rigorous and collective work in which each of us plays a role. All of this takes place in several steps:

φ **The identification of important parameters** which generated the accident (reconstruction of the puzzle of circumstances, highlighting of causes, aggravating circumstances, …), painstaking work by the operator, reinforced where needed by expert technical assessments conducted either spontaneously or upon request by the inspection organisation. For example, the thorough analyses of the causes can appreciably advance the preventive measures specific to the site studies, or in a more general manner, to the industrial sector. In this manner, a cause initially catalogued as being the result of human error may actually hide, after further analysis, a flaw in the system. In the first case, it is clear that the means to be implemented will be more limited, while in the second configuration, means and organisational or even technical countermeasures will have to be created or modified (modification of procedure, organisation of inspections, …).

At this point, our attention must not be drawn away from "**near accidents**" and the incidents for which the consequences are much lighter. For this reason, they can be "classified" without a serious study of the causes and risks incurred. Their repetition, however, often constitute the "forerunner" of more serious accidents. In other respects, they sometimes provide better access to the event than the accident itself which destroys part of the information.

κ Another deciding element in the acquisition of feedback is the **transfer of information** from the operator to the inspection organisation. This is a crucial phase which bears witness of the need for transparency and openness between the two levels. If the obligation to report accidents to the authorities is provided for in the texts, whether they be French or European, that of reporting "near accidents" for example or other feedback elements, is not that clear. It is in fact left up to individual discretion and often remains limited.

λ And finally, **the grouping of data** collected by the authorities is indispensable in light of national and European sharing. The access to the largest amount of data constitutes an element of progress in terms of accident prevention. In order to illustrate this necessity, serious accidents such as that which occurred in Blaye (France) in 1998 or more recently and which is still on everyone's mind, the tragic explosion at Enschede (The Netherlands), have already and most certainly will form the subject of precise information exchanges which are of the utmost importance for the safety of pyrotechnic storage facilities. Moreover, we won't hesitate to open our forum to our Dutch colleagues during future meetings of this type if they wish to participate.

µ I spoke of the grouping of data, although the chain is not just limited to an "upward" collection system: **the restitution of trends and developments** for a site, branch, activity sector and type of process is a necessity. It must enable companies and the inspection organization to particularly benefit from the development and inspection of safety management systems. Resorting to existing tools and structures is thus the order of the day. Furthermore, this trend has also been initiated by the past: last year, the MATE answered 930 accidentology requests, the majority of which were sent to companies or inspection organisations.

I would now like to address the **possible support tools**: the databases collecting the information issued from accidents form a "type". In France, the tool created 8 years ago to address this need is the BARPI. The BARPI, within the MATE, is responsible for gathering data in the ARIA database (literally the "Analyse, Recherche et Informations sur les Accidents", the French accident information, research and analysis database), processing the information and also disseminating it in various forms. At the European level, the ISPRA Community Centre, in Italy, created practically at the same time, manages the European MARS database (the Major Accidents Reporting System). This database includes the accidents reported by European Union member countries.

I would also like to add that the new version of the directive imposes **more precise accident notification criteria**: in particular, the quantities of products implemented in relation to thresholds (% of the upper threshold), the impact on the environment (km of river or lake surface area affected), personal injuries (number of victims or wounded), and material damages (greater than a certain amount) are now taken into account. The accidents to be reported will most likely be more numerous. We will have to see to it that the information and exchange procedures between the inspection organisation and the notifying agency, the BARPI in France, operate in the strict respect of the texts and enable the feedback to be compiled in a database that is as rich as possible.

The use of existing but updated tools, the accident sheet for example, reviewed and reduced to 2 pages for easier completion while still remaining efficient, will contribute to the detection of the accident situations concerned (the sheet is enclosed in your dossier). In these cases, more intense dialog must be initiated between the DRIRE and the BARPI.

In conclusion, the improvement of quality and the enhancement of our exchanges internally well as internationally, and further recourse to feedback for the traditional and daily tasks, form a wealth of means which can be used to enhance the quality of our efforts.

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Since the BARPI was created in 1992, **José Mansot** (Director since 1999) has participated considerably in the implantation of accidentology feedback in France, and the organisation of exchange forums including you, dear colleagues, within the scope of the IMPEL programme. Thank you for your hard work!

As Mr. Mansot was called upon to fulfil other functions, **Mr. Denis Dumont** is now in charge of coordinating the BARPI missions. I am sure that his field experience in the inspection of regulated facilities will assist him in understanding the inspector's needs. We are counting on him to further develop the distribution of feedback and to continue organising our seminars.

I now hand the podium over to him. I hope that the 2000 edition of the IMPEL Inspectors Days may be the occasion for numerous exchanges and contribute to the progress of our missions for enhanced environmental protection.

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VCM leak in a chemical plant.
Solvay in Tavaux (39 - Jura)
August 25th, 1999

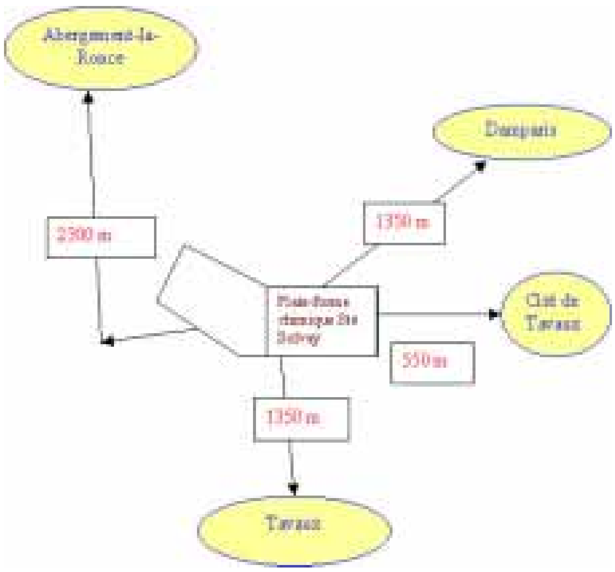
PART OF THE PLANT INVOLVED

The SOLVAY Company is located in the 3 communes of Abergement-la-Ronce, Tavaux, and Damparis, near the city of Dole (Jura – 39). Created in 1930, the establishment covers 100 ha and currently employs slightly less than 2,000 people on-site and groups together some 700 jobs in various service providing companies.

All of the platform's manufacturing operations are based on the transformation of salt into chlorine by electrolysis, which is used to make 3 plastic materials on site :

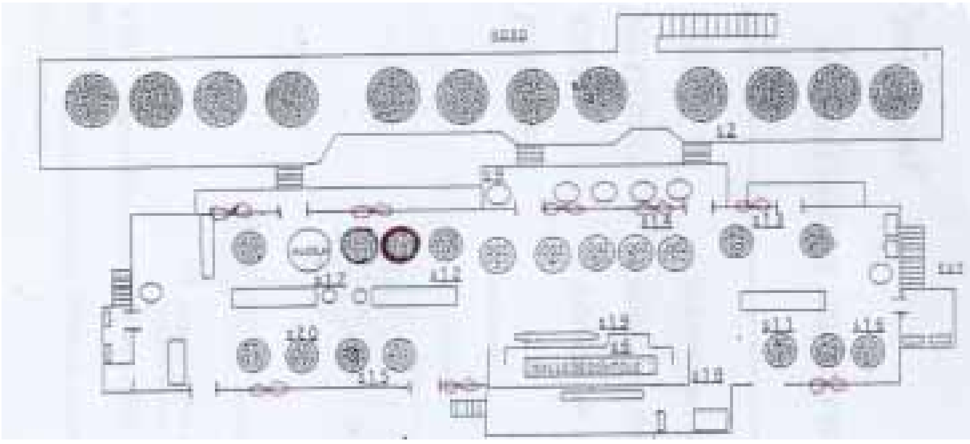
- polyvinyl chloride (PVC),
- polyvinylidene chloride (PVDC),
- polyvinylidene fluoride (PVDF).

This operation is a high-risk establishment containing 8 installations which fall directly under the Sevesco directive. The establishment benefits from authorization orders which, on the one hand, set the general operating conditions for the entire operation and, on the other hand, regulate the fifteen or so installations which exist on the site. A POI ("Plan d'Organisation Interne", internal contingency plan) was drafted by the operator. An associated PPI ("Plan Particulier d'Intervention", emergency response plan) was established in 1992 and was revised following an exercise conducted in 1995.



The enclosed diagram shows the remoteness of the various communes in relation to the plant. Community planning control is assured by the Tavaux and Damparis POS ("Plan d'Occupation des Sols", land-use plan) and the Abergement-la-Ronce PIG (Plan d'Intérêt Général", general interest plan).

The installation concerned by the accident is the PVC manufacturing facility, itself including 3 workshops. Workshop P69 corresponds to the polymerisation of PVC by a "suspension" process. In order to better understand the progression of the accident, this process is detailed below.



Production is carried out in a discontinuous manner, by "batch", with the reaction taking place in dual-casing autoclaves (a stainless steel tank and steel casing) having a volume of 27.5m³. The shop includes 13 autoclaves of this type. The reaction takes place under a pressure of 6 to 9 bar and at a temperature from 40 to 70°C.

The principle phases are as follows:

- Π demineralised water and dispersing agents are loaded into the autoclave,
- Π agitation,
- Π the autoclave is closed and placed in a vacuum to remove the oxygen,
- Π 10 tons of vinyl chloride monomer (VCM) is loaded into the autoclave,
- Π preheating to the polymerisation temperature by circulating hot water in the dual casing,
- Π polymerisation at constant temperature and the addition of reagents,
- Π depressurisation and transfer from the reaction environment to a different tank,
- Π the autoclave is placed under vacuum,
- Π degassing of the residual VCM,
- Π prior to the launch of a new production cycle, the autoclave is opened by the manhole and cleaned using water at high pressure.

Considering its importance in the train of events, further information is provided about the autoclave's closure mechanism (see photo opposite).

It consists of a pivoting system comprised of the manhole cover and an adjoining elbow-shaped tube section enabling the autoclave to be connected to the overpressure protection system consisting of a rupture disk and a valve mounted in series. A seal is required at 2 levels: one seal is located at the cover/manhole junction, and the other is located at the junction between the elbow tube and the stationary overpressure protection pipe. Two jaws, one at each level and actuated by a lever, ensure the overall tightness of the device.

THE ACCIDENT, ITS DEVELOPMENT AND CONSEQUENCES

On August 25th, the unit in question was operating normally. The chain of events which characterizes the accident and how the accident was handled is presented below:

-7:30 pm: A leak is detected on the autoclave at the start of the polymerisation phase.
Poor visibility in the workshop does not allow the origin of the leak to be determined.
Nitrogen is injected to inhibit the reaction in the autoclave.

- 19h30 to 19h40 pm:
The operator checks the concentration VCM in the atmosphere using portable devices in the immediate proximity of the building involved in the accident.

- 7:32 pm: Detection of more than 1,000 ppm of VCM in the polymerisation hall by the monitoring probe.

- 7:35 pm: Location of the leak which is located on the tube connection the roof of the autoclave to the rupture disk.

- 8:02 pm: Preparation of a foam injection operation in order to reduce the risk of explosion inside the polymerisation hall.
Activation of the POI ("Plan d'Organisation Interne", internal contingency plan) due to the flammable characteristics of the gas emitted.

- 8:55 pm: The decision is made to transfer the contents of the leaking autoclave to the neighbouring, empty autoclave.

9 to 10 pm:
Additional measurements of the concentration of VCM performed at various locations of the establishment, outside the polymerisation hall.

- 9:10 pm: The transfer operation is started.

- 9:40 pm: Depressurisation of the leaking autoclave to atmospheric pressure. The chromatographs record a rapid decrease in the VCM content in the polymerisation hall.
Improvement of visibility in the hall enabling intervention by an operator and a fireman: the report that the jaws of the closure system on the autoclave/rupture disk junction are loose.
The jaws were put back into correct position after having bent the safety rod (preventing the closure manoeuvre).

- 10:00 pm: Leak under control and transfer complete.

- 10:05 pm: The internal contingency plan is lifted.

As far as the consequences are concerned, the accident claimed no victims. The leak did not result in a fire or explosion.

VCM is a highly flammable and explosive substance. In addition, it has proven carcinogenic characteristics. However, the acceptable effects on human heath were not defined in France at the time of the incident.

ORIGIN, CAUSES AND CIRCUMSTANCES OF THE ACCIDENT

The main conclusions of the inquiry may be resumed as follows:

- The launch of the operation was prepared normally and the operator began the habitual procedures, particularly the closure of the autoclave.
- The operator believes to have closed the autoclave but in fact forgot to tighten the jaws of the previously described mechanism.
- The launch of the vacuum operations, the loading of the product and the following phases were carried out: polymerisation began.
- The leak did not occur immediately: only when the pressure was sufficiently high, that is to say at the end of the heating phase, the leak occurred suddenly at the "quick" junction. The mechanism remained in place although the seal slipped out of its housing causing the leak.
- The VCM spread through the workshop …
- Then it spread to the exterior via the facility's mechanical ventilation system.

ACTIONS TAKEN

The regulated facility inspectorate carried out their inspection the next day. The operator was questioned about various subjects, including the exposure of the surrounding population to VCM. Beyond its flammable characteristics, VCM is also classified as carcinogenic (category 1 in the European classification, group 1 as per the CIRC - category F+; risk phrase R12-45. It is thus important to have a study relative to the consequences on the surrounding population.

In other respects, the BARPI (Bureau for Risk and Industrial Pollution Analysis is requested to conduct a search of previous accident. A list of accident of the same type were transmitted.

The same day, the inspectorate proposed a draft order in accordance with the emergency procedure, requesting:

- that a study be conducted on the consequences of the emissions generated in the environment,
- that a study be conducted on the precise circumstances of the accident in order to determine the causes as well as the means to be implemented to prevent such situations from happening again.

Further to the first study, a third-party expert, the INERIS, was asked to perform a critical analysis. The analysis dealt with the study estimating the consequences and, on the other hand, on the study of the dispersal itself and the conclusions presented.

In its conclusions, the INERIS indicated that the concentration of VCM remained well below the LEL (in the order of 10 times) for the entire room. In these conditions, a homogenous volume occupying the entire volume of the polymerisation hall could not have formed. On the other hand, the critical concentration level (between LEL and UEL) was a most certainly reached. There was not, however, a fire.

As far as the toxic hazard is concerned, the conclusions are as follows: the most credible estimation of the leak takes into account a quantity of 6,100 kg of VCM released. The calculations show that the population located in the first homes downwind, approximately 1,350 m away, were exposed to concentrations in the order of 3 to 5 ppm for a period of 2 hours. In the worst-case scenarios, the concentrations calculated give maximum values in the order of 50 to 80 ppm.

The expert estimated that "the risks for the heath of the persons exposed is negligible".

LESSONS LEARNT

In response to the reported human failure, a mechanical device was installed by the operator. It now detects where the not the jaws are actually tightened during the autoclave vacuum operation.

The device and the corresponding procedures were in place as of late 1999 on all of the autoclaves of the same type and operating discontinuously (by batch).

Thought was given to the autoclaves of the other "close process" manufacturing units and which are opened less often. The operating procedures have been completed and now include tests prior to pressurization and depressurisation before the introduction of products in to the reactors. The deadline objective was set for May 2000.

Thought was also given concerning the modification of intervention plans in order to integrate the feedback elements collected after the incident.

This text is a summary of Dominique Vanderspeeten's presentation.

Fire and explosion in a chemical plant Manerbio (Italy)

February 19th ,2000

PART OF THE PLANT INVOLVED

The company where the accident occurred is located in Manerbio (Brescia) and manufactures pesticides and other products (drug products). In light of its activity and products stored, the company is subject to the Seveso 2 directive.

The accident occurred in the pendimethalin production unit (pendimethalin is an active ingredient in the manufacture of a selective herbicide). The manufacturing process consists of the following phases :

- φ mononitrification,
- κ alkylation of 4-nitroxylene,
- λ denitrification of the intermediate chemical,
- μ purification and washing of the pendimethalin.

The fabrication process takes place in 3 buildings in the following manner:

_ in building 1, denitrification and recovery of nitric acid,

_ in building 2, mononitrification of orthoxylene, purification of the pendimethalin, 1st and 2nd distillation operations.

_ in building 3, reduction of 4-nitroxylene.

THE ACCIDENT, ITS DEVELOPMENT AND CONSEQUENCES

On February 19th at approximately 2 am, the nitric acid concentration unit exploded. As of June 2000, the inquiry is not yet finished although the scenario is most likely as follows:

_ An explosion occurred on the lower part of the distillation column and the associated heating tank.
_ 2 tanks are located not far away: one containing nitric acid (40% solution) and derivative products resulting from cleaning the distillation column. The other was empty. The explosion caused the acid tank to be projected against the other tank. The full tank suffered damage (cracks) due to projectiles from the explosion and began to leak.
_ A fire was reported in the zone where the explosion occurred: the flames reached heights of several meters.

_ The smoke column from the fire reached twenty or so meters and, due to the wind, was directed toward the highway nearby.
_ The residual products from the process as well as the products contained in the tank were diluted by the fire-fighting water, and then were drained into a treatment container prior to discharge.

According to the company, the quantities involved in the accident were as follows :

_ 1,000 to 1200 litres of nitric acid mixture (30 to 40%) / organic substances in solution: these were products contained in the distillation column and the associated heating tank. The volume of the piping is approximately 300 litres.
_ The nitric acid tank contained 6,000 litres of acid and a small quantity of diluted organic substances. However, the organic fraction consists of nitro-pendimethalin, nitrous pendimethalin and pendimethalin which are classified as harmful and toxic products.
_ In addition, the establishment also uses substances which are classified as very toxic, such as hydrofluoric acid.

The consequences were particularly visible in building 1; buildings 2 and 3 were only indirectly damaged by projectiles from the explosion (a few pieces of equipment and structures damaged). The control room was damaged (exterior walls damaged as well as the windows and ceilings) as well as the fire-protection pump room.

The accident claimed no victims.

On the outside of the establishment, damage was visible over a perimeter of 400m: this damage was essentially windows broken by the shock wave and facades damaged by flying projectiles.

As far as the cloud is concerned, which was apparently comprised of combustion products from the insulating materials covering the surrounding structures, its diffusion into the environment was no longer apparent as of 4:30 am, as reported by the competent authority.

ORIGIN, CAUSES AND CIRCUMSTANCES OF THE ACCIDENT

An inquiry was ordered to clarify the exact causes of the accident and the installation was sealed. However, after the initial meetings with the operator, it was indicated that just prior to the explosion, the shift operator observed a sudden increase in pressure. This allows us to suppose that there was an uncontrolled reaction that developed within the process which then lead to the explosion.

ACTIONS TAKEN

An administrative inquiry has been started as well as a judicial inquiry conducted by the Brescia authorities.

LESSONS LEARNT

Any lessons to be learned will only be available following the completion of inquiries currently in progress. At this time it is too early to make any formal declarations.

The text is a summary of ioren o Damiani's presentation

Fire Incident in a Multi-Purpose Plant (Germany – North Rhine-Westfalia State) 1997

PART OF THE PLANT INVOLVED

The following incident took place at the low pressure hydrogenation unit of a multi-purpose plant. In the plant a variety of organic substances are produced by chemical reactions, e.g. hydrogenation.

The plant was subject to licence according to German Federal Immission Control Act and basic obligations of the Hazard Incident Ordinance had to be fulfilled. Therefore a safety analysis has not been proved.

The process unit affected by the incident was a two step production of an organic substance. In the first step a hydrogenation of phenyl acetyl carbinol with benzyl amine in a isopropyl alcohol/water mixture by means of a catalyst was carried out. In the second step the catalyst is removed and the hydrogenation of the solution goes on.

THE ACCIDENT, ITS DEVELOPMENT AND CONSEQUENCES

At the moment the incident occurred the operator was preparing the make-up of the first step of the planned hydrogenation. The following scenario took place:

- At 17:04 o'clock : The automatic signalling fire detector actuates. The alarm is firstly transmitted to the gate keeper and then to the establishments fire brigade. At the same moment an explosion occurred.
- At 17:06 o'clock : The establishments fire brigade arrives and begins to extinguish the fire. At the same moment an employee notices that there is a hydrogen flux from the feeding tank to the source of fire. He closes an interlock.
- At 17:20 o'clock : It is noticed that there is a flow of phenyl acetyl carbinol into the source of fire by a broken pipeline. The pump at the tank farm is tuned out.
- At 17:44 o'clock : The fire is extinguished. The fire alarm could be cancelled.

The consequences :

The operator, who was alone in the plant at the moment the incident occurred, got hurt by the fire. His injuries were so heavy, that he died a few weeks later. Between the fire and his own death he was not able to talk to anybody.

Three members of the fire brigade were injured by smoke. They could leave the hospital the same day.

The plant has been destroyed completely. The costs of damage reached several million marks.

ORIGIN, CAUSES AND CIRCUMSTANCES OF THE ACCIDENT

An independent expert group got the task to find out the reasons leading to the incident especially to its tremendous consequences. The job was very difficult because due to the death of the operator there was no witness. Furthermore all operating instructions, print-outs and operation recorders were burnt. So the experts on one hand had to interview the employees working in the neighbourhood and the foreman of the operator. On the other hand they had to do some research about circumstantial evidences.

The stock-taking showed that the operator was preparing the make-up of the first step of a planned hydrogenation.

The stock-taking showed that the operator was preparing the make-up of the first step of a planned hydrogenation.

At the counter for the following substances values were adjusted:

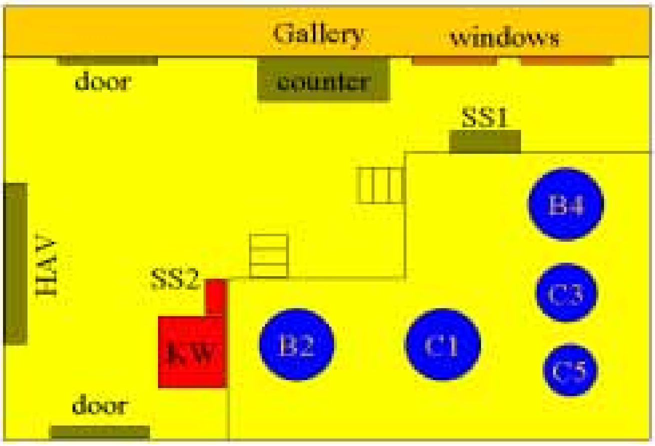
Π phenyl acetyl carbinol

Π benzyl amine

P isopropyl alcohol.

For isopropyl alcohol the allowed value was a little bit bigger than the value adjusted. This means that a small amount of isopropyl alcohol must have been pumped when the pump has been tuned out by an emergency shutdown. The emergency shutdown switch at the counter of isopropyl alcohol has been activated. Before the pipeline for isopropyl alcohol passed the counter there was a bifurcation leading to the catalyst washing plant, an apparatus built out of glass. So there was a change-over from steel to glass in the pipeline. To protect the glass apparatus there were two valves, one in the steel-part of the pipeline and one in the glass-part. In operating instructions it is said that both have to get closed if the glass apparatus is out of operation. But interviews with other employees and with the foreman showed that the valve in the steel-part of the pipeline has never been closed. So the change-over from steel to glass always got the maximum overpressure of 3,5 bar at the begin of pumping.

In the following picture you can have a look to the room the fire occurred.



C_1, C_3, C_5 :	hydrogenation reactors
B_2, B_4:	vessels
SS1,2 :	switch cupboards
KW :	catalyst washing plant
HAV:	main shut-off valve

Evaluation of all perceptions available led to the following most likely scenario:

φ Due to material destruction of the glass apparatus there must have been a release of isopropyl alcohol. The substance wets the ground floor, creates a pool and evaporates. This lead to an ignitible atmosphere which is fired by an unknown ignition source. The operator activates the emergency shutdown at the counter and tries to put out the fire with a halone extinguisher. After having no success due to unknown reasons he chooses an uncertain escape which is located very near the fire source. There he gets hurt by the fire in a tremendous manner.

κ Above the source of fire there was a hydrogen pipeline. Due to the heat of the fire a soldering point of the pipeline fails. Hydrogen is released and an explosion happens.

λ At the broken part of the pipeline a big flame appears destroying the windows in the wall near the gallery. So the manual shut-off valve located in the gallery cannot be reached. Furthermore the hydrogen flame fires with high energy a wall with several shut-off valves. This can be concluded due to burned out valves and leaky flanged.

μ A switch cupboard located in the area of fire influence gets on fire. A short circuit and a fire of the electric installation happens. The pump for phenyl acetyl carbinol misunderstands the signal and starts pumping phenyl acetyl carbinol through a leaky flanged joint into the source of fire. It needs 15 minutes till this is recognised and the pump is tuned out.

As reasonable for the apparatus failure supposed the opened position of the ball valve in the steel pipeline was indicated.

It was not possible to find out the ignition source. The installations of the room were performed in ex-zone 1. Due to regulation it would have been adequate to perform the room in ex-zone 2. Therefore the measures preventing ignition sources were of higher quality as they had to be. The development from a small fire up to such a catastrophic fire accident was an interlacing of several ill-fated circumstances.

Further theories:

1 - Failure of the soldering point of the hydrogen pipeline as releasing incident.

The pipeline had been inspected half year ago. So a sudden total failure of the soldering point is not probable. Moreover there is the kind of fire combat by the operator, it means the use of a manual fire-extinguisher without closing the hydrogen feed before. Also the fact that witnesses gave evidence that the operator got hurt by fire after the hydrogen explosion occurred is a serious reasoning against this theory.

2- Release of isopropyl alcohol at a flanged joint or a leaky valve of the steel pipeline.

Indeed a leaky shut-off valve was found. But it was several meters beside the broken soldering point of the hydrogen pipeline. So it has to be assumed that the leakage occurred due to the heating of the hydrogen flame. To realize the incident progress very much isopropyl alcohol should have been needed. This is only possible by pressing out the whole seal. The seals used in the plant make such a scenario impossible.

3 - Release of solvent from the destroyed catalyst washing plant.

Such a scenario is possible but due to the following reasons not probable:

- An adequate vessel contained contaminated wash solvent. This means that the catalyst washing plant had been discharged.
- The next washing procedure was planned for next day. Therefore there was no reason to fill it again. So it is very probable, that the catalyst washing plant was empty.

4 - Release of methanol from a connecting pipeline to the methanol storage tank.

Though methanol had not been used in the operation concerned there was a methanol pipeline crossing the room the accident happened. But several days before and after the accident no methanol was used in the whole plant.

Indeed after the fire there was an open ball valve but the expert group concluded that this happened due to the fire.

5 - Release of phenyl acetyl carbinol at a leaky flanged joint.

On one hand it is very sure that the flanged joint became leaky due to influence of the hydrogen flame. On the other hand it is not probable that phenyl acetyl carbinol (flashing point 102 °C) released at ambient temperature would be ignited.

6 - Solvent release in the neighbouring room.

In the neighbouring room no signs of fire were found. So this Theory is also improbable.

7 – Fire of electric installations.

On principle this scenario is always possible but in our case not probable. Such a fire progress is not possible without participation of solvents. Fires of electric installations lead to a violent development of smoke and creates a small release of energy.

ACTIONS TAKEN

The incident had been classified as a major accident because

- It was a fire respectively an explosion with great consequences with participation of substances listed in annex II of the Hazardous Incident Ordinance
- One person died.

The incident showed defects or malfunction of the plant the operator didn't take into account before, for example the change-over from steel to glass or the deficiency of plant emergency shutdown. It is most likely that these defects would have been recognized in context with systematic safety analysis. So due to a demand of the competent authority the operator did an accurate safety analysis in context with plant rebuilding.

On the other hand it is a typical incident which lead to its final extent of damage due to bonding of ill-fated circumstances, a kind of internal domino effect. If you take a look to other incidents happening over the year you may see that most of the great material damages correspond with such bonding of ill-fated circumstances.

But it also has to be recognized that the main consequence, the death of the operator, is a direct result of the rising fire. Furthermore this example shows how difficult and speculative finding out of reasons can be. The scenario I presented was the most likely scenario but a rest of uncertainty remains.

LESSONS LEARNT

The expert group worked out the following measures taken into account when the plant was rebuilt sometimes later :

Π Steel pipelines were chosen instead planned glass pipelines. Only if absolutely necessary glass was used.

Π The manual valve in the hydrogen pipeline got a pneumatic drive. This valve closes automatically if the hydrogen detectors give an alarm.

Π Emergency shutdown buttons were installed which can convert the whole plant to safe operation.

Π As you've seen the main reason for the incident was the open valve in the steel pipeline. Now there is an automatic interlocking to prevent erroneous positions of valves. Starting of pumps is only possible if every valve gets the right position due to operating instructions.

Π Additional to quarterly safety training now short talks about safety take place every month.

The text is an extraction of Dr Norbert Wiese's presentation.

Fire wash tank explosion in a hydrazine derivative manufacturing facility
Elf Atochem in Lannemezan (65 - Hautes Pyrénées),
u 11th,1999

PART OF THE PLANT INVOLVED

The Elf Atochem facility in Lannemezan employs 180 persons and synthesizes hydrate from hydrazine and some of its derivatives. The establishment is SEVESO classified for its chlorine (100 tons) and ammonia (500 tons) storage facilities.

THE ACCIDENT, ITS DEVELOPMENT AND CONSEQUENCES

The accident occurred on July 11th at 11:53 am, at the end of an AIVN (Azobis 2 methylbutyronitrile) production series. AIVN is a hydrazine hydrate. This was the 4th production series of this product, each series lasting 2 to 3 weeks. After reaction, the AIVN is recovered using a centrifuge, and then dried.

The wash-water from the centrifuge is collected in a tank then drained into the acid juice pit. As the centrifuge was damaged, the AIVN content in the wash-water was too high. The operator, anticipating that draining the tank would be difficult using the tank's pump, introduced a hose into the tank via the inspection hatch and heated the mixture with steam (128°C) for 15 minutes.

The instructions call for washing with water at 40°C; the AIVN decomposes at 50°C. The decomposition of the mixture began to accelerate and after 70 minutes of latency, with the operator absent (due to a shift change), the tank exploded; the cover, secured by 50 bolts, was ripped off and thrown away by the blast. The decomposition gases spread through the workshop and caught fire, with flashback to the tank. The fire then attained the combustible parts of the unit.

The POI ("Plan d'Organisation Interne", internal contingency plan) was put into action. Combustion of the AIVN stopped 5 minutes later. Total extinction of the areas where the fire started by hot points in the workshop occurred after 35 minutes thanks to the plant's internal fire prevention means. The damage (10 MF) concerns primarily the equipment in question (tank, centrifuge, belt filter…) and combustible materials (electric wiring, PVC piping…).

No one was injured; the 2 individuals normally present during the operation had left (shift change between 11:45 am and 12:00 pm). The workshop was 50% destroyed and all derivative manufacturing operations were suspended. The accident had no environmental consequences.

ORIGIN, CAUSES AND CIRCUMSTANCES OF THE ACCIDENT

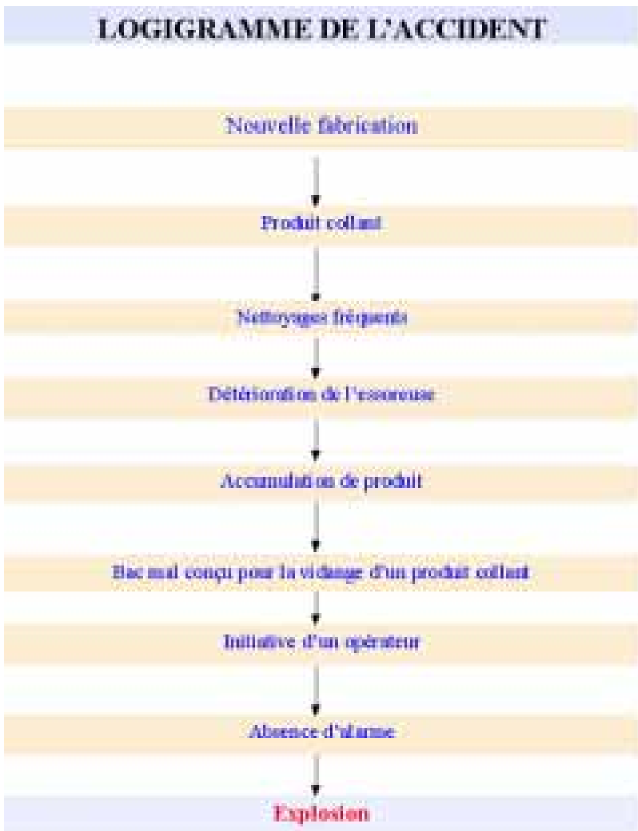
There was abnormal accumulation of AIVN in the tank considering the wear of the centrifuge fabric (sheet ripped). The accident occurred on a new fabrication using an existing production line.

The safety manual had been compiled by analogy with the product previously manufactured (AZDN), although the latter was less tacky and less abrasive than the AIVN. Having anticipated pumping difficulties, the operator replaced the hot water washing operation by heating the solution with steam, causing the temperature of the tank to rise to a temperature greater than the AIVN's self-accelerated decomposition temperature. The self-accelerated decomposition temperature is 85°C for AIVN in powder form and 50°C in this case (AIVN in blocks).

The rinsing water formed a buffer until depletion by boiling; the rise in tank pressure thus caused the cover to rupture and be projected into the air. The combustion of the AIVN was incomplete as it was very avid for oxygen, causing a significant blacking carbon deposit. It can be affirmed that the AIVN decomposition gases exploded then caught fire with flashback to the tank as the internal surface of the cover shows no sign of deposit while the inside of the tank is entirely black.

There are thus 3 simultaneous causes for this accident :

- Accumulation of the product in the tank due to the deterioration of the centrifuge caused by the abrasive character of the AIVN.
- AIVN is more tacky than AZDN (product previously manufactured). The tank designed for AZDN was not suitable for the production of AIVN. The preliminary hazard analysis should have certainly identified the differences between the 2 products. The safety mechanisms existing for the AZDN could have been completed.
- There was excessive heating of the tank as a result of these 2 abovementioned causes and the initiative of the operator, ignoring the hazards involved with this manufacturing operation.



The absence of an alarm and temperature measurement should also be noted.

ACTIONS TAKEN

The procedure for shutting down the AIVN manufacturing operation was not adequately precise, particularly concerning the tank drainage operations. This procedure was still undergoing tests for a production cycle that had just begun (4th series). This was the second accident in less than one year, due to the unfortunate initiative of an operator associated with a weakness in the safety organization.

In consideration of the above findings, a prefectorial order was issued 07/23/99 conditioning the restart of the derivatives facility upon the presentation of a safety study and manual for AIVN. The study must include an analysis of the accident's circumstances and causes, the measures to be taken to ensure that an accident of this type does not happen again and to ensure production in safe conditions (to avoid product accumulation), a reliability study on the operation of the AIVN fabrication activity with the establishment of recommended safety measures. Prior to 11/01/99, the operator must conduct a study of the decomposition hazards and establish measures to be taken relative to all the derivatives produced at the site. General awareness-raising actions must be taken with the personnel relative to safety (strict respect for procedures and instructions). The activity will only be allowed to resume after regulated facility inspectorate has issued its report relative to the study on the AIVN process.

The inspectorate reports the disregard for certain provisions of the prefectorial authorization order regulating all of the site's activities.

The proposed safety manual includes the following points :

- Reduction of the sticky characteristic of the AIVN. This property is a result of the impurities produced during the process. The manufacturer plans to optimise chlorine consumption, to improve the purity of the Cyanhydric MEK by changing the supplier, and to increase its introduction speed in order to improve yield.
- Search and elimination of accumulation zones (examination of all product lines, vent and effluent). The design of the wash-water recovery tank must be reworked: addition of an agitator, temperature and pressure control, explosion vent and the workshop roof with conical bottom. A new vent recovery line must be installed: removal of high points, hot-water cleaning is replaced by cleaning with pressurized water.
- Temperature monitoring resulting in modifications on the safety devices to be installed.
- New instructions and training for the personnel about the specific hazards related to the decomposition of unstable products.
- Complete safety analysis.

LESSONS LEARNT

Characterized by a flaw in procedural control, the accident was due to the insufficient study of the safety conditions related to the new fabrication. The existing production line was used without modification even though the products manufactured have different characteristics (AIVN is more sticky and abrasive than AZDN; the AIVN has an accelerated decomposition temperature). Furthermore, the operator's misunderstanding of the process and the hazards associated with the fabrication of this product were at the origin of an unfortunate initiative on his part. It is thus important that the personnel be informed of the specific hazards concerning the production under his/her control, and that the specified procedures and instructions be followed.

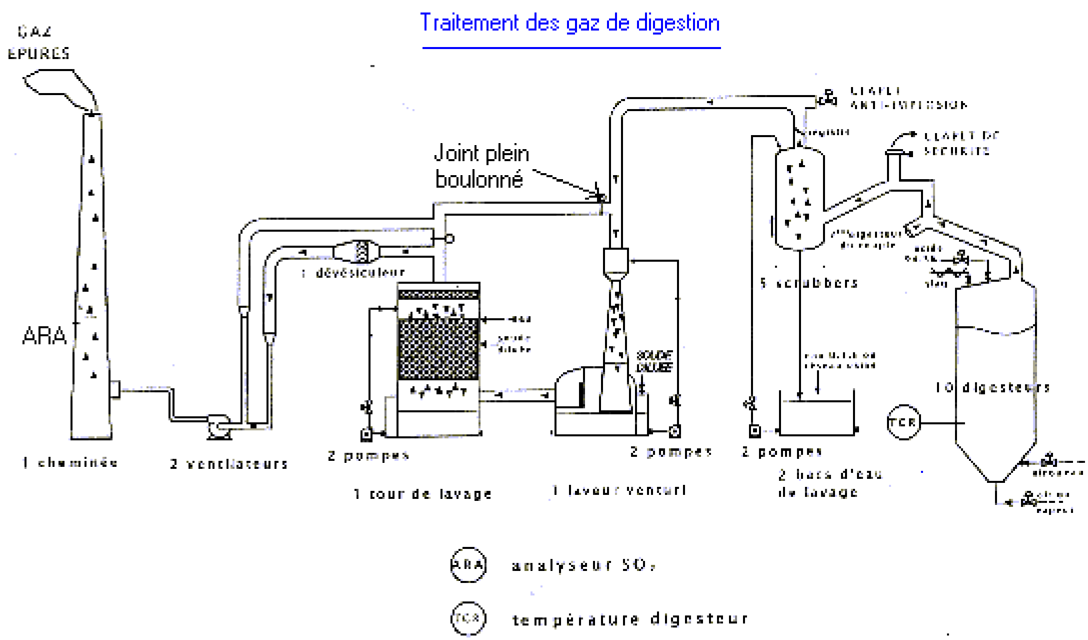
This text is a summary of aude De mas's presentation.

Cloud of toxic gases coming from an ore digestion unit,
Tioxide Company in Calais (62 - Pas-de-Calais),
t 9th, 1999,

PART OF THE PLANT INVOLVED

The Tioxide Company employs 420 persons and manufactures titanium dioxide pigments. The site consists of two parts: the manufacturing facility itself and the aqueous effluent treatment facility commissioned in June 1993. The digestion unit, in which both accidents occurred, is located near the manufacturing facility.

The digestion operation consists in treating titanium ore with acid (H_2SO_4). The gases produced by this reaction (SO_2, SO_3 and H_2SO_4 droplets) are scrubbed through a water cleansing operation and two soda washing cycles.



THE ACCIDENT, ITS DEVELOPMENT AND CONSEQUENCES

The accident of September 3rd, 1999:

At around 5:25 am, the automatic control system which manages the atmospheric releases from the digestion unit went out of service, consequently interrupting the treatment of gases generated by the manufacturing facility. The untreated gases left the building via a valve located on the roof as the reaction could not be stopped. The reaction is self-sustaining beyond a certain temperature (exothermicity). The quantity of gases released is estimated at 600kg, over a period of 45 minutes. An irritating cloud was noticed by a passer-by on the Calais eastern ring-road. Having been alerted, the fire brigade arrived at the Tioxide site at around 5:45 am while attempts were being made to implement the free-phone alert network without success.

The accident of November 9th, 1999:

A power outage occurred from 8:47 to 9:27 am, causing the gas suction and treatment installation to shut down. As during the accident of September 3rd, the safety valve opened allowing a thick cloud to be emitted (approximately 600kg of gas) which was noticed in the vicinity from 9:00 to 9:30 am. Children at a neighbouring school complained of respiratory difficulties without the causal relationship being established.

In both cases, a digestion cycle was lost. Modifications are estimated to cost several million francs.

ORIGIN, CAUSES AND CIRCUMSTANCES OF THE ACCIDENT

During the first accident, the gas treatment and digestion unit's automatic control system failed following a short circuit caused by the poor condition of the electrical wiring. During the second accident, there was a general power failure. Both accidents caused the gas treatment unit (extraction fans + pumps) to shut down, causing a pressure increase in the digester as the reaction could not be stopped. The digester's safety valve thus opened allowing untreated gases to be released into the atmosphere.

ACTIONS TAKEN

An emergency prefectorial order was initiated November 10th, 1999 (accident report, supplemental danger study, measures to be taken). Disregard for the provisions of the prefectorial order of 11/25/94 was noted. In order to prevent these events from happening again, the regulated facility inspection organization proposed that the company be required to perform a detailed analysis of the causes of the accident within 8 days and to update the site's danger study within two months, taking into consideration the electrical power failure, water supply and transmission systems, and to propose means adapted to avoid all risks (power generators, scrubbers,…) as well as the installation of detection systems which would be efficient even in the case of a power failure.

LESSONS LEARNT

These two accidents show that the company did not implement sufficient means to mitigate the consequences of an electrical power failure. There was a lack of procedural control. The danger study also exhibits weaknesses. The measures foreseen by the operator to prevent such accidents from happening again are as follows :

_ The site must be backed up by a 20 kV automatic line,
_ Internal emergency power supply for certain installations (pumps, fans, automatic control system),
_ Automatic control systems: different autocontrol system cards for dual equipment (pumps, fans),
_ SO_2 recording backup(out of service after 20 minutes during the accidents).

However, the general automatic control system breakdown remains unresolved.

The text is a summary of aro ine Tain's presentation.

Silane leak and fire in a gas conditioning facility
Air Liquide Europe in Chalon-sur-Saône (71 - Saône-et-Loire),

h th, 1999

PART OF THE PLANT INVOLVED

The Air Liquide Europe site in Chalon-sur-Saône is a storage, conditioning and unloading centre of gases primarily used in the high-technology electronics industry (the manufacture of semi-conductors).
The gases used at the site are grouped into four main categories:

- hydrides (silane, arsine, phosphine, diborane,…),
- corrosives (chlorine, hydrogen chloride,…),
- fluorinated gases (hexafluoroethane, tetrafluoromethane,…)
- organometallic gases (trimethylgallium, trimethylaluminium,…) which are only stored.
- A fifth category is stored in greater quantities: oxide gases (nitric oxide, carbon monoxide…).

The establishment is located approximately 1,500m from the Chalon-sur-Saône town centre and employs 48 persons. The plant operates under the SEVESO directive for its arsine and phosphine storage facilities.

The workshop in question was built in 1993 and formed the subject of a specific authorization request file which resulted in the prefectorial authorization order of July 22nd, 1993. The request concerned a white room to avoid pollution during cylinder connection and disconnection operations. The gases concerned by the authorization were silane, phosphine and the CF4 type fluorocarbon compounds. The workshop was used only for conditioning silane and, in light of the quantities used, it was not subjected to a section in the nomenclature.

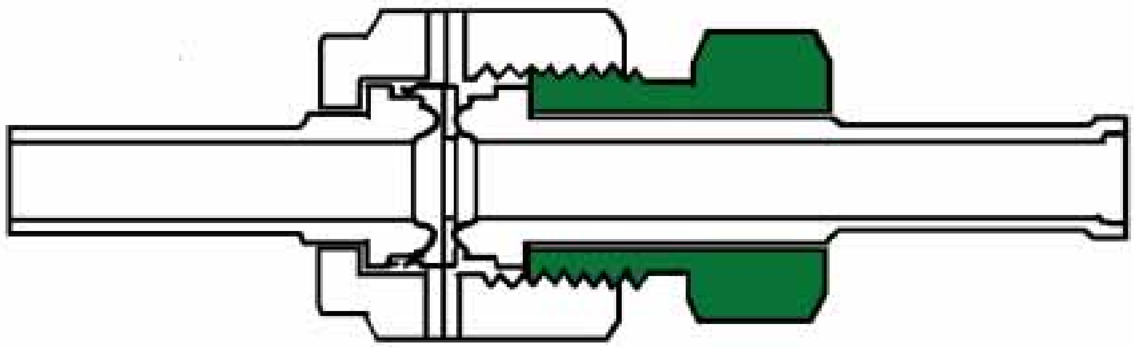
THE ACCIDENT, ITS DEVELOPMENT AND CONSEQUENCES

At about 9 am on March 30th, a fire was reported in the white room of the silane workshop. The fire started during the filling operation of 16 silane cylinders from a bank of high-pressure cylinders located outside. An alarm was then sounded following the detection of a silane leak. The operator activated the emergency shutdown which closed all of the automatic valves. No fire was observed. The operator then closed the two manual supply valves on the bank of cylinders. A second operator who was observing the white room via the observation hall observed two small symmetrical flames develop after approximately 1 minute (typical of a

VCR connection) on one of the cylinders. These two flames grew then set the interior of the laminar flow hood on fire without explosion. After fifteen minutes, thick smoke filled the white room. The electricity was cut to spray down the latter which caused the ventilation to shut down. The fire brigade arrived at the site 20 minutes later, broke the observation hall window and opened the doors to gain access. The natural ventilation of the air revived the fire. The fire was brought under control after a half hour, except for the silane fire as some of the cylinders had ignited leaking silane gas at the neck. The intervention lasted more than 8 days, until April 7th at approximately 4 pm. At this time, all of the silane in 16 cylinders located in the white room had been released and the entire installation inside the workshop was secure. The accident had no consequence on the environment nor on the population or the personnel. Equipment damage was significant: the direct losses associated with the refurbishing operations were estimated at 11 MF, and production losses at 15 MF.

ORIGIN, CAUSES AND CIRCUMSTANCES OF THE ACCIDENT

The origin of the accident was due to a defect in the design of the VCR connectors between the gooseneck and the valve on the cylinders. These components consist of parts supplied by different suppliers which lead to guide length differences of the fitting nuts. In some cases, this could lead to a cross threading which may be gas-tight at the time of leak testing but are rather precarious. In certain cases (hammering or humming transmitted by the gooseneck, shocks, vibrations…), the connection may shift slightly and develop a leak.



Représentation schématique d'un raccord VCR.

The cylinders were filled from a bank consisting of two independent half-banks: while the pressure in the system was stabilized at 17 bar, the operator switched from one half-bank to another and set the pressure of the system at the latter's pressure, or 60 bar. The overpressure probably caused the seal on the VCR connector to suddenly burst.

The installation itself is also at issue as it was designed to load phosphine type toxic gases: workshop confinement, dual ventilation and treatment with active carbon gas in case gas is detected. In this case, the silane caught flame spontaneously in contact with the air creating silica which quickly saturated the filters. Due to the confinement of the facility and the interconnection of the cylinders, the fire spread, strengthened by the presence of the hood and its combustible curtain. The temperature was so hot that the false ceiling collapsed. When the water sprinkler system was activated, the electricity was cut causing the ventilation system to shut down and the re-ignition of the fire when the firemen opened the doors. Also, the fire caused the Teflon seal on the cylinder valves to be damaged, resulting in silane leaks on the other cylinders.

ACTIONS TAKEN

It should be noted that the activity actually performed in the workshop (silane conditioning) is not covered by the regulations to which regulated facilities must comply. As the workshop was in compliance with the provisions of the prefectorial order, no official report was drawn up. However, all of the elements which demonstrate insufficiencies regarding the workshop's design, the study of the intervention in the case of accident, and the actions to be taken following the leak test, the inspectorate proposes that the restart of the installation be subject to a new authorization.

LESSONS LEARNT

Causes or the accident :

- Poor installation design (VCR connector poorly designed, poor work station ergonomics).
- Lack of precise and strict organization in terms of the analysis of test results: the day before the accident, during the leak test, a leak was detected on a VCR connector. Leaking during tests occurred frequently and no follow-up was initiated.
- The VCR connectors must be reviewed (parts of the same origin, connector locking…), and leak tests should be given more importance. All of the cylinders must be able to be closed independently and be isolated by a fire protection, response in case of accident must be better studied, and finally, the design of the facility must be reviewed (hood made of non-combustible materials, heat-resistant false ceiling support structure, smoke ventilation triggered automatically upon detection of smoke, and the room must be insulated by a fire-stop door …).
- The consequences of the accident were limited due to the absence of toxic products in the workshop. Even though incorporated in the design of the facility, the operator's choice not to mix toxic and flammable products in the white rooms appears to have been a wise one.

This text is a summary of Yves Liochon's presentation.

Chlorine leak in a gas packaging facility
Air Liquide in Chalon-sur-Saône (71 – Saône-et-Loire),
t 2 th, 1999

PART OF THE PLANT INVOLVED

The Air Liquide Europe site in Chalon-sur-Saône is a storage, conditioning and unloading centre for gases primarily used in the high-technology electronics industry (the manufacture of semi-conductors).

The gases used at the site are grouped into four main categories :

Π hydrides (silane, arsine, phosphine, diborane,…),

Π corrosives (chlorine, hydrogen chloride,…),

Π fluorinated gases (hexafluoroethane, tetrafluoromethane,…)

Π organometallic gases (trimethylgallium, trimethylaluminium,…) which are only stored.

Π A fifth category is stored in greater quantities: oxide gases (nitric oxide, carbon monoxide…).

The establishment is located approximately 1,500m from the Chalon-sur-Saône town centre and employs 48 persons. The plant operates under the SEVESO directive for its arsine and phosphine storage facilities.

The chlorine depot forms the subject of a special autorisation (prefectorial order of July 27th 1999 – section 1138-2).

THE ACCIDENT, ITS DEVELOPMENT AND CONSEQUENCES

The workshop in question is used to condition corrosive gases. On October 27th, at approximately 9:40 am, during a chlorine conditioning operation to a daughter cylinder (B10), a leak occurred on the mother cylinder allowing approximately 4kg of chlorine to escape. The workshop's toxic alarm was triggered immediately. The operator sounded the alarm, closed the valves on both cylinders and, with the leak continuing, left the workshop. The five other operators secured their workstations and also left the premises.

The fire brigade was notified initially at 9:51 am and a second time by two neighbouring companies which were alerted by the smell of chlorine. The P.O.I ("Plan d'Organisation Interne", internal contingency plan) was initiated. The leaking cylinder was transported to a containment facility designed for this purpose. As the room was not completely hermetic, the cylinder was then transported to an isolated sector of the establishment. The remaining gas was purged in a sodium carbonate bath.

The P.P.I. ("Plan Particulier d'Intervention", emergency response plan) was initiated at around 10:50 am, then the P.P.I. and P.O.I. were lifted at around 11:40 am. The operator was hospitalised for observation and was released rapidly with a clean bill of health. The leak had no significant effect on the surrounding population nor the environment. The estimated costs correspond to 2 weeks of production. The workshop upgrade operations total approximately 8 MF.

ORIGIN, CAUSES AND CIRCUMSTANCES OF THE ACCIDENT

The mother cylinder is emptied by reheating the cylinder using a sleeve equipped with an electrical resistance, while the daughter cylinder is cooled by a system circulating a coolant. A 3kw heating sleeve had been ordered to replace the 1kW sleeve in order to increase the shop's productivity. It was being used for the first time and the temperature probe was not correctly positioned to ensure good contact with the cylinder. The mother cylinder was fitted with a safety plug which opens at 75°C. The excessive and uncontrolled heating of the cylinder raised the temperature of the valve to such a point that the fuse melted. The design of the exhaust hood did not allow it to draw off a leak of such magnitude and its ventilation system was not designed to neutralize the exhausted gases.

ACTIONS TAKEN

The manufacturer undertook the following measures: use of the new sleeve was suspended, distribution of a reminder concerning the management of procedure modifications, and extensive reflective thinking as to the packaging procedures, the ventilation of the workshop and its treatment were reviewed.

It does not seem that the company finds itself guilty of a violation. Suspension of the plant's activity was not proposed due to the limited consequences of the accident, the operator's control of the situation and the corrective measures proposed. However, we can conclude that the danger study was insufficient as it did not account for the cylinders equipped with the safety plug. The inspectorate proposes that the operator be asked to thoroughly update the danger study and to reinforce requirements to avoid a new leak, such as the installation of a gas extraction system slaved to the detection system, treatment of the gases extracted by a scrubbing system having at least 99% yield, and verification and retesting of the confinement facility.

LESSONS LEARNT

This accident highlights that the modification project (a new, more powerful heating sleeve) was not adequately analysed to evaluate the consequences. Accidents are often due to the implementation of a poorly controlled modification, even though Air Liquide has a procedure that recommends that a modification project be validated by someone other than the person proposing it, generally by the line supervisor or a member of functional management. It is thus important that a reliable procedure for managing modifications be implemented. It must be able to update the danger study. Thought must also be given to the conditions for triggering the emergency response plan (P.P.I.).

This text is a summary of es io hon's presentation.

Leak of refrigerant gas in a food factory (Coldwater Seafood – Grimsby (United Kingdom) November 11th ,1998.

PART OF THE PLANT INVOLVED

On the 11th of November 1998, there was a leak of refrigerant gas from an air conditioning system in use in a factory in Grimsby, a large town on the East Coast of England The leak set in motion a chain of events which lead to 13 employees being treated in hospital for symptoms that included nausea, headaches, nose and throat irritation and shortage of breath As the local HSE Inspector, I investigated the incident The investigation took some time to complete but eventually resulted in the prosecution of the company which employed the injured workers and which owned and operated the air conditioning system.

The company in this case was Coldwater Seafood (UK) Ltd. This long established company employs approximately 700 people in the production of fish ready meals which are then sold in supermarkets throughout the UK. Several different refrigeration and air conditioning systems are installed in the company's two factories. Raw materials and finished product are stored in large freezers which use ammonia as a refrigerant. Smaller air conditioning systems. are installed in the factories to keep production areas at low temperature. The air conditioning systems use chloro difluoro methane as a refrigerant. A team of people had been given the responsibility for health and safety and this team included engineers, production managers and a full time health and safety officer.

AIR Conditioning System

The air conditioning system from which the refrigerant gas leaked was installed in 1990 by a local specialist company. It was a common type of installation known as a vapour compression system. This means that a refrigerant is pumped into an evaporator where it changes state from a liquid at high pressure to a vapour at low pressure. This change of state produces a cooling effect in the evaporator and air drawn from the factory and through the evaporator is cooled before being returned into the factory.

The refrigerant in use in the air conditioning system was chloro difluoro methane which is also known as R22. It is one of the members of the general group of hydro chloro fluoro carbone or HCFCs which are known to be harmful to the ozone layer.

On contact with a naked flame, thermal decomposition occurs and irritant and toxic compounds such as phosgene, Hydrogen chloride and hydrogen fluoride are released. These decomposition products can cause damage to the eye and respiratory tract.

The main motor in the air conditioning system was rated at 30kW and the system contained approximately 120 to 150 kg of R22. The air conditioning system from which the leak occurred was one of several similar systems in use in the factory.

THE ACCIDENT, ITS DEVELOPMENT AND CONSEQUENCES

The findings of the investigation were that :

- Approximately 120kg of R22 had been released
- The R22 had leaked from a small hole in the high pressure pipeline. The pipeline was made of copper and had a diameter of approximately 28 mm. The hole had developed because a water pipe located above the high pressure pipeline had also leaked. The water contained a corrosive biocide which, over the course of several months, caused the copper high pressure pipeline to corrode and eventually to split.
- The R22 leaked from the pipeline over the course of two or three hours.
- R22 is heavier than air and so a cloud sank to floor level where air currents pushed it from the site of the leak and into a different part of the factory. Eventually, the cloud reached a part of the factory where a large industrial fish fryer was in use. The fryer was heated by gas burners. The R22 came into contact with the naked flame of the burners causing thermal decomposition as previously described.
- 13 employees were exposed to the thermal decomposition products which may have included phosgene. Fortunately, extraction ventilation was in use and so the employees were probably exposed to only low levels of irritant and toxic gases. These low levels were still sufficient to produce ill health effects. Some employees required several weeks of medical treatment although, fortunately, none appear to have suffered lasting damage to their health.

ORIGIN, CAUSES AND CIRCUMSTANCES OF THE ACCIDENT

The investigation revealed several weaknesses in the company's procedures for operating the air conditioning system. (refer to each point on overhead) :

- The procedures for ensuring that risk assessments were carried out and reviewed periodically were very weak

  - There were no risk assessments for the operation of refrigeration and air conditioning systems.
  - The health and safety officer had carried out some risk assessments relating to food production activities but, generally speaking, these were only produced in response to accidents or other incidents. Risk assessment was reactive rather than pro-active.
  - The health and safety officer lacked technical knowledge of air conditioning systems and she relied on the engineering department for advice in this area. Unfortunately, the engineering department tended to work in isolation and had not contributed or offered to contribute to the risk assessment process.

- There was no scheme of planned preventive maintenance.

Π No one had been given the responsibility for checking lubricant levels, the level of refrigerant in the system or the condition of pipework. No one was ensuring that parts were being replaced before they became worn.

Π The company which installed the system did send an engineer once a year but he merely cleaned the condenser filter and recharged the system with refrigerant.

Π A senior member of this company told me that he could have provided a planned preventive maintenance scheme. It would have involved his engineers attending site twice a year during which they would make detailed checks on the compressor, the condenser and the electrical control panel. They would also carry out a leak test of the system.

Π There were no arrangements for detecting leaks of refrigerant. A halide lamp was available but no training in its use had been provided. A halide lamp is a simple piece of equipment. It has a small naked flame which will turn green in the presence of small quantities of refrigerant and purple for larger quantities.

Π The engineers who were responsible for the operation of the air conditioning system were keeping very poor records. There were no record of repairs carried out, of how much refrigerant had been used of running hours of the system and there were no diagram or plan showing the layout of the system.

a) Π None of the engineers were trained in the maintenance of refrigeration and air conditioning systems.

Π There was a lack of knowledge within the company about codes of practice such as the Institute of Refrigeration Code of Practice for the Minimisation of Refrigerant Emissions from Refrigerating Systems. This code gives advice on all aspects of design and construction of a system, operation and maintenance, leak detection and training for personnel. The code is recognised by the HSE as setting out good practice in the use and maintenance of refrigerating systems.

ACTIONS TAKEN

My conclusions at the completion of the investigation were that the company had failed to take sufficient precautions to protect both its employees and the environment. By putting employees at risk, the company had failed to comply with section 2 of the Health and Safety at Work Act 1974.

By releasing an ozone depleting substance, the company had failed to comply with Regulation 6 of the Environmental Protection (Controls on Substances that Deplete the Ozone Layer) Regulations 1996. (the Ozone Regulations for short).

The decision was taken to prosecute Coldwater Seafood for failing to protect its employees and the environment.

The HSE will prosecute when :

a) it is appropriate in the circumstances as a way to draw attention to the law and the standards required
b) or where breach of the law has given rise to potential for considerable harm
c) or where the seriousness of an offence together with the generally poor conduct of the offender makes prosecution necessary.

In making our decision to prosecute in this case, we realised that the refrigerant leak had the potential to cause considerable harm to the health of employees, we realised that prosecution under the ozone regulations may act as a deterrent to others whose actions may harm the environment and we believed that the company had not done all that it could have done to comply with necessary standards.

The company was fined £l5 000 for failing to comply with the Health and Safety at Work Act and £4000 for failing to comply with the Ozone Regulations. The HSE was also awarded costs of over £5 000. The company was given 21 days to pay the fines and costs. A number of employees are now pursuing compensation claims and it is therefore likely that the company will suffer further financial penalties.

In court, the prosecution stressed that this was an unusual case in which one incident had not only put employees at risk but had also put the wider public at risk by the potential for environmental damage. The magistrates followed the case closely and took some time to decide on appropriate penalties.

The case received quite widespread media interest. It made the front page of the local newspaper, it was reported on the television news and I was interviewed about on local radio.

LESSONS LEARNT

Lessons have been learned following the investigation and court case.

Coldwater Seafood have introduced many improvements to the way in which they manage refrigeration and air conditioning systems. They began by dismantling all refrigeration and air conditioning systems over a period of months and replacing or repairing parts as necessary. This work cost the company well over £20 000.

A planned preventive maintenance system has now been introduced. A new computer programme has been installed and this is used to record the number of running hours of each refrigeration and air conditioning system. The programme will automatically indicate when certain parts of a particular system are due for maintenance or replacement.

One of the company engineers has now completed a college course on refrigeration engineering. He will be assisted by a specialist refrigeration company who have been contracted to provide expert guidance to Coldwater Seafood. All work carried out by the specialist contractor will be recorded on the Coldwater Seafood computer system.

New leak detection methods have been introduced. A fluorescent dye is now mixed into the refrigerant. Each week, an engineer examines pipework using an ultra violet lamp. If there are any leaks then the dye will fluoress under the UV light. This has already been a success as several minor leaks have been detected over the course of the past 18 months. Electronic leak detectors have been trialled but have not been successful. It has been found that gases other than HCFCs will trigger the detectors. The company still has halide lamps which, together with the ultra violet light, can be used to detect leaks quite quickly.

Extensive records of all leak tests, pressure readings, hours run and all maintenance work undertaken are now kept.
Coldwater Seafoods learned the hard way that plant and equipment cannot be left to look after itself and that if things do go wrong then the impact may be felt well beyond their own factory.

The company also learned a valuable lesson on the nature of risk and the crucial role that risk assessment plays in successful health and safety management. Any incident has the potential to give rise to secondary risks. In this case the leaking water pipe lead to a leak in the pipe containing refrigerant. The leaking refrigerant gas posed no immediate threat to employees. The leak occurred in a part of the factory which is normally unoccupied The risk to employees only arose once the refrigerant travelled through the factory and came into contact with the naked flame. The lesson to be learned is that some lateral thinking is necessary when assessing risk and the assessor must always look beyond the obvious.

Finally, 1 think that, in the short term at least, this investigation and the subsequent prosecution did help in the ongoing struggle to raise awareness of environmental issues. It showed that environmental risk can arise from simple equipment in widespread use and not just from the more obvious causes of environmental damage.

The text is an extra tion of i a eton's presentation.

Leak of a toxic agent
Construction of the Hallandsäsen Tunnel (Sweden)
A 199

PART OF THE PLANT INVOLVED

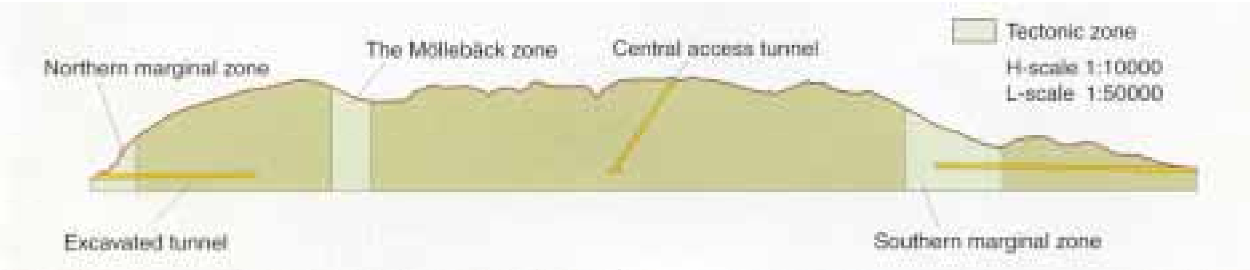
In the summer of 1991, the Government assigned the National Rail Administration to construct a tunnel through the Hallandsåsen ridge in Southwest of Sweden. This project is part of the west-coast rail-link between Gothenburg and Malmö. One of the most difficult passages was the Hallandås so they had do construct a 8,6 km long tunnel (double tracks, with one track in each direction, 25 meters apart). Construction of the tunnel commenced in April 1993 and was due to be completed by December 1996. It was estimated that the cost of construction would be SEK 1, 5 billion.

Construction ceased in October 1997 when approximately one third of the total main-tunnel stretch had been blasted. The reason was high levels of acrylamide from sealing agents in the drain water.

The Hallandsåsen ridge is a primary horst formation consisting of rock with many fissures partly converted into clay. It is considerably more aquiferous than most primary rock formations in Sweden. The ridge and the neighbouring coastal area are considered to be of national interest and are protected by law. The project started using a gigantic drilling machine (TBM) but due to the material in the ridge, that would not be drilled, they changed to conventional methods.

Inflow of water

One of the problems during the construction of the tunnel was the inflow of water that was higher than permitted. This problem started in August 1996. The water rights court granted permission to remove 3,5 litres/second for every 1 000 meters of tunnel. In a few months the outflow increased rapidly and was 40 litres/second at the north side (1 100 meters tunnel) in the summer of 1997.



Sealing agents

In December 1996 the National rail company recommended the constructor to examine alternative chemical sealing agents. More than 80 or so cement-based sealing agents, which were tested earlier did not reach into all the cracks. One of the alternative chemical sealing agents was Rocha-Gil. The chemicals were tested in laboratories for persistens (durability) but not environmental effects in March 1997.

THE ACCIDENT , ITS DEVELOPMENT AND CONSÉQUENCES

The first tests with injection of chemical sealing agents started in March 1997 without any information to the county administration board, or the municipality. 24 June 1997 the sealing agent was used in full scale in 200 meters of tunnel. But no information to the authorities.

On 14 August 1997 when the county Administrative Board and the municipality were informed that Rocha-Gil was to be employed, the municipality decided to ascertain the risks in more detail. After contact with the National Chemicals Inspectorate they sent a letter to the constructors and the railway administration requesting that they would use a less hazardous grouting material. Before this stage was reached acrylamide and n-methylacrylamide had polluted the water in streams, wells and the ground water.

The immediate reason for stopping construction was that the water seeping out of the tunnel had a high acrylamide and N-methylacrylamide contant. The contractor had taken samples of the water following complaints by workers. 26 September fish died in a breading facility in

Vadbäcken, (one of the watercourses into which seepage water was released). The municipality took samples of the water. 30 September three cows that had drunk seepage water became paralysed.

The use of Rocha-Gil was stopped 30 September while we waited for the test results of acrylamide-test in the water. Results arrived 2 October. (The constructor had the results three days earlier, but did not inform the authorities.) The inspector from the municipality Båstad ordered that animal along the brook should be removed so that they could not drink from the water course.

Results of water test showed high levels of acrylamide; 92 mg/l and 342 mg/l N-methylacrylamide in drainage water into Vadbäcken. The cows drank undiluted drainage water. (WHO´s limits for drinking water is 0,0005 mg/l. At this point there were no analysing facilities in Sweden that could analyse in accordance with accredited methods at that level.) Estimated emission to Vadbäcken during 24 hours was more than 500 kg for a few days. The municipality recommended that the water from wells along Vadbäcken should not be used. Samples of the municipal water supplies were taken immediately and preparations were made for transporting water supplies.

5 October municipality Båstad initiated legal proceedings against Rhône-Poulenc (manufacturer of Rocha-Gil), the constructor and the national rail administration. More then ten persons have been summoned on charges of suspected breaches of environmental and working environmental legislation, the water act or the act on chemical products.

The municipality and county administrative board demanded that the construction of the tunnel were stopped. Which it did 7 October 97. And still is. Investigation if it is possible to restart construction is going on and should be ready 1 October 2000 to be decided by government.

THE ORIGIN, THE CAUSES AND THE CIRCUMSTANCES OF THE ACCIDENT

Rocha-Gil has been used since 1950s and, in the last twenty years, in a number of major international construction projects. It consists of two solutions that are mixed with water: acrylamide and sodium silicate (water glass) which is set to a gel. The acrylamide is polymerised and a dense elastic substance is formed. The acrylamide forms long chains bound together to form a three-dimensional network. An accelerator is added to speed up the setting process. Mixing the accelerator, the accrylamide and the water glass incorrectly or diluting too much with water results in a poor reaction, or at worst no reaction at all. If this occurs then traces will remain of the original - and toxic – acrylamide or the speed at which it changes from fluid to solid is reduced..

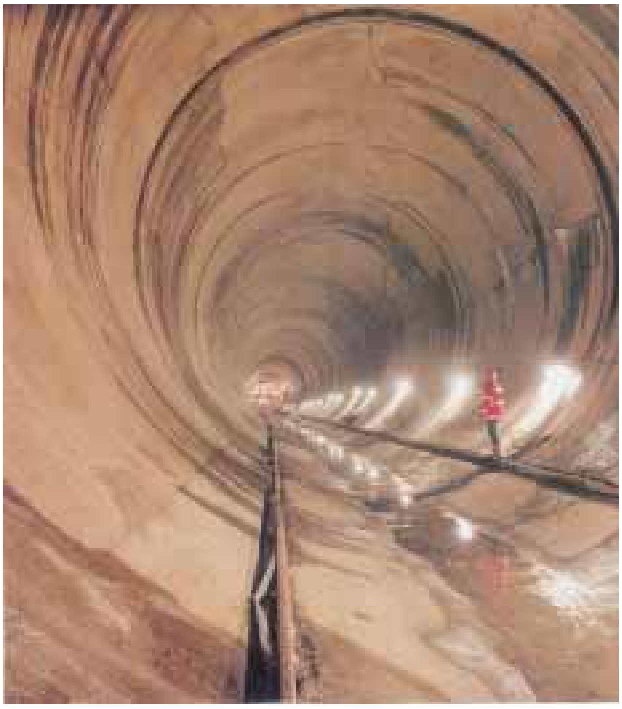
Injection of Rocha-Gil into cracks in rock takes place after mixing but before the gel has formed. As the acrylamide is water-soluble and can be treated as a fluid before it reacts, it can be used as a sealant under difficult conditions. The gel that is formed during the process expands in the cracks, strengthening the agents blocking effect and sealing holes and pores in the rock. The large amounts of water and the high water pressure (15 Bar) in Hallandsås diluted the mixture.

Acrylamide is principally a neurotoxin, which causes damage to the peripheral nervous system, in the event of skin contact or when consumed orally by drinking. There is reason to suspect that acrylamide may cause cancer and hereditary genetic damage. By the time construction ceased, a total of 1 400 tonnes of ready-mixes grouting had been used which, it is estimated corresponded to approximately 140 tonnes of acrylamide and N-methylacrylamide. They planned to use 23 000 tonnes ready-mix!

Media had more than 500 bulletins and lack of correct information via media caused panic in the beginning. In general foodstuffs were not passed as unsuitable for human consumption as the health risks were considered to be too minimal. Even so, with reference to the precautionary principle, the Swedish national food administration, decided that 370 animals (dairy cows, suckling cows, bulls, deer, sheep and horses) were to be slaughtered. In the beginning even the milk (330 000 kg) was poured away. Vegetables and root-crops were dumped and, for a time, growers found it difficult to sell their produce.

20 of the 223 workers who were medically examined immediately after cessation of construction were diagnosed as suffering from peripheral effects on the nervous system, for example in the form of irritation/numbness in their arms or legs.

As far as people living in the neighbourhood were concerned, exposure primarily took the form of polluted water supplies. In all, water from 310 wells was analysed. Acrylamide/N-methylacrylamide was detected in 29 cases. A total of 196 persons from 75 households in the area



were examined. It was considered that people living on or close to the Hallandsåsen ridge had not been subject to any physical health risks.

Since the beginning of March 1998, laboratories have been able to analyse the extremely low levels required in a quality assured manner down to a level of 0,0005 mg/l. The risk zone classification could then be removed. I was unnecessary to maintain the risk zone for such a long time.

ACTIONS TAKEN

Compensation, in total 31 millions SEK, has been paid for slaughtered animals, farming produce which the market rejected, cancelled hunts, damage to business activities, decreased property value and personal injuries. House-owners have been connected to the municipal water network, wells for irrigation hare being drilled, and fencing installed along the Vadbäcken.

Decontamination:	100 million SEK.
Lining of tunnel:	200 million SEK.
New wells for drinking-water:	25 million SEK.
Analyses:	10 million SEK.
Water transports:	15 million SEK.

The environmental inspection group "Miljögranskningsgruppen" 30 million SEK.

The tunnel project is delayed for at least 4 years at a cost of 250 million.

The text is an extra tion of o endt's presentation.

Overflow of petroleum products in a depot CIM in Grigny (91)

September 7th, 1999

PART OF THE PLANT INVOLVED

The CIM company operates a petroleum product depot with a capacity of approximately 85,000 m³ in the city of Grigny, on the banks of the Seine river. The site was commissioned in 1964. Storage capacity is divided among 28 reservoirs each having a capacity between 1,400 and 11,500m³. The products stocked are essentially heating fuel, gasoline and diesel fuel.

As far as supplying the site is concerned, the site is equipped with 2 oil pipelines belonging to the TRAPIL company. One of the pipelines comes from Le Havre (76 – Seine-Maritme) and the other from the ELF refinery in Grandpuits (77 – Seine-et-Marne). Supplying the site by truck is possible. The site is equipped with 20 tanker truck stations.

THE ACCIDENT, ITS DEVELOPMENT AND CONSEQUENCES

The accident occurred as follows:

11:28 pm: The operator finished filling 5 tanks with a volume of 2,640m³ sent by the TRAPIL pipeline. This operation took a total of 28 hours.

Shortly thereafter, inhabitants living near the depot were alerted by a suspicious smell of hydrocarbons. The fire brigade was called and arrived at the scene.

12:00am: Upon arriving at the site, they confirmed that it was necessary to cease using the railways and water routes next to the site, without being able to enter the depot compound.

3:00 am: Upon the arrival of the director of the Essonne Reeve's office, the fire brigade were able to intervene. Up until this time, the local CIM representative had refused assistance from the rescue services. The firemen were thus then able to intervene. They noted that a tank (No. 3 having a capacity of 2,450m³) had overflowed and several cubic meters of unleaded gasoline had been collected in the associated retaining basin. They thus sprayed a layer of foam onto the basin in question.

4:00 am: Termination of the basin covering operation which lasted approximately 1 hour due to the accumulation of various unfavourable configurations: lack of output and pressure on the internal pre-mix network, rupture of a valve requiring partial shut-down of the fire protection system.

The case encountered may be considered as a near accident as it had relatively zero impact on the environment (2 to 3m³ poured into the retaining basin). However, it generated a high risk relative to the exterior which could have escalated into a real accident. The incident provides numerous feedback elements.

ORIGIN, CAUSES AND CIRCUMSTANCES OF THE ACCIDENT

If we examine the transfer operation from the TRAPIL hydrocarbon pipelines to the stationary reservoirs in the depot, the analysis of the situation has shed light on the following operating procedure :

_ In order to prevent internal manoeuvres, the inlet valves of the tanks selected were opened and the tanks linked together,

_ To enable maximum filling of the various tanks, the high and very high level detectors were inhibited. In these conditions, it is clear that the retransmission of alarm signals to the pipeline administrator, the TRAPIL Company, was not possible. As a result, the site was without a line of defence; during normal operation, the TRAPIL Company could effectively stop delivery at any time when an alarm signal is detected.

_ At the end of the operation, the product level evens out by gravity flow from tanks 18, 23 and 24 (these tanks are located at 1.5 m higher than the others although are filled first due to the lower pressure losses on their supply lines). In the case of this incident, it was the difference in level which generated the overflow into the retaining basin of one of these tanks.

_ At the depot organization level, during periods when the depot is closed to customers, the workforce is reduced to 1 or 2 individuals. The transfer by pipeline preferably takes place during this period.

Safe operating procedures were thus downgraded which lead the inspectorate to draft official reports and provide certain proposals.

As far as the protective devices are concerned, the safety operations conducted following the incident and the inspection performed the following day by the regulated facility inspectorate enabled the illustration of the following situation:

_ A modification of the electrical system inside the depot, carried out several months earlier, rendered the electrical supply to the fire-fighting pumps connected on the general electrical network (EDF) to be inoperative,

_ The operator was not able to start the fire-fighting pumps with the emergency power supply (auxiliary power generator),

_ Part of the fire-fighting hydraulic network was not operational. After discovering a leak on a branch connection, the operator had blocked off part of the pre-mix network which thus prevented the injection of foam into 2 storage tanks, Nos.°26 and 27 having a capacity of 2,350 and 3,800m³ (on which the firemen had encountered difficulties during the night).

_ The operator had apparently not detected the problems related to the electrical supplies of the fire-fighting network pumps: a major shortcoming in the organization was thus noted. For informational purposes, it should be reminded that the site is subject to the SEVESO 2 directive due to its storage capacity.

ACTIONS TAKEN

As mentioned previously, an inspection was conducted the day after the incident. The inspectors suspected serious malfunctions following their observations and those of the fire brigade during the night.

The inspectorate officially reported the disregard of several regulatory texts in force at the site (particularly prefectorial orders).

Further to the inspectorate's reports and proposals, the Prefect issued an order requiring emergency measures to be taken. In particular, the operator was requested to cease supplying his depot by the TRAPIL Company until the upper level detectors on the reservoirs and the pre-mix network had been checked and the accident report drafted. Furthermore, the operator was ordered to restore his fire-fighting network to full capacity within 24 hours. In this respect, it was proposed that the fire and rescue services conduct a fire drill in order to test the repaired installations.

LESSONS LEARNT

Once again , the incident called attention to the following points:

Π the alarm management system was voluntarily rendered inoperative,

Π the site's nighttime automated pipeline product transfer systems were manned by a reduced staff,

Π the site's limited capacity generated the crisis: the individuals present initially refused access to the emergency response teams without correcting the problem themselves,

Π the availability of emergency equipment had become insufficient following modifications on the electrical installation and hazardous repairs on the hydraulic installation.

Π The deficient safety management organization had led the operator to not be aware of the deficiencies of his own depot,

Π Disregard for the already rich feedback: 6 incidents are recorded in depots operated by CIM during the last 8 years.

It should be noted that recent regulatory texts insist on the important points on which disregard for regulations were noted: this is the case of the ministerial circular of 05/06/1999 which provides special coefficients for calculating extinguishing ratios in penalizing circumstances such as operation with a reduced workforce.

Furthermore, the ministerial order of May 10th, 2000, which transposes the Seveso 2 directive under French law, requests that the safety management system include near accidents….

The text is a summary of hristian e i and's presentation.

Rupture of a phosphoric acid storage tank
Grande Paroisse SA in Rouen (76 – Seine-Maritime)
April 23rd , 1999

PART OF THE PLANT INVOLVED

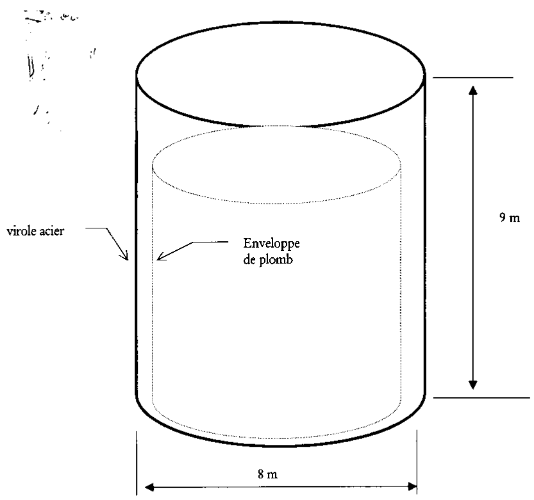
The Grande Paroisse factory in Rouen manufactures fertilizer. The Rouen B facility, where the storage tank concerned by the accident was located, was used within a special context as it was scheduled for shut-down in the short term; the workshops were to be transferred to Rouen A.

THE ACCIDENT, ITS DEVELOPMENT AND CONSEQUENCES

In order to run a production series lasting 3 to 4 weeks per year, the company used a 450m^3 overhead phosphoric acid storage tank. On April 23rd, when the tank has just been placed back into service and contained approximately 350m^3 of product, its casing suddenly ripped. The violent release of the acid cased the concrete retaining basin to rupture. Traces left of an adjoining wall show that the wave was several meters high. Most of the acid spread over the ground and in the bulk fertilizer warehouses. The accident claimed no victims as the accident occurred on a Friday evening.

Upon discovering the accident, the plant watchman immediately closed off the wastewater system with a guillotine valve designed for this purpose. The manager on duty informed the regulated facility inspectorate by fax. Owing to the closure of the guillotine valve, the accident did not cause any pollution.

Cleanup of the accident did not generate waste: all of the liquid recovered was directed into the attack tanks of the phosphoric acid shops of Grande Paroisse's Rouen A facility. All of the natural phosphate which was purposefully spread on the ground to absorb the acid was stored at Rouen B and will be used as raw material in the complex fertilizer production shops at Grande Paroisse's Rouen A facility. The wastewater network remained isolated for several days following the accident, then was flushed into the zone affected by the spread off product prior to the restart of the installation.



ORIGIN, CAUSES AND CIRCUMSTANCES OF THE ACCIDENT

The tank in question was made of a steel casing lined with lead sheeting to ensure a hermetic seal in relation to the structural casing. This tank, measuring 9 meters high by 8 meters in diameter, was correctly dimensioned to contain phosphoric acid at atmospheric pressure. The retaining basin consisted of a slab (thickness: 15cm) and retaining walls (thickness: 15cm at the base, 10cm at the top). The entire structure was made of reinforced concrete. The mechanical resistance at the slab-wall intersection was ensured by two metal brackets made of 10mm steel round stock placed every 20 centimetres. This dimensioning should have resisted the hydrostatic pressure exerted by the tank.

For the follow-up of its units, the company operates an inspection department and a maintenance department. The inspection department had checked the tank in anticipation of its return to service after 8 months of inactivity and reported a lack of material on the first ring of the structural casing. The department recommended that a thorough inspection be conducted to determine the zone of the internal casing which was at the origin of a probable acid leak and to conduct a series of thickness measurements on the external casing in order to determine the extent of the corroded area. In order to ensure a satisfactory seal, the maintenance department decided to add an internal casing made of 6mm-thick polyester sheeting reinforced with an anti-acid skin. On the exterior, the lack of material was compensated by the installation of a metal plate banded onto the tank by two slings. These repairs were subjected to a water resistance test for 24 hours. The tank was placed back into service two days later and the first production operations were launched in the afternoon prior to the accident.

The post-accident assessment revealed the following defects :

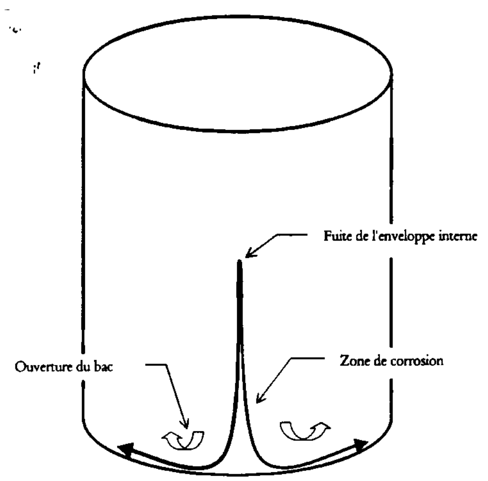
<u>On the 5 rings which make up the cylinder:</u>

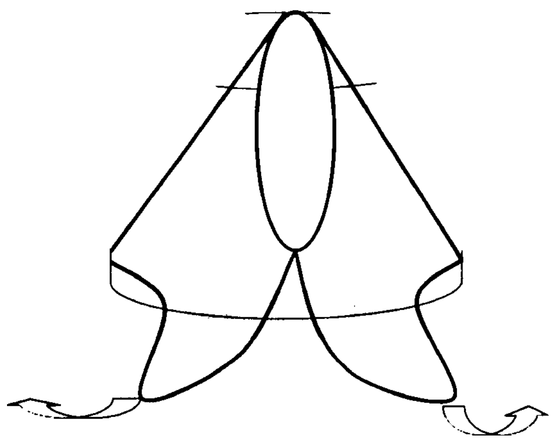
Lack of metal on the generatrix of the lower ring of the structural casing, significant thickness loss on the following three rings along the same generatrix, and a rip in the structural casing along this generatrix.
On the tank floor:

Significant corrosion was noted at the foundation skirt junction level; a symmetrical opening of the foundation skirt junction in relation to the cylinder's corroded generatrix.

There was a failure in the seal which initially occurred on the internal casing at the level of the 4th ring of the structural casing. As both casings were not bonded, the acid leak was routed vertically causing the corrosion along a generatrix and then along the foundation skirt junction. The repair carried out by the maintenance department did not correct the weak point between rings 2 and 4 of the cylinder.

Furthermore, the pressure exerted by the acid is greater than that exerted by the water during the resistance test (1,640 kg/m^3 for phosphoric acid). The rupture occurred suddenly and the wave effect created pressure on the retaining walls must greater than the hydrostatic pressure. In addition, defects were discovered in the concrete reinforcement: the reinforcement bars were not correctly attached.





ACTIONS TAKEN

An emergency action order was initiated which called for the suspension of all site activities. On the one hand, it requested an analysis of the causes and consequences of the accident and ordered, on the other hand, the definition of an inspection plan for all of the tanks and associated retaining basins located on the site. The damaged tank was not returned to service. As the storage requirements for phosphoric acid were limited to 3-4 weeks, the operator wanted to use another tank normally used to stock sulphuric acid. The nature of the internal casing of this tank allowed a product change to take place without risk. Furthermore, this tank would contain only the quantity of phosphoric acid strictly required, or $45m^3$. A certain number of verifications were performed on the replacement tank: inspection of the tank by the inspection department, hydraulic test with water filled to the maximum level, rework of the seal on the retaining basin, external signage on the tank in relation to its new contents. Production operations were resumed in late July 1999. The site was totally shut down in late December 1999 and is currently being disassembled.

LESSONS LEARNT

The special context in which the plant was operating (last production series) did not incite the operator to rigorously apply the establishment's operating procedures. The measures recommended by the inspection department should have been carried out prior to a joint definition of the repair program. The accidents occurred due to hasty repairs which were performed without respect for the existing instructions. As the accident occurred on a Friday evening, there were no victims. The consequences on the environment were limited owing to the guillotine valve on the wastewater network and the fact that the spreading of natural phosphate on the ground to absorb the acid reproduces the same chemical reaction as that implemented in the plant. However, an increase in the phosphate content in the ground and the underground water table was observed requiring the company to add phosphorous to the list of substances for which it monitors the concentration in the water table.

This text is a summary of   atri e   hemin's presentation.

Leak of hydrochloric acid in a storage facility Aventis Company in Villeneuve-la-Garenne (92 – Hauts-de-Seine),

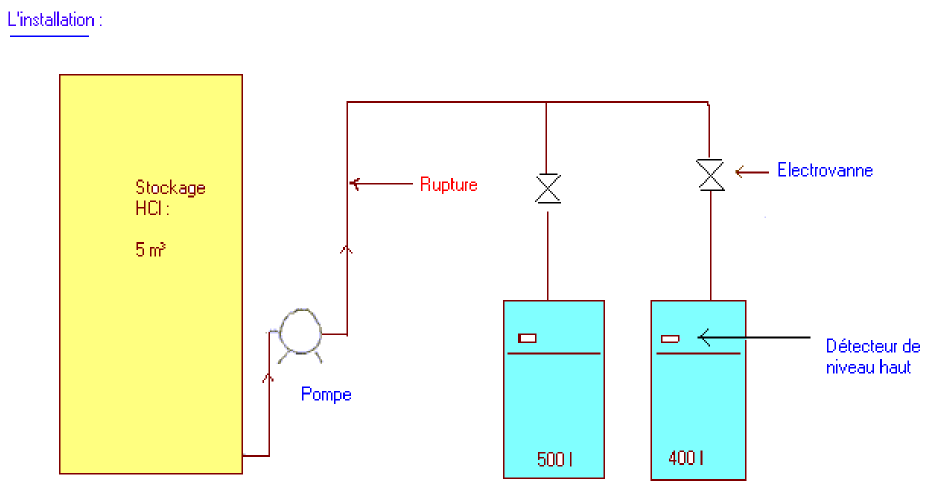
12th, 1999

PART OF THE PLANT INVOLVED

The Aventis Group (formerly Rhône Poulenc Rorer) operates a site in Villeneuve-la-Garenne, north of Paris. The environment is highly urbanized. The facility produces active pharmaceutical ingredients with high added value.

THE ACCIDENT, ITS DEVELOPMENT AND CONSEQUENCES

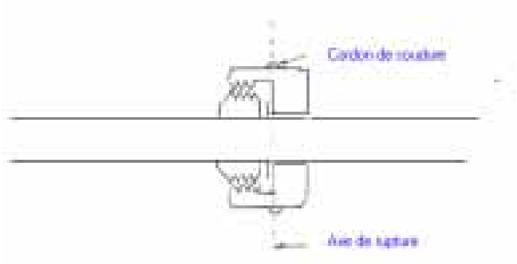
On May 12th, a plant employee noticed a whitish cloud at the facility. The alarm was sounded immediately and the external fire brigade was summoned. The cloud was due to a leak from a 35% hydrochloric acid storage tank used for regenerating ion-exchange resins. Approximately five hundred litres of acid were recovered in the retaining pit with an equal quantity protected outside of the pit onto the concrete slab of tanks located nearby; the resulting desorbing gas formed a fog. A water curtain was established to abate the acid vapours. An employee was able to stop the hydrochloric acid transfer pump and the supervisor ensured that there was no danger outside the plant. The plant's emergency response team set up an extractor-ventilator and spread sodium carbonate on the ground. By the time the fir department arrived, the situation was under control. The accident caused no bodily harm. The cost of the accident is estimated at 700,000 F (installation: 400,000 F, supplementary cost due to 7 months of inactivity: 250,000 F, interventions and meetings: 50,000 F).



ORIGIN, CAUSES AND CIRCUMSTANCES OF THE ACCIDENT

The leaks were caused by the rupture of a 3-piece connector. The latter was broken during previous operations and had been rewelded by the plastics technician. The weld was insufficient and the repair was not reported to the operator.

A similar installation had been used for years without incident. The latter was replaced: a new 5m^3 PEHD tank was made and a new pump installed which held up for only a short period of time. Upon the advice of the installer, a pump with a larger output (100 l/min.) was installed and the installation was modified: a check-valve was installed downline from the pump (hammering protection), and a degasser was installed upline from the pump. The accident occurred more than one month after these modifications were made.



On the day of the accident, the electrician had modified the installation in order to slave the start-up of the pump to the opening of the solenoid valves which feed the two hydrochloric acid tanks. The pump started although the solenoid valves remained closed. The pressure thus began to rise until the 3-piece connection burst.

The pump was over-dimensioned, on the one hand, and the ventilation valve of the device was located too far from the pump (on the storage tank's high level), on the other hand. The pipework support elements were insufficient; there was only one single stop button located near the pump and thus difficult to access.

ACTIONS TAKEN

In order to correct the malfunctions reported, several modifications were undertaken:

The pierced check valve and the ventilation valve were removed.

The PVC piping installed without an inspection of all the welds were replaced by banded PVC pipework: the expert examination highlighted defects at the branch connections on the dome of the polyethylene tank.

The piping was tested at 10 bar for one hour. Hydraulic testing had in fact not been carried out after the installation operations. The remainder of the installation, untouched, was tested at 5 bar for 5 hours. The tank was checked by filling it with water until it overflowed.

Three emergency stop switches were installed allowing the installation to be shut-down remotely.

All of these automatic control systems were checked.

An installation operating procedure was drafted.

LESSONS LEARNT

The accident, and the resulting limited consequences, could have had serious consequences considering the extent of the hydrochloric acid projection.

The design of the modifications must be reviewed as well as the acceptance of works, which is insufficient: there was an initial fault committed by a sub-contractor who "rigged" a repair on a connection instead of changing it, without notifying the operator, then a second error was committed by an electrician who performed an inappropriate modification on the automatic control systems. These two errors, associated with the poor design of the installation (installation of an over-dimensioned pump, insufficient pipework support elements, a single poorly located stop button) and a disregard for the operating instructions, lead to the accident.

This text is a summary of ean hi ippe ernard’s presentation.

Fire in an aerosol container warehouse at a chemical plant
Sico Company in Saint Egrève (38 - Isère),
u 1 th, 1999

PART OF THE PLANT INVOLVED

The Sico Company, created in 1952, employs 66 persons. The company manufactures and packages various types of aerosol containers. The establishment is located in a dense urban zone in an old brewery. A prefectorial order was issued in 1986 authorizing usage of part of the warehouse.

THE ACCIDENT, ITS DEVELOPMENT AND CONSEQUENCES

On July 13th, 1999, at around 5:00 pm, a fire was reported in the 2 basement level of the Sico facility, in the finished product warehouse, consisting of aerosol containers. The fire brigade was called immediately.

A fork-lift driver saw a flash appear under his fork-lift truck and the surrounding atmosphere catch fire. Although only slightly burned, the driver was able to immediately leave the area. Several explosions occurred (BLEVE, "boiling liquid expanding vapour explosion" caused by the aerosol containers); thick smelly black fumes began flowing from the roof and chimneys of the warehouse building which lead to the evacuation of 59 inhabitants.

The resulting smoke and heat complicated the fire brigade's rescue operations. Four firemen were slightly wounded by an explosion, 25 others who were intoxicated by the combustion gases were hospitalised. Eight emergency response centres were mobilized, including 130 firemen and 42 rescue vehicles. The fire was extinguished at around 9:00 pm.

The damage (approximately 5-6 MF) was limited to the warehouse and a few neighbouring buildings: the fork-lift truck and the freight elevator were destroyed, numerous aerosol containers burned (approximately 75,000 units, or $35m^3$ of LPG and flammable liquids), and the electrical installation and fire detection system are out of service. One of the chimneys and the roof are damaged. The fire protection water contained in the establishment's retaining facilities did not cause pollution.

Production activities, which was not stopped, were transferred to the plant's 2nd site.

ORIGIN, CAUSES AND CIRCUMSTANCES OF THE ACCIDENT

A standard-type fork-lift truck was used in a full warehouse. The propellant gas in the aerosol containers was either a propane-butane mixture or hydrofluoro-alcane, so the fork-lift should have been adapted to operation in an explosive atmosphere. If the exact origin of the fire start point is unknown, several hypotheses are possible :

- The fork-lift may have collided with and damaged a pallet causing an aerosol container to fall.

- Damaged aerosol containers may have leaked.

The operator did not detect any odour enabling him to suspect an explosive atmosphere.

ACTIONS TAKEN

The operator was not able to indicate the types and quantities of aerosol containers in storage. A prefectorial order for emergency and protective measures was issued July 22 requiring the damaged installation to maintain permanent security, to remove rubble and polluted waters, and to permanently maintain a precise status report of stocks. The installation will be put back into service conditionally.

A thorough monitoring visit took place on August 13th: a prefectorial order of notice to perform (31 points) and 2 additional prefectorial orders were issued (restart under terms, overall evaluation in terms of the hazard plan). A violation report was drawn up, including 39 reasons :

- the absence or insufficiency of retention facilities
- the absence of impact protection for mobile recipients
- a hole in the fence, the presence of dead ends, and the lack of instructions
- the lack of permanent human surveillance, direct telephone line
- the absence of data relative to stock status…

The removal of polluted water and the elimination of wastes was performed by a specialized company. The burnt facility is no longer in use.

LESSONS LEARNT

The plant is located in a former brewery, the warehouse was extensively filled and the passageways narrow and complex: the facility seemed to be poorly adapted to the activity and its development. The site has experienced 5 fires over the last fifteen years.

Fifteen or so accidents concerning the storage of aerosol containers were recorded in the ARIA database. All present the following common characteristics: rapid spread, very intense heat flux, a fork-lift truck fork. The potential hazards of this type of storage were not sufficiently accounted for.

Equipment and machinery operated in this type of storage environment must be adapted to the explosive atmosphere hazard.

The warehouse should have been laid out better, with sufficiently wide alleys.

The warehouse should have been correctly ventilated and equipped with efficient explosive atmosphere detection equipment.

This text is a summary of hristian a em ier's presentation.

Outbreak of fire in a silo of an agricultural cooperative Lusignan (86 - Vienne),

u 29th, 1999

PART OF THE PLANT INVOLVED

The Centre Atlantique Union Poitou-Anjou Group is an agricultural cooperative comprised of 7,700 members, employs 163 persons and operates, among others, a 40,500-ton storage silo in Lusiganan.

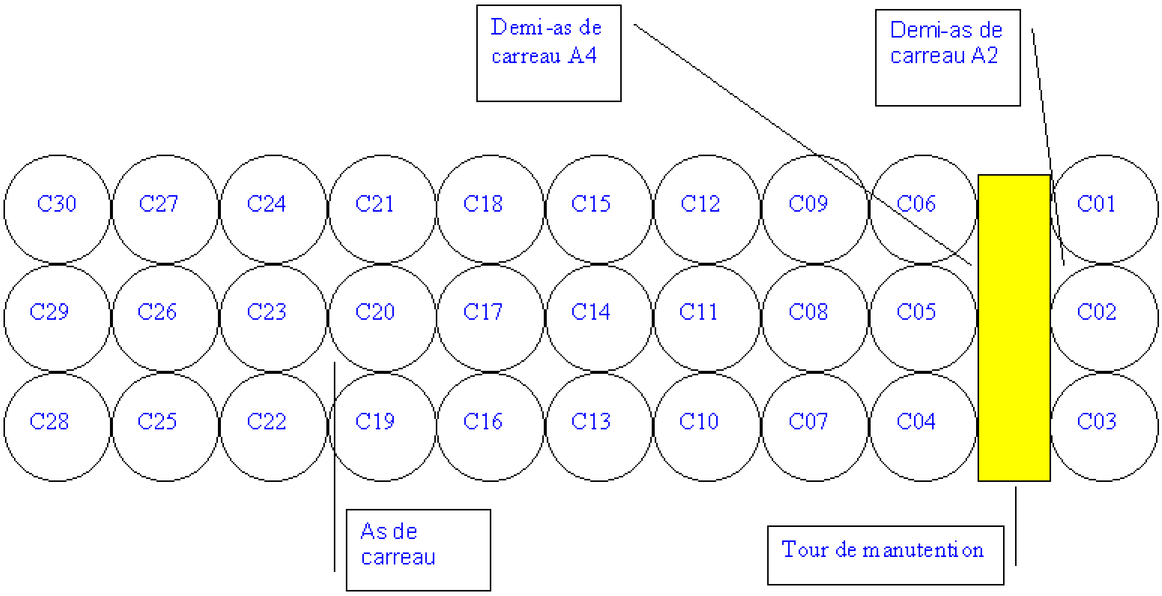
This vertical, reinforced concrete silo consists of 3 rows of 10 cells having a unitary capacity of 1,500 to 1,600m³, completed by 16 "ace of diamonds" (intercellular spaces) measuring 220 to 450m³. The total storage capacity of the silo is 53,815 m³.

The 40m-tall storage cells are closed at the top by a uniform concrete slab. Ten or so hoppers used to transport products are located in the handling tower (60m tall).

The silo was constructed in two phases: the tower and 12 cells in 1974, then an additional 18 cells were built in 1981.

The silo is located 80m from the first third party property and the other installations of the cooperative are located more than 25m away.

The installations received prefectorial authorization on June 6th, 1977.



THE ACCIDENT, ITS DEVELOPMENT AND CONSEQUENCES

At around 10:15 am during one of his regular inspections, the silo supervisor discovered smoke coming from an air purifier. The smoke was not yet visible inside the tower. The decision to shut down the silo was made at 10:30 am.

His diagnosis lead him to the hanging feed tube located underneath this air purifier and to the two half-ace of diamonds located on each side of the tower. The smoke was rather thick although no flames were present. The fire brigade was contacted at around 12:10 pm.

After studying the area, the fire brigade sprayed down the inside of the half-ace of diamonds in question. After opening the lower hatch of one of these half-ace of diamonds, and cleaning out the accumulated sludge, the firemen installed forced ventilation in the cell comprised of a fan driven by a hydraulic turbine (without electricity: explosion-proof equipment).

It was impossible to open the lower hatch of the other half-ace of diamonds. Ventilation was then ensured by natural circulation by removing the drain piping.

The railway hopper was emptied by gravity (handling operations stopped) and the corn was dumped into the cooperative's yard.

A systematic inspection of all of the cells was started by the fire brigade officer in charge of the operation, the site supervisor and the ICPE inspector. Smoke and burning smells once again appeared at the hanging feed tube. In fact, the smoke was coming from the railway hopper which had just been emptied. The firemen then sprayed down the inside of this hopper and left it open to natural ventilation.

Once the smoke had cleared from the hopper, the complete inspection of all the cells is resumed, including the ace of diamonds and the tower equipment. At 7:00 pm, the fire was fully extinguished.

None of the installations were damaged by the fire nor by the firefighting operations (water). The silo was ready to resume operations as soon as the fire brigade has finished their operations and left the site.

ORIGIN, CAUSES AND CIRCUMSTANCES OF THE ACCIDENT

When the smoke was discovered, the 2 cells and the 2 half-ace of diamonds supplied by the hanging feed tube were empty. This was not the case for the railway hopper.

There was still approximately 200 tons of corn in this hopper as a train had been loaded the day before. This is why it was decided to empty the hopper to check the condition of its contents. Nothing on fire was found in the corn. This operation, however, allowed smoke to be discovered in the hopper and a large quantity of dust on its internal walls.

The reason why the fire thus left the feed tube remains unidentified. It then continued into the half-ace of diamonds and the shipment hopper (but not in the 2 cells which were to be filled) due to the ***combustion of the dust accumulated in the bottom and on the sides***.

The dust primarily accumulates on the upper part of the cells (ceiling and walls) and at a height of approximately 1 m from the bottom (zones where the walls are not cleaned by the emptying operations).

Owing to the concrete slab on top of the cells, access to these areas for cleaning is difficult.

Dust thickness had reached several centimetres, particularly in the railway hopper which is systematically used for the emptying operations for all of the silo's cells.

The large quantity of sludge recovered after the firefighting efforts in the half-ace of diamonds and the shipment hopper bear witness to the significant amount of dust which had accumulated on the walls.

ACTIONS TAKEN

Since the port elevator accident of August 20th 1997 in Blaye, France, the Lusignan silo has been monitored carefully as its design is the same as that of Blaye. It was inspected twice in 1997 (one of which was with 2 engineers from a private engineering consultancy firm within the framework of a report for the Ministère de l'Aménagement du Territoire et de l'Environnement (Ministry of Territorial Planning and the Environment), and once again in 1998 with the INERIS engineer and an independent reinforced concrete advisory engineer.

Further to an additional prefectorial order of January 27th, 1998, the operator was required to conduct a study aimed at dimensioning the venting surfaces to be installed on the entire silo structure. This study was subjected to critical analysis by the INERIS.

This analysis essentially targeted protection against the effects of dust explosion for which the entire silo could be concerned. It stipulates extensive works to be undertaken and particularly the replacement of practically the entire concrete slab which covers the cells by a light-weight structure and the need to condemn the ace of diamonds except if they are always surrounded by full cylindrical cells.

The operator must submit his observations and propose a completion deadline.

Furthermore, if all of the studies agree on the need for vents to be created at the top of the cells to prevent the silo from collapsing in the case of explosion, opinions differ concerning the surface area of the vents and the manner in which they are made: cut sections out of the roof of the cells or "simple" cracking.

Without waiting for the conclusions of the danger study, the operator began a backfitting program in application the other points of the ministerial order of July 29th, 1998 relative to silos, on all of the silos, particularly the Lusignan silo, with particularly the installation of lighting protection and fixed centralized vacuum installations.

It should be noted that even prior to the installation of this equipment, the cleanliness of the Lusignan silo was not declared at fault during the various inspections.

However, this accident did highlight that the shipment hopper concerned by the smouldering fire and which was located inside the handling tower, was not considered as the rest of the storage containers. This hopper has a capacity of 300 tons, and a volume of 400m³. Roughly ten or so other hopper having a capacity of 15 to 250 tons are also located in the handling tower.

None of these hoppers has a venting surface and no vent dimensioning calculations were foreseen in the danger study or the critical analysis.

A further danger study was requested in this respect.

LESSONS LEARNT

Even though the fire had no harmful consequences, it lead to the completion of the danger study which took into consideration the hoppers located in the handling tower since these components present an explosion hazard.

Furthermore, this accident justified the operator's immediate implementation of certain recommendations indicated in the report submitted by the INERIS concerning the handling tower :

- a high level of cleanliness maintained and the selection of appropriate equipment or their modification,
- insulation of the tower in relation to the gallery on the cells and underneath the cells.

In addition, the installation of vents on the old installations and the accessibility by the cleaning equipment of the parts of the installation where dust accumulates should be given special attention.

This text is a summary of hi ippe Dumora's and ain ou haud's presentation.

Spontaneous combustion of animal meal Plouisy (22 – Côtes-d'Armor) and Cleguer (56 - Morbihan),

July 20th and August 29th, 1999

PART OF THE PLANT INVOLVED

A French ministerial order dated June 28th, 1996 provides for the obligatory destruction of animal meal produced prior to that date by incineration. Thereafter, only hazardous animal meal is to be destroyed. The government is responsible for providing storage facilities for the meal prior to its destruction. The warehouses located in Plouisy and Cléguer, in France, which were affected by the phenomenon of spontaneous combustion, are two such storage facilities.

Plouisy Storage Facility:

Between November 1996 and February 1998, 47,000 tons of animal meal were stored in Plouisy, in two covered warehouses that formed part of a factory that produces cattle feed (Trieux Co-operative). Warehouse No. 1 contained 34,000 tons of meal, stacked to a height of 16 to 18 metres, while warehouse No. 2 contained 13,000 tons of meal, stacked to a height of 6 to 7 metres.

Cléguer Storage Facility

The animal meal was stored in Cléguer from 1997 onwards, and no additional meal was recorded as having been stored after March 1997. This storage facility comprises two warehouses, the first of which contains 8,000 tons of meal, up to a maximum height of 10 metres, while the second contains 6,000 tons, stacked to a maximum height of 4 metres.

THE ACCIDENTS, THEIR DEVELOPMENT AND CONSEQUENCES

Incident of July 20th, 1999:

In Plouisy, during the night of 19 to 20 July, a motorist noticed an unusually bright light coming through a translucent sheeting of warehouse No. 1 and alerted the caretaker. The flames were extinguished using a powder type fire extinguisher. The fire brigade is advised.

The storage conditions made it difficult to intervene: the recommended stacking height of 8 to 12 metres, which has been considerably exceeded, embedding of the layers underneath, that makes it difficult to chart the temperatures, the risk of dust explosion, etc.

An expert was appointed. Continuous measurement of the temperature showed the existence of hot spots (up to 150°C). Cooling with dry ice was attempted, but was soon abandoned due to its ineffectiveness and the resulting release of CO_2. The strategy then chosen was that of spreading the stocked product out in thin layers approximately 50cm thickness. Covering the stacks with sheeting made it possible to block the exothermic reaction and lower the overall temperature. The left hand side of warehouse No. 2 was emptied and part of the stock from warehouse No. 1 was transferred, following cooling to a temperature lower than 35 °C, to warehouse No. 2, at a stacking height of less than 8 metres. The cooling operation and transfer between warehouses No. 1 and No. 2 took place from July 1999 to December 1999. Transfer of the meal is still underway, as it is being incinerated in a cement plant or specialised centre. Analysis of air samples taken within a 500-metre radius show that the incident has not caused any notable pollution. At March 23rd, 2000, the volume of meal still to be eliminated was 23,000 tons, with complete destruction of the stock expected to take place by Spring 2001, taking into account market forecasts.

Incident of August 29th, 1999:

On August 29th, in Cléguer, a resident alerted the fire brigade and administrative departments concerned, after having observed suspicious fumes escaping from a 2000m² warehouse that houses 8,000 tons of animal meal. The firemen extinguished the area affected by spontaneous combustion by covering it with cold meal, then with sheeting. An expert report was made. RBA firemen took temperature readings that were as high as 118°C in some places. Destocking began on 6 September, but three hot spots remained at temperatures in excess of 80°C for the next fortnight. From October 4 to 8, particularly unpleasant fumes were emitted into the neighbourhood, accompanied by strong smells of ammonia. From October 4 to 16, 317 tons of hot animal meal were transferred to another site for cooling. Three hot spots with temperatures in excess of 60°C persisted until October 25th on which date the area affected by spontaneous combustion, which is fairly deep and close to a utility pole is finally reached. The temperature then gradually decreased. An active search for incineration sites was initiated as part of the requisitionary procedure to speed up the stock depletion process.

ORIGIN, CAUSES AND CIRCUMSTANCES OF THE ACCIDENTS

Since 1996, the government has been in charge of providing storage facilities for animal meal prior to its incineration. In 1998, 85,000 tons of animal meal were incinerated by cement manufacturers, thus making it possible to regularly eliminate the flow of animal meal production and reabsorb stocks. As of December 31st, 1998, 100,000 tons of old meal, mostly accumulated throughout 1997, remained in storage. These stocks, which are often overfilled, are only gradually destroyed and must therefore be monitored, as they are potentially dangerous, the main risk being that of spontaneous heating of the stored product. In addition, there is a potential danger of dust explosion in certain confined storage conditions.

In Plouisy, the product stored in warehouse No. 1 reached a height of 18 metres in some places, and studies have shown that the inflammability of animal meal is directly related to the volume, and therefore to the height of the stacked product. Indeed, an expert report has shown that the critical temperature for spontaneous combustion of a cubic storage volume with a 4 cm edge is 160°C, while with an edge of 2 m it is only 75°C. Given the dimensions of the stacked product involved, the spontaneous combustion of the stack is easy to explain. The same observation can be made in the case of the Cléguer facilities, where the warehouse involved was filled to a height of 10 metres. In Plouisy, in warehouse No. 2, overheating did not occur, and in fact the height of the stacked product remained reasonable, not exceeding 6 to 7 metres. This was also the case for the second warehouse located in Cléguer, where the height of the stacked product was 4 metres. It should be noted that both incidents took place during the summer period, at a time when the outside temperature was high. In the case of Cléguer, the warehouses had been treated with insecticide a few days before the incident occurred. Tests were carried out, in order to determine whether the presence of the insecticide had an influence on the inflammability of the animal meal, but these were shown to be negative. In Plouisy, the combustion and handling operations generated smells, gases and dust which upset the residents. Two series of analyses of the ammonia, CO, H_2S, methane and dust, both inside the storage facilities and in the surrounding environment, revealed concentrations well below the recommended limits. In Cléguer, measurement of the gas emissions also gave low readings.

ACTIONS TAKEN

Various emergency measures were taken on July 22nd and 23rd, in the Plouisy storage facilities: a precise chart of the temperatures of the stocked product was carried out, in order to locate the precise location of the centre of the fire, and the hottest area of warehouse No. 1 was cleared and sprayed; an access ramp was created, using a digger, at the hot spot of warehouse No. 1, in order to evacuate the meal. This action involved considerable banking-up operations.

Other measures were taken: continued charting of temperatures, continued emptying of warehouse No. 2 to spread out the hot meal from warehouse No. 1, opening of the roof of warehouse No. 1, in order to create natural ventilation, placing of sheeting on the right and left hand sides of the stacks in warehouse No. 1, in order to limit the air intake, etc. Similar measures were taken in Cléguer. The incidents led to increased monitoring of these storage facilities, and in particular, they led to permanent monitoring of the temperatures, even after the meal had cooled.

LESSONS LEARNT

These incidents showed that stocked animal meal can produce the phenomena of spontaneous combustion and even explosion, and therefore require constant monitoring. Certain precautions should therefore be taken, in order to reduce such risks :

Π Meal should be stored on a flat surface,

Π The warehouse should be tight (air and humidity),

Π The sides of the stocked product should be covered in sheeting,

Π The storage of wet meal on dry meal, and cone-shaped storage, should be avoided,

Π The height of the stocked product should not exceed 7 to 8 metres,

Π The temperature, which should be monitored by thermal readings, should not exceed 30°C, and hot meal should be spread out,

Π Fuels or oxidising agents should not be stored on the same premises,

Π Handling equipment should be fireproof.

The text is a summary of rs ay or's and i hard em ri es's presentations.

Accident on a cooling shroud of an oven loading chute at a domestic waste incineration facility Tiru in Saint Ouen (93 – Seine-Saint-Denis), July 22nd, 1999

PART OF THE PLANT INVOLVED

The Tiru Plant in Saint Ouen employs 122 persons. This domestic waste incineration plant has three oven-boiler shrouds with a maximum capacity of 28 tons per hour, or approximately 600 tons per day.

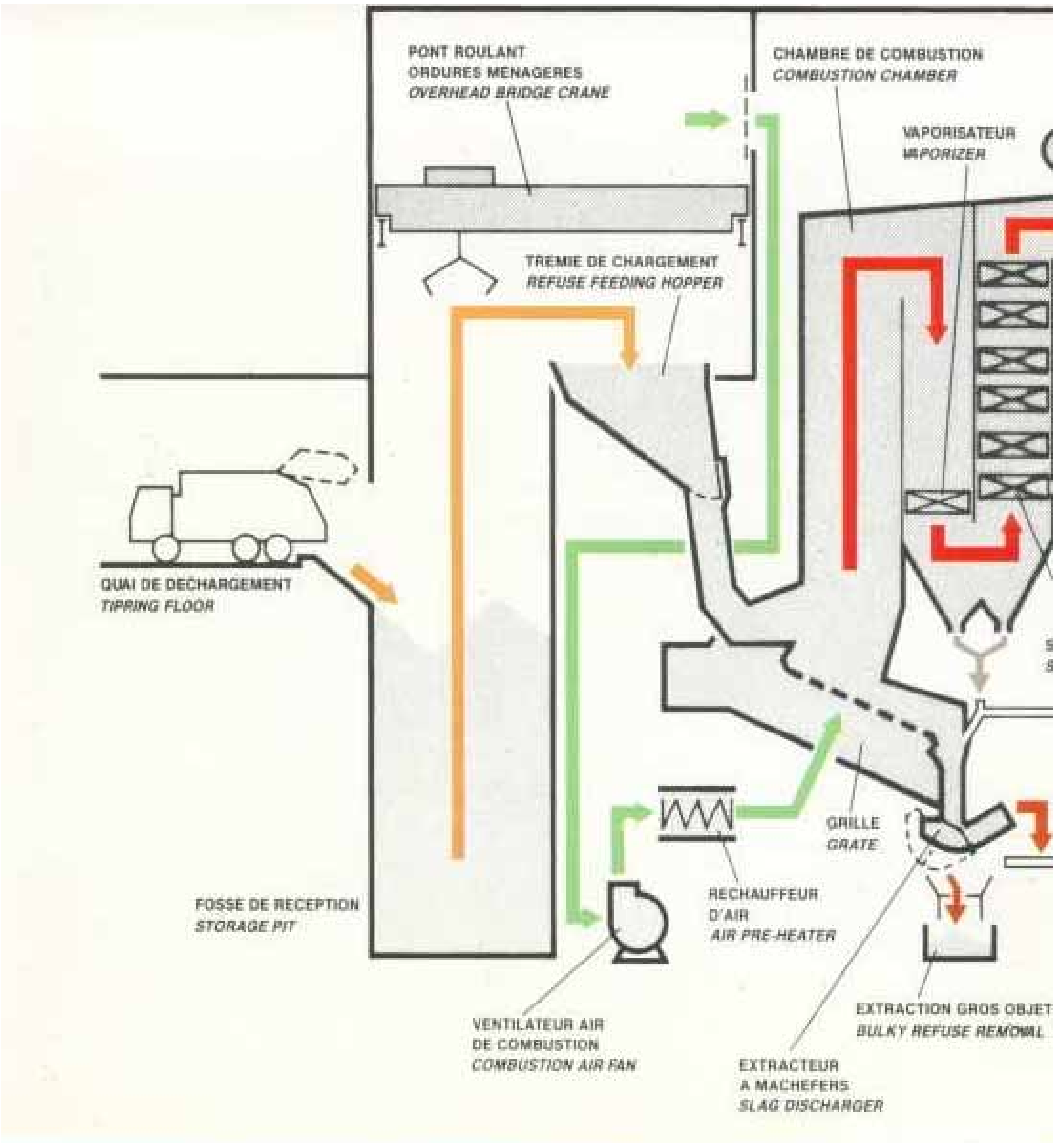
THE ACCIDENT, ITS DEVELOPMENT AND CONSEQUENCES

On July 22nd, 1999 at 3:00 pm, an explosion occurred while a technician was making a routine patrol around oven No. 1. The technician, seriously burned, was thrown approximately 3 meters above the catwalk he was on. The explosion occurred at the level of the cooling shroud for the oven's loading chute which was recently modified. The accident caused oven No. 1 to shut down as well as oven No. 3 on which identical modifications had been made. Plant operation was strongly disturbed, oven No. 2 operating alone was not enough. The domestic waste was sent via tractor trailer (75 rotations per day) to either incineration facilities in the Paris region or to dump sites. The plant returned to normal operation only in September 1999.

ORIGIN, CAUSES AND CIRCUMSTANCES OF THE ACCIDENT

The lower part of each oven loading chute must be cooled to prevent the metal sheeting, subjected to the heat radiation rising off the oven, from heating up and deteriorating (1,000°C). Cooling is ensured by a water-jacket system consisting of 20 shrouds measuring 2.50 m in length, in which water circulates at 3 bar between the sheets (8 and 16mm thick). The water circuit is equipped with input and output valves for each shroud, divided the assembly into 4 compartments by three panels acting as a baffle.

Water leaks were noted during the general shut-down of the installations for routine maintenance between July 4th and 8th. Such phenomena was apparently a common occurrence in view of the stresses to which the metal parts are subjected (expansions which cause cracks). To remedy these repeated anomalies, the operator removed the water circuit on oven No. 1's shroud filled the shroud with "insulating" concrete. The same operation was performed on oven No. 3 in order to observe the resistance of this new process as the shut-down of this oven was scheduled for shut-down due to technical reasons in two months later.



The quality of the concrete introduced was not checked. The purge vent was left open during drying to avoid any increase in pressure and was to remain in this position.

The installation was restarted July 8th. The operator reported that operations continued until the date of the accident without any incident. The explosion occurred at the level of the shroud filled with concrete 1(exterior sheeting ripped, interior sheeting compressed toward the oven, indicating that the explosion occurred inside the shroud). On the latter, the vent valve was closed. More in-depth observation revealed that the interior sheeting was also ripped; the flames from the oven burned the technician. The fist analyses lead us to believe that the explosion was linked to a brutal vaporization of water in a closed volume.

ACTIONS TAKEN

The "Laboratoire Central de la Préfecture de Police" (police department central laboratory) went to the site the next day. The STIIC ("Service Technique de l'Inspection des Installations Classées", technical department of the regulated facility inspectorate) was informed about the accident two days after the incident as the operator had not included it in the list of authorities to be contacted in case of bodily injury, as the accident did not directly affect the site's regulated installations (treatment of domestic waste).

Oven No.3 having been shut down by precaution, on July 23rd the operator requested authorization to restart the oven, considering the modifications and repairs made, inspected the same morning by the AIF: the internal sheeting of the shroud filled with concrete was dismantled in order to observe its arrangement. The concrete was removed and the repairs were made (steel reinforcement of the internal face of the exterior wall and concrete spayed on top).

The STIIC did not grant the restart of oven No. 3 and initially requested the accident report as per article 38 of the decree of 09/27/77, amended. The operator was informed that the restart of oven No. 3 would only take place upon approval by the prefect, based on the report of an inspection organization making a precise analysis of the causes of the accident and explaining the consequence, showing that the repairs made on oven No. 3 enable the oven to be restarted without risk. The procedure is identical for oven No. 1, the modification of which would take place after the inquiry by the judiciary police ordered by the district attorney is finished.

The accident report was sent July 27th with the AIF expert's report and a letter addressed to the prefect requesting authorization to restart oven No. 3. This report shows that the incidents had already occurred on the shrouds of oven No. 3 (plate unwelded and vent close) and oven No. 1 (vent closed, the opening of which caused a powerful jet of steam). These precursor incidents should have led the operator to take the necessary measures and draw up strict and clear instructions. The work carried out on oven No. 3 after the accident were not inspected by AIF. In light of these documents, the STIIC proposed the prefect to give an unfavourable decision concerning the return to service of oven No. 3. This proposal was followed by a letter from the prefect informing the operator of this unfavourable decision, and stipulating that the oven could only be returned to service after a report had been drawn up by another inspection organization.

As far as oven No. 1 was concerned, it will only be placed back into service following a judicial inquiry, following agreement by the prefect and the operator's submittal of a safe-T-tree detailing the circumstances of the accident.

After obtaining a new report and following a meeting on site, the STIIC proposed the prefect to grant a favourable report concerning the restart of oven No. 3 provided that numerous provisions were respected :

- Permanent monitoring of the condition of the concrete (measurement and recording of the temperature of the shroud plating, periodic inspections of the oven's internal walls).

- Operating and inspection instructions displayed and understood by the personnel.

- The installation of valves on shrouds left full of water; failing that, the water inlet and outlet valves on the shrouds and those upline and downline which supply the system must be secured in open position with no risk that they could be operated.

- The restriction preventing the restart of oven No. 1 must be maintained until written authorization by the prefect. This authorization will be granted under the condition that the judicial inquiry proves favourable further to the operator's submittal of a risk analysis, a detailed and complete analysis of the causes of the accident, an analysis of the feedback and the measures implemented as well as a precise description of the work performed on the shrouds, accompanied by an inspection organization's report.

Oven No. 3 was placed back into service on August 4th. On August 5th, a alarm was triggered by the temperature of the sheeting of the modified shroud which exceeded 250°C. The oven is shut down. Once cooled, it was noted that part of the concrete did not resist. This time, the procedure was respected: temperature alarm, oven shut-down, incident reported to the STIIC, repair work is started upon receipt of their report. The STIIC requested that a new analysis be conducted and declared that the restart of oven No. 3 would be subject to a hazards analysis which would include:

The examination of the causes which lead to the deterioration of the shroud, the most realistic cause being the vaporization phenomenon linked to the sudden introduction of water into the shroud.

The feedback problem: even if the anomalies experienced on the installation had been reported to the management and supervisory staff, the installation's potential hazard was not correctly understood at the time.

The feedback and the measures implemented to eliminate the hazards.

The following modifications were made :

-The valves on each shroud were removed.

-The general shut-off valves at the input and outlet of the network of each chute were fitted with limit stops; the boiler be able to be started only if these valves are open.

The effects of progressive pressure increases must be abated by the presence of an expansion tank; furthermore, the shroud circuits exposed to heat from the oven (16 to 19) were initially fitted with burst disks the, as the operator was required to regularly shut down the ovens to load them, the disks were replaced by valves.

Specific water-jacket operating instructions were drafted and it was decided to submit all installation modifications to an outside organization to approval, as the decision applied for the refurbishing of ovens Nos. 1 and 3.

LESSONS LEARNT

This accident is characterized by :

- A succession of near accidents for which the operator did not measure the magnitude.
- A series of technical modifications on the equipment by the operating personnel, without external technical support nor risk analysis. There was a flaw in procedural control as the specifications were not taken into consideration.
- After performing hazardous and hasty repairs after the accident, with neither control office nor external assistance, the operator was intent on putting the installations back into operation very rapidly.

Despite the pressure associated with putting the installation back into service, time had to be taken in order to analyse the causes, to ensure that no residual hazards were present and to be sure that the repair operations were performed properly. A great number of accidents are due to the poor apprehension of the risks associated with hasty modifications.

This text is a summary of as a ritier's presentation.

| Annexes

1 Accidents involving the incineration of DW / CIW and similar cases

Study achieved following participants' demand for IMPEL meeting, June 6th and 7th 2000.

2 Accident reporting :

First information French form, presented for the meeting.

MINISTÈRE DE L'AMÉNAGEMENT DU TERRITOIRE ET DE L'ENVIRONNEMENT

DIRECTION DE LA PRÉVENTION DES POLLUTIONS ET DES RISQUES

Accidents involving the incineration of DW / CIW and similar cases

Reference No. ED3960

Study carried out by the industrial environment Department
BARPI - Bureau for risk and industrial pollution analysis, using the ARIA database
Using the data of 05/07/2000

- Scope of the study
- Main types of accident
- Consequences
- Circumstances and causes
- Statutory references
- Recommendations
- Bibliography

Appendix: Summary of the 51 accidents examined

The ARIA database, managed by the Ministry of national planning and environment, mainly includes the accidental events which have or which could have affected public health or safety, agriculture, nature and the environment. Most of these events result from the activity of plants, workshops, storage facilities, work sites, quarries, farms, etc. and the transport of hazardous materials. The list of accidental events contained in ARIA cannot be considered as exhaustive. When statistics are supplied, they concern a reference sample composed of accidents included in ARIA and which occurred in France since January 1st, 1992.

I – <u>Scope of the study</u>

This study mainly concerns the household or common industrial waste incineration plants (INSEE NAF 90.0B list of activities) which represent almost 80% of the cases selected. Certain cases not involving these plants have also been included due to a fairly similar typology: incineration of hospital waste, incinerators in industrial establishments or accidents involving standard auxiliary equipment such as waste grinders.

51 accidents of this type, of which 46 occurred in France, are listed in the ARIA database. This study successively restores and analyses the information stored concerning the nature of these accidents, their consequences, causes and circumstances.

Although in-depth statistical processing is impossible due to the number of accidents stored, comparisons have been made with the 10,330 accidents listed in France between January 1st, 1992 and July 5th, 2000, taking all types of accident into account. Considering the small sample size (46 cases), the corresponding figures must be examined carefully.

II – <u>Main types of accident</u>

Examination of the 46 French accidents reveals ***a wide variety in the types of event recorded***.

Accident types	DWIP and similar (46 cases)	Reference (10,330 cases)
Fire	50%	49%
Explosion	**28%**	4.9%
Discharge of hazardous substances	37%	50%
Projecting or falling equipment	**11%**	2.2%
Irradiation	**6.5%**	0.2%
Domino effect	**8.7%**	2.3%

Whilst ***fires*** and ***explosions*** represent the dominant events affecting the incineration processes, the related units such as smoke purification, water treatment, steam production installations and the handling of polluting or toxic materials in the peripheral installations must not be ignored in the debate on risk prevention.

Out of the 12 ***atmospheric discharges*** recorded, 6 concern the emission of thick smoke during a fire, 6 others involve the emission of smoke from chimneys or the dispersion of dust (lime, slightly radioactive ash or ash containing heavy metals) during transfers of materials.

4 accidents concern ***liquid discharges*** (fuel oil, acid or base) spilling into the drains before ending up in the natural environment.

Lastly, ***radioactive emissions*** were observed in three cases relating to sources for medical use.

III – Main accident consequences

Whilst in the majority of cases the consequences concern indoor or outdoor property damage, or damage to the environment, air, water or soil pollution, a certain number of accidents caused victims or involved the implementation of rescue plans to protect the neighbourhood.

Consequences	DWIP and similar (46 cases)	Reference (10,301 cases)
Injured people	11%	12%
Indoor property damage	**80%**	64%
Outdoor property damage	2.2%	4%
Atmospheric pollution	**28%**	6.3%
Surface water pollution	4.3%	29%
Soil pollution	6.5%	6.2%
Increase of the risk	26%	12%

Five accidents caused personal injury: employees not seriously injured by explosions (No. 1816 and 3196), one operator seriously injured on the face and legs (No. 10471) and one technician caught in the blast is seriously injured (No. 15953) also following ***explosions***. Finally 3 employees are injured following the ***release of gaseous chlorine*** at an unloading station (No. 14693).

The accidents concerning the related activities affected the neighbourhood by emissions into the atmosphere ***exposing operators*** (Nos. 7667, 10340 and 14693) or ***nearby residents***. In several cases, ***the population is evacuated*** (No. 11381) ***or confined*** (No. 14693) to be protected against a potential or actual release of toxic gases.

The peripheral installations caused ***accidental flows to the surface water or to the catchment water*** (Nos. 7833, 13779 and 11612). Depending on the ***site configurations***, and especially the ***proximity of sensitive installations or infrastructures***, there may be considerable property damage caused by fires outside, e.g. collapse of a high voltage power line (No. 13374).

Accidents involving the incineration of household waste or common industrial waste often lead to ***property damage on the installations*** and the buildings housing them.

The indoor property damage observed in 80% of the cases may result in the ***installations being unavailable*** for more or less long periods and involve the implementation of alternative waste elimination means, sometimes expensive for the operator of the installation, the subcontractor bound by contract or the community.

The ***worsening of consequences*** feared during the interventions of the emergency services may result in the risk of dispersal of toxic (No. 17762) or radioactive (Nos. 7767, 12401 and 12657) materials whose presence, relatively frequent according to these services, is detected before treating the waste or sometimes too late. The consequences may also be worsened due to a potential domino effect (Nos. 3343, 4439, 4447,5070 and 15953).

IV - Circumstances and causes

Most of the time, the accidents occur during normal operation of the installations, frequently being caused by ***work and modifications*** on the installation.

Accident circumstances	DWIP and similar (46 cases)	Reference (5,644 cases) (*)
Normal operation of the installations	94%	83%
Repair or maintenance	8.7%	6.6%

(*) Number of accidents in the ARIA database for which the information is available.

Most of the accidents studies are mainly due to equipment failure, a process control fault, human failure or the presence of hazardous materials left amongst the rubbish.

Accident causes	DWIP and similar (46 cases)	Reference (4,126 cases) (*)
Equipment failure	39%	48%
Process control fault	**36%** (**)	10%
Human failure	31%	24%
Hazardous product/equipment abandoned	**25%** (**)	**3.2%**
Accident outside the establishment	**11%** (**)	3.1%
Vandalism or attack	0.0%	6.0%
External aggression	5.6%	7.9%
Unsuitable use of hazardous products	5.6%	1.0%

(*) Number of accidents in the ARIA database for which the information is available.

(**) Values significantly different from those obtained from the reference sample can be mainly explained by the waste collection methods, negligence by the producers and poor selective sorting, as well as by the difficulties encountered in checking the materials to be treated arriving on site. These checks generally seem to be limited to the detection of radioactive objects (using detection devices) and more or less cursory visual examination.

Fires have various identified or presumed causes:

- ***Maintenance work*** and the use of blow torches or portable lamps (Nos. 3343 and 16079);
- ***Spillage of flammable materials*** (No. 4439).
- ***Waste upline from the process catching fire***, by spontaneous combustion (No. 10340), admission of incandescent waste (No. 12725), presence of calcium carbide in the waste (No. 12159), failure regarding a anti-freezing device (No. 10912) or electrical fires (Nos. 16957 and 1717).

Atmospheric pollution is generated by waste fires, as well as by the ***malfunction of installations*** (smoke extraction fan stopped, washing machine failure, runaway of a furnace) (Nos. 5060, 3169 and 10328).

The sometimes violent ***explosions*** (Nos. 3626, 3658, 5827 and 15953) most frequently occur in ***grinders***, fires spread along conveyors. They are often due to ***the admission of highly flammable*** (Nos. 1816, 3626, 5827 and 14365), ***oxidising*** (No. 3658) or highly ***reactive***, e.g. weedkiller or chlorate, (Nos. 436 and 1816) ***solid, liquid***

or gaseous materials, or badly controlled fermentations (Nos. 2004 and 3196). Design errors, modifications or poor maintenance of installations (Nos. 3658 and 15953) may also cause explosions of dust and vapours.

In some cases, the presence of ***toxic or hazardous materials near furnaces*** caused accidents by domino effect (No. 5070) or represented a threat for the neighbourhood (No. 11381).

Lastly, in some cases, ***the materials used to produce auxiliary equipment***, and especially plastic materials, caused the accident or helped it to spread more easily (Nos. 16079, 9162,10912, 14693 and 12370).

V – Some specific statutory references

European directives No. 89-369 and No. 89-429 dated 8 and 20 June 1989 concerning the prevention of atmospheric pollution from new and existing municipal waste incineration installations.

Ministerial decree dated August 23rd, 1989 concerning the incineration of contaminated waste in an urban residue incineration plant.

Ministerial decree dated January 25th, 1991 concerning urban residue incineration installations.

The decree dated January 25th provides for several essential measures concerning risk prevention. Some of these measures could have either directly or indirectly helped prevent the accidents listed or limit their consequences:

- Implementation of restrictions to preserve a ***safe distance*** from housing (art. 6).
- If it is likely that the waste will not be ***treated 24 hours at the latest after its arrival***, the area or pit used to store it must be closed and depressurised during furnace operation (art. 8).
- Limitation of the periods of ***breakdown or shutdown of the purification devices*** and, during these periods, a maximum content of the dust discharge (art. 12).
- ***Separate storage of the smoke purification residues*** and of the clinkers in a sealed area, protected from rain and wind, especially designed to allow the collection of the drainage water and leachates (art. 14).
- The transport of the incineration residues between the production site and the pre-treatment or elimination site ***ensuring that no material is blown away***, especially as regards the pulverulent waste (art. 14).
- ***Specific measures for the elimination*** or revalorisation of clinkers and ***Household Waste Incineration Smoke Purification Residues*** (art. 14).
- ***The electrical installations***, and the pressurised fluid and steam circuits must comply with legislation, statutory provisions, professional standards and be periodically checked (art. 16).

- The establishment must be equipped with ***suitable emergency means*** positioned to enable rapid intervention by the emergency services, and designed to provide easy access by the rescue vehicles to the waste storage areas and to the bottoms of pits (art. 17).
- Suitable arrangements must be prepared ***in case of power failure*** (art. 19).

Lastly, the inspector of classified installations must be notified if an operating incident occurs or if the limiting values set in the decree are exceeded (art 20).

VI - Recommendations

In the light of several events (see Nos. 3169, 5070, 10098, 11381 and 13374), it seems that it would be appropriate to ***separate sensitive installations and toxic material storage facilities from heat sources produced by combustible waste or material storage areas*** by sufficient distances and/or firebreak partitions.

Suitable measures must also be taken to ***avoid dust dispersion*** when unloading raw materials (see No. 17629) or when removing incineration residues (No. 7833).

The ***detection of radioactive materials*** when the waste arrives on site and the ***creation of suitable intervention procedures*** (see No. 12401 and 12657) will help prevent the emissions from chimneys in the clinkers and the ashes (see No. 7667).

Measures to prevent and detect fermentation of the waste and the release of combustible or toxic gases in the upstream sections of the incineration could be provided (see Nos. 2004 and 3196).

The prevention of ***accidental leaks*** of liquid such as fuel oil, acid, base, etc. (see No. 5893, 13779, 11612, 14099) represents a basic necessity.

Lastly, depending on the type and size of the stock of materials and waste which could be involved in a fire, the question arises of ***the definition of the volume required for retention of extinguishing water*** (see No. 10098).

VII – Bibliography

- L'incinération des déchets ménagers – February 1995 (Jean-Yves LE GOUX, Catherine LE DOUCE – Published by ECONOMICA 49, rue Héricart, 75015 Paris).

LIST OF ILLUSTRATIVE ACCIDENTS

(non exhaustive list taken from the sample)

16079
01/01/00 -
90.0 - Sanitation, public highways and waste management
At a domestic waste incineration plant, a fire broke out in a waste gas flue during a break in maintenance work being carried out in the flue gas scrubber. The fire grew as it fed on combustible linings, storage tanks and a large number of plastic ducts. Metal frames buckled in the heat. The fire is thought to have been started with a halogen lamp used by the workers and which had temporarily been set inside the scrubber. The damage is estimated at 65 million DM. The exact date and location of the accident are not known.

436
29/09/88
33 - SAINT GIRONS D'AIGUEVIVES
90.0 - Sanitation, public highways and waste management
An explosion occurred in a garbage grinder containing sodium chlorate and sulphur based phytosanitary chemicals. There was substantial damage to property.

1717
09/02/90
77 - MELUN
90.0 - Sanitation, public highways and waste management
A fire was started following a short-circuit at a domestic waste processing plant. Damage to property amounted to 1.6 MF.

1816
15/03/90
31 - MURET
90.0 - Sanitation, public highways and waste management
At a domestic waste processing plant, a powerful explosion damaged the grinding equipment. Several municipal workers were shocked, but not seriously. The explosion is thought to be connected to the abnormal presence of an incompletely emptied petrol can, a gas canister or some left-over weedkiller in the domestic waste being processed.

1922
08/05/90
66 - PERPIGNAN
90.0 - Sanitation, public highways and waste management
Fire broke out in a storage area at a domestic waste processing plant. There was slight damage to the building frame.

1933
10/05/90
89 - SENS
85.1 - Human health-related activities

On some days, depending on atmospheric conditions, thick smoke is released from a hospital incinerator. The neighbours complain of a smell of chlorine, causing eye irritation and burns to the nasal duct and throat.

2004
08/06/90
78 - ACHERES
90.0 - Sanitation, public highways and waste management
An explosion and fire occurred at a refuse processing centre. The fire broke out on a storage tank containing methane. There were no casualties. No notable pollution was recorded.

3196
04/04/91
33 - MASSUGAS
90.0 - Sanitation, public highways and waste management
An explosion occurred at a domestic waste processing plant following a build-up of gases generated by the fermentation of the waste. One employee suffered from shock.

3343
30/05/91
37 - AMBOISE
90.0 - Sanitation, public highways and waste management
A fire occurred at a domestic waste processing plant during maintenance of a grinder. A flash from a blowlamp reached a conveyor used to transport refuse to the tower fermenter. The blaze was fanned fiercely by convection of hot air inside the tower, with thick smoke was released. The tower fermenter was damaged, and the outer cowling and a 35m long conveyor belt were destroyed. Plant operation suffered partial stoppage for 3 weeks.

3169
19/08/91
62 - VIOLAINES
37.2 - Salvage of recyclable non-metallic material
At a works recycling wooden pallets, a fire broke out near an incinerator located within the 1.5 ha pallet yard; 70,000 pallets were destroyed, along with 2 lorries, 1 semi-trailer and several forklift trucks. A column of smoke was visible over 25 km away in every direction. It took 65 firemen over 2 hours to put out the blaze.

9162
20/04/92
GERMANY - BIELEFELD
90.0 - Sanitation, public highways and waste management
At a domestic waste incineration plant, an emission of acid droplets (HCL, HF) occurred via a faulty gaseous effluent chimney following a breakdown of the combustion gas scrubber. A section of chimney came away from the distribution and spraying system. The uneven distribution of water caused considerably reduced gas absorption. Plant foliage was burnt over a 14 hectare area. Environmental nuisance was valued at 10,000 DM (35,000 FF). After the accident was detected, the volume of domestic waste processed was reduced.

3626

11/05/92
14 - PERIERS-EN-AUGE
90.0 - Sanitation, public highways and waste management
A gas canister present among the refuse exploded at a domestic waste processing plant. The building's reinforced glass windows were shattered and the plant was shut down for a fortnight. Solid waste from 9 communes was placed in temporary storage in an area set up for the purpose.

3658
27/05/92
68 - MULHOUSE
90.0 - Sanitation, public highways and waste management
In the sludge drying and incineration building at a sewage works, an explosion occurred on the water and dry matter separator. The accident was caused by oxygen arriving in dry dust. The sheet metal separator was torn, the supporting beams were buckled, and the building structure was damaged. A motor was pulled away and fell into the control room. The 100 tons of sludge produced each day will have to be stored on site.

4349
01/03/93
35 - MESSAC
15.3 - Fruit and vegetable industry
Owing to wind, sparks escaping from a fire burning in a rudimentary incinerator started a fire in a large store of crates and empty bottles. Firemen were quickly on the scene and so the damage was limited.

4439
29/04/93
57 - METZ
90.0 - Sanitation, public highways and waste management
Fire broke out at an incineration plant after a private company poured flammable products (ether flakes) into the incoming waste bunker. The fire spread to several tonnes of refuse awaiting processing. The oil tank of an overhead gantry caught in the blaze sent up large flames (10m high). Firemen from the nearby fire station were quickly on the scene and were able to prevent the fire spreading to the rest of the plant.

5060
02/07/93
94 - CRETEIL
90.0 - Sanitation, public highways and waste management
A combustion gas ejector fan broke down in a thunder storm at a hospital and municipal waste processing plant. The combustion gases were discharged with no filtering when a safety device was triggered. Blackish smoke was given off. The ejector fan was repaired after a shut-down lasting several days.

4747
16/10/93
22 - PLEUMEUR-GAUTIER
90.0 - Sanitation, public highways and waste management

A fire broke out in the control room at a domestic waste incineration plant. The fire, which completely gutted the control room, was only discovered in the morning as the plant was in a remote location. The facility had already had a fire 18 months previously. The police are conducting an inquiry.

5070
24/01/94
13 - AUBAGNE
90.0 - Sanitation, public highways and waste management
At a firm specialising in the incineration of paper and photographic films, fire broke out in some bales of paper near the combustion furnace; 2,200 l barrels containing cinders exploded in the heat. In the presence of powerful chlorine evolutions, 30 firemen were able to bring the blaze under control 2 hours. Sand was spread over the extinction water containing hazardous chemicals before it reached the nearby Huveaune river. Drums of soda and hydrochloric acid were found on the site.

5893
20/09/94
69 - LYON 7
90.0 - Sanitation, public highways and waste management
At a waste incineration centre, hydrochloric acid was found to be leaking from a pipe connected to a 2,000 l tank. Firemen diluted the acid that had spilt into the internal sewage network and repaired the leak. In the end the tank was emptied so as to avoid any further accident.

5827
10/11/94
57 - SARREGUEMINES
90.0 - Sanitation, public highways and waste management
On a domestic waste dump, a violent explosion destroyed a grinder, causing considerable damage to the building in which it was housed (siding blown in, metal structure needing checking, etc.). The cause of the explosion may have been the grinding of a large number of spray cans from a supermarket. The police and mine-clearance services are conducting an inquiry. The grinder, using out-of-date technology will not be repaired (damage assessed at 5 MF, work expected to last: 3 months), 4 employees have been laid off and waste is being forwarded to another subsurface containment centre.

6824
14/04/95
44 - COUERON
90.0 - Sanitation, public highways and waste management
A fire broke out at a refuse incineration plant. A CMIC (mobile chemical intervention unit) was called in.

7667
27/06/95
29 - BREST
90.0 - Sanitation, public highways and waste management
Bags containing smoke cleaning residues at a domestic waste incineration plant were contaminated by radioactive elements: iodine 131 (maximum activity measured 8,000 Bq/kg of ash) and thallium 201 (876 Bq/kg). The measured activities were very low and close to the values encountered with natural background radiation. The identified elements came from unsealed radioactive sources used for medical purposes (therapy and diagnosis). Shortcomings in waste management at the level of one

laboratory are the cause behind this pollution. Staff at the incineration plant underwent a medical examination and residual radioactivity levels were measured at the site.

10340
29/09/95
GERMANY - BARGESHAGEN
90.0 - Sanitation, public highways and waste management
At a domestic waste disposal plant, waste spontaneously caught fire near the end of a conveyor, up from a grinder. As soon as the fire was detected, the facility went into emergency shut-down and the fire was put out by the staff and by firemen. They are receiving a medical follow-up (monitoring of CO levels in the blood). Damage to property was assessed at 1.7 MF. From now on the prior inspection of waste is to be reinforced.

7833
22/11/95
70 - VAIVRE-ET-MONTOILLE
90.0 - Sanitation, public highways and waste management
During the transfer of domestic waste incineration flue gas cleaning residues to a silo in the emptying area at a special industrial waste stabilisation/solidification platform, a tanker lorry released a stream of ash (4 t). Most of this ash, with a high lead, zinc and chromium content, fell on the ground in the vicinity of the platform. The relevant services are carrying out checks and taking samples. No housing was affected.

9300
26/06/96
71 - BRANGES
90.0 - Sanitation, public highways and waste management
An explosion of cause unknown occurred in the tank of a grinder at a waste disposal plant. The grinder unit was destroyed. A mine clearance team was called in.

10098
17/11/96
95 - PONTOISE
90.0 - Sanitation, public highways and waste management
A fire broke out at a hospital's medical waste incinerator facility. Firemen took 2 hours to bring the blaze under control. The damage was substantial with the incinerator facility and 2,000 m^2 of building destroyed. A soda reserve spared by the flames was evacuated by an outside firm. The plant had been shut down for technical reasons for 13 days (reconditioning of the heat-resistant incinerator work). According to the fire brigade, the fire started near the waste reception areas. The floor of the building and a rainwater collector ditch only held back part of the water used to put out the fire, most of it being discharged through the rainwater drainage system. An urban station was placed on the alert. An action has been brought against person or persons unknown.

10328
08/12/96
90 - BELFORT
90.0 - Sanitation, public highways and waste management
At a domestic waste incineration plant, the explosive rapidity of one incinerator caused a substantial amount of smoke to be released. The fire was brought under control within an hour. The incinerator

and related equipment were slightly damaged, and out of order for 3 days. A backup incinerator was brought into commission, thereby avoiding any loss in output. The incident was caused by a failure of the air regulation system.

10471
23/01/97
63 - CHATELDON
90.0 - Sanitation, public highways and waste management
An explosion occurred in a hopper at a domestic waste processing plant. A worker attempting to put out the early stages of a fire was badly burned to the face and lower limbs by a flashback.

13779
21/03/97
22 - PLUZUNET
90.0 - Sanitation, public highways and waste management
At a waste incineration and upgrading plant where building work was in progress, 100 l of soda were spilt into a sealed tank. While a pump was being set up to discharge the chemical, an incident occurred which resulting in the soda flowing off into the natural environment. A stream was polluted and the fish stocks (young trout and eels) were killed over a distance of 2.7 km. Samples were taken and analysed. A report was drawn up.

10912
01/04/97
94 - IVRY-SUR-SEINE
90.0 - Sanitation, public highways and waste management
At a municipal waste incineration centre, fire broke out in a shop making lime milk for use at a smoke cleaning facility. Decarbonated water is stored in a plastic tank kept above freezing by an electric immersion heater tube controlled by a low level sensor. This sensor's failure to operate caused the tank to melt and catch fire. The fire then spread to two 90 m^3 storage tanks of lime milk also made of plastic. Firemen brought considerable resources to bear to contain the blaze. Incineration of domestic waste resumed that same day, and the lime milk was delivered in tanker lorries. The destroyed facilities are to be rebuilt.

11381
24/04/97
SWITZERLAND - LA CHAUX DE FONDS
90.0 - Sanitation, public highways and waste management
A fire of unknown origin broke out at a domestic waste incineration plant. The fire threatened a stock of 2 tons of hydrochloric acid and various other toxic chemicals. Considerable resources were mobilised (100 firemen). A neighbouring secondary school and a centre for the handicapped were evacuated.

14693
02/05/97
GERMANY - KARLSRUHE
90.0 - Sanitation, public highways and waste management
At a sewage sludge incineration facility, a new process using sodium chlorate was introduced. When the chemical was delivered, an uninformed employee took the delivery driver to the iron sulphate storage tank that was generally used. The driver connected up the pipes, leading to an exothermic reaction

releasing 300 kg of gaseous chlorine, pulling away the plastic pipes. The population had to be confined and 3 employees were injured. Damage to property was assessed at DM 100,000. The operator is introducing an internal prevention plan in agreement with the fire brigade.

12159
06/06/97
44 - COUERON
90.0 - Sanitation, public highways and waste management
At a domestic waste incineration plant, an employee who had just opened some feed hoppers made a broad visual inspection of the unloading dock and noticed a fire starting in some common industrial waste beyond the dock. The alarm was raised and a hose reel was quickly set up in position. Firemen from 3 fire stations and the police arrived 15 minutes later. The waste was spread out and fanlights opened to evacuate the smoke and fumes. The fire was brought under control in 20 minutes and contained 1 hour later. A battered old canister, containing calcium carbide powder and giving off a powerful smell of acetylene was discovered in the midst of the common industrial waste. Hydrolysis of this powder probably taking one of the materials present to flashpoint was doubtless the cause of the fire. Instructions were issued to tighten up monitoring of the danger area.

11612
05/07/97
77 - SAINT-THIBAULT-DES-VIGNES
90.0 - Sanitation, public highways and waste management
Downstream from pumps feeding the furnaces of a domestic waste incineration plant, a leak of 7 m3 of fuel oil occurred on a pipe (6 m3/hr, 4 bar), fitted with a valve to be closed after use then with a tap used to supply handling vehicles. At 7 p.m., an employee failed to close the valve. A hose under pressure came loose from the pipe connector. The oil spilled into the pumping plant, a decanter, the internal drains and then into the Marne river. The accident was not discovered by night watchmen until 8 p.m. The fire brigade was called by bargemen at around 11 p.m. The network was sealed, an oil boom contained the pollution. One station stopped pumping for 12 hours. Tapping was moved upstream of the pumps and a hand pump was fitted.

14099
17/07/97
94 - FRESNES
85.1 - Human health-related activities
When fuel oil was being delivered to a hospital, the incinerator closed circuit supply was placed under pressure, thereby causing failure of the tank/incinerator connection. The fuel infiltrated the soil. Pollution abatement work was carried out: the soil was excavated, the polluted earth was put in storage, 1,600 l of fuel oil was pumped out and eliminated at a centre; only 3 to 400 l of hydrocarbons were left in the tank. The connection was strengthened.

11312
27/07/97
54 - NANCY
90.0 - Sanitation, public highways and waste management
A blazing fire, cause unknown, broke out at an old domestic waste incineration plant used as a sorting centre. A thick plume of smoke rose up that was visible for tens of km all around. Damage was estimated at 2.5 MF.

12370
15/10/97
44 - COUERON
90.0 - Sanitation, public highways and waste management
At a domestic waste/common industrial waste incineration plant, maintenance work needed to be carried out on a turboalternator (cogeneration) on which the steam supply and exhaust were fitted with blind flanges. The operation was coordinated with the technical shut-down of one of the site incinerators. With the 2nd taking over, part of the steam was fed to an outside plant and the rest was directed to an air condenser through a turbine by-pass system valve. The unit was in normal operation, without producing electricity, when the incinerator's waste feed hopper became stuck. Steam production dropped and the turbine by-pass system valve regulating the steam pressure gradually closed. When the pressure rose to 0.02 bar, the 1.1 m diameter pipe connecting the plant's turboalternator exhaust to the air condenser was flattened under the effect of atmospheric pressure, forcing a shut-down of the plant. A thicker pipe is to be fitted.

12401
02/02/98
78 - THIVERVAL-GRIGNON
90.0 - Sanitation, public highways and waste management
Following the triggering of a radiation protection beacon at an incineration plant, a CMIR (mobile radioactive intervention unit) was called in to localise the radioactive source; 2 contaminated handkerchiefs were found in a truck containing 9 tons of household waste. A spectrum analysis was carried out on the handkerchiefs.

12657
20/03/98
82 - MONTAUBAN
90.0 - Sanitation, public highways and waste management
Firemen and a CMIR were called to an incineration plant to examine hospital waste carrying a certain amount of radioactivity. The source was identified and put in storage until the level drops.

12725
02/04/98
78 - GUERVILLE
90.0 - Sanitation, public highways and waste management
At a domestic waste incineration plant, fire broke out on 2 conveyors and in a grinder feeding a fluidised bed incinerator. The fire may have been caused by incandescent waste. The smoke control system was ineffective. Firemen had to work in hazardous areas with no visibility (presence of bunkers and hoppers). The plant suffered extensive damage and had to be closed for 2 months for repairs. An extinguisher device is to be fitted above the conveyors and grinders, the partitioning of the premises is to be improved notably as regards conveyor belt passages and smoke control, which is to be tested. Hot spot detection in incoming waste is being looked into.

13374
12/08/98
24 - MILHAC-DE-NONTRON
20.1 – Wood sawing, planning and impregnation
At a sawmill closed for the annual vacation, fire broke out near a waste incinerator (for burning remains of pallets and sawdust). The fire destroyed 3,000 m³ of wood and damaged a 1 500 m²

building (siding and roof). A high voltage (63 KV) cable passing over the site collapsed and in its fall cut through a 20 KV cable. The electricity supply was cut off for 2 hours. The emergency services worked for 18 hours before the fire was contained.

13857
21/09/98
29 - PLOURIN-LES-MORLAIX
52.4 – Other specialist retail stores
A pallet fire broke out in the outside storage area of a DIY store. The fire brigade brought the blaze under control in 10 minutes. The fire is thought to have been caused by a small refuse incinerator used to burn wood off-cuts and cartons from the store.

14365
15/11/98
31 - TOULOUSE
90.0 - Sanitation, public highways and waste management
An explosion on an incinerator caused damage to the domestic waste loader box. The incinerator was shut down and the waste taken to another incineration plant. Samples were taken from a greasy magma found at the inlet to the furnace (contaminated earth?). An external firm and the incinerator manufacturer are carrying out an expert appraisal.

15004
23/12/98
44 - COUERON
90.0 - Sanitation, public highways and waste management
A fire that broke out at a domestic waste incineration plant was brought under control by plant staff.

15616
08/06/99
67 - STRASBOURG
90.0 - Sanitation, public highways and waste management
A fire that broke out at a waste processing plant damaged a turbo alternator used to turn the steam produced by incinerating refuse into electricity (cogeneration). Staff were evacuated and there were no casualties.

16082
02/07/99
54 - LUDRES
90.0 - Sanitation, public highways and waste management
At a domestic waste incineration plant, a fire broke out for an undetermined reason in a flue gas residue silo (REFIOM) liable to contain some traces of active carbon but no organic substance. The incident was quickly brought under control by staff. For 2 weeks, 3,000 tons of refuse had to be evacuated to a landfill centre.

15953
22/07/99
93 - SAINT-OUEN
90.0 - Sanitation, public highways and waste management

The lower section of a waste feed chute to an incinerator (28 t/hr) at an incineration plant exploded. A technician was thrown back and seriously injured. Water at 3 bar cooled the base of the hopper exposed to radiation from the combustion grid (1000°C). To improve circulation, the hopper comprised 20 independent box sections with 2 metal walls (internal 16 mm, external 8 mm) 10 cm apart, isolatable from the water circuit through 2 valves (inlet/outlet) and fitted with an air vent. As the boxes expanded due to heat, stress cracks causing water leaks had to be repaired during incinerator shut-down periods. The latest hard to get at cracks were detected on box sections n° 18 on 2 boilers. The operator decided to drain the 2 box sections involved to fill them with insulating concrete (heat screen). With the vents open, the incinerator had been restarted 14 days earlier. The damaged incinerator is being examined by experts.

16957
03/11/99
52 - CHAUMONT
90.0 - Sanitation, public highways and waste management
At an incineration plant, a fire broke out during the night in an electric cable raceway located at a height of 5 m, under the ceiling of the water treatment room. Thick smoke belched out, triggering the safety system. The electrical installation was cut off, cutting off power to the entire site including the ventilation device. As the 240 tons of waste collected each day could no longer be processed, the fire brigade set up an electricity generator for 5 hours to reactivate the system.

17629
27/03/00
29 - CONCARNEAU
90.0 - Sanitation, public highways and waste management
At a domestic waste incineration plant, air slaked lime dust was dispersed when lime was emptied. The incident occurred to the south of the facility and the lime was scattered over 1 hectare of land up to the nearest houses. The population concerned was informed, and the operator offered to clean up the soiled areas, automobiles in particular.

17505
30/03/00
38 - La TRONCHE
90.0 - Sanitation, public highways and waste management
An explosion occurred in the grinder at an incineration plant. After reconnoitring and in agreement with the police, the fire brigade decided to call in the mine clearance service. There were no casualties, but there was considerable damage to property and the waste processing operations were disrupted.

17762
27/04/00
52 -
90.0 - Sanitation, public highways and waste management
When a domestic waste collection vehicle emptied the morning's refuse into a waste bunker at a domestic waste incineration plant, the operator received a belated message warning him that 6 or 7 spray cans (495 cm^3) containing trichloronitromethane (chloropicrin), a chemical used to kill pests (foxes, etc.) and liable to give off an irritating tear gas, had been placed in the vehicle that had just been emptied. Access to the unloading area was prohibited and trucks were diverted to another site. A special procedure was set up to isolate and process waste containing the hazardous chemical (reduced

use of the grapple, wearing of protective breathing apparatus, etc.). In view of the small quantity of chloropicrin, incineration of the waste in question will have no effect on the quality of gas emissions.

FICHE DE NOTIFICATION

Accident – Pollution
Incident significatif

Date de la fiche : N° ARIA :

Rédacteur :

Organisme :

Tél. : Fax : E mail :

Accident notifiable SEVESO ☐

Commune : Département :

Date de l'évènement (début) : Heure de l'évènement (début) : Durée totale :

Exploitant : (titulaire de l'autorisation pour une IC)

Adresse :

Activité NAF de l'établissement : (liste 1ère partie)
(liste 2ème partie)
(ne mentionner qu'une activité) (liste 3ème partie)

SITUATION DE L'ETABLISSEMENT EN CAUSE

Situation administrative

Régulière	☐	Irrégulière	☐
Non classé	☐	Déclaration	☐
Autorisation	☐	Seveso SB ☐ SH	☐
Etude des dangers	☐	Servitudes (AS)	☐
POI	☐	PPI ou PSS	☐

DESCRIPTION RESUMEE DE L'EVENEMENT

Typologie générale

Dissémination de produits dangereux			☐
Incendie	☐	Explosion	☐
Effet domino	☐	Presque accident	☐
Chutes / projections	☐	Autres	☐

Etat de l'installation lors de l'événement

Exploitation normale	☐	Entretien / travaux	☐
Marche continue	☐	Marche discontinue	☐
Mise en service	☐	Mise à l'arrêt	☐
Activité réduite	☐	Arrêt longue durée	☐
Abandonnée	☐	Démantèlement	☐

Secours

POI déclenché	☐	PPI/PSS déclenché	☐
Mesures d'urgence	☐	Alerte population	☐
Evacuation	☐	Confinement	☐

Principales matières impliquées

Nom :
Conditionnement :
Quantité présente sur le site / unité t
Quantité perdue dans l'accident t

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NATURE ET EXTENSION DES CONSEQUENCES

		Sur site		Hors site
Morts				
Blessés				
Chômage technique				
Dommages matériels		☐		☐
Privations d'usage	Eau	☐	Electricité	☐
Atteintes aux milieux	Eau	☐	Air	☐
	Sol	☐	Nappe	☐
Atteintes à la faune	Sauvage	☐	Elevage	☐
Atteintes à la flore	Sauvage	☐	Cultures	☐
Effets transfrontières				☐

Coût total estimé		**MF**
Pertes matérielles sur site		MF
Pertes d'exploitation du site		MF
Pertes et dommages externes		MF

ANALYSE DES DEFAILLANCES ET DES CAUSES

Analyse défaillance faite Oui ☐ Non ☐

Intervention tiers expert (administration/autre)	☐
Défaillance matérielle	☐
Défaillance humaine	☐
Défaut d'organisation / Management	☐
Intervention insuffisante, inadaptée	☐
Abandon produits / équipements	☐
Accident extérieur à l'établissement	☐
Défaut approvisionnement en eau	☐
Défaut approvisionnement en électricité	☐
Défaut approvisionnement autre	☐
Malveillance / attentat	☐
Agressions d'origine naturelle	☐
Usage inadapté de produits dangereux	☐
Cause inconnue	☐

SUITES TECHNIQUES, ADMINISTRATIVES ET PENALES

	Réalisé	Prévu
Enquête de l'inspection des ICPE	☐	☐
Procès-verbal ICPE	☐	☐
AP fixant des mesures d'urgence	☐	☐
Application article 39 (D. 77-1133)	☐	☐
AP prescriptions complémentaires	☐	☐
AP de mise en demeure	☐	☐
AP de suspension d'exploiter	☐	☐
Autres procès-verbaux	☐	☐
Procédure judiciaire	☐	☐
Expertise judiciaire	☐	☐
Décontamination des eaux	☐	☐
Décontamination des sols	☐	☐
Décontamination des nappes	☐	☐
Amélioration de la prévention	☐	☐
Amélioration de la protection	☐	☐
Amélioration du management	☐	☐
Amélioration des plans de secours	☐	☐

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