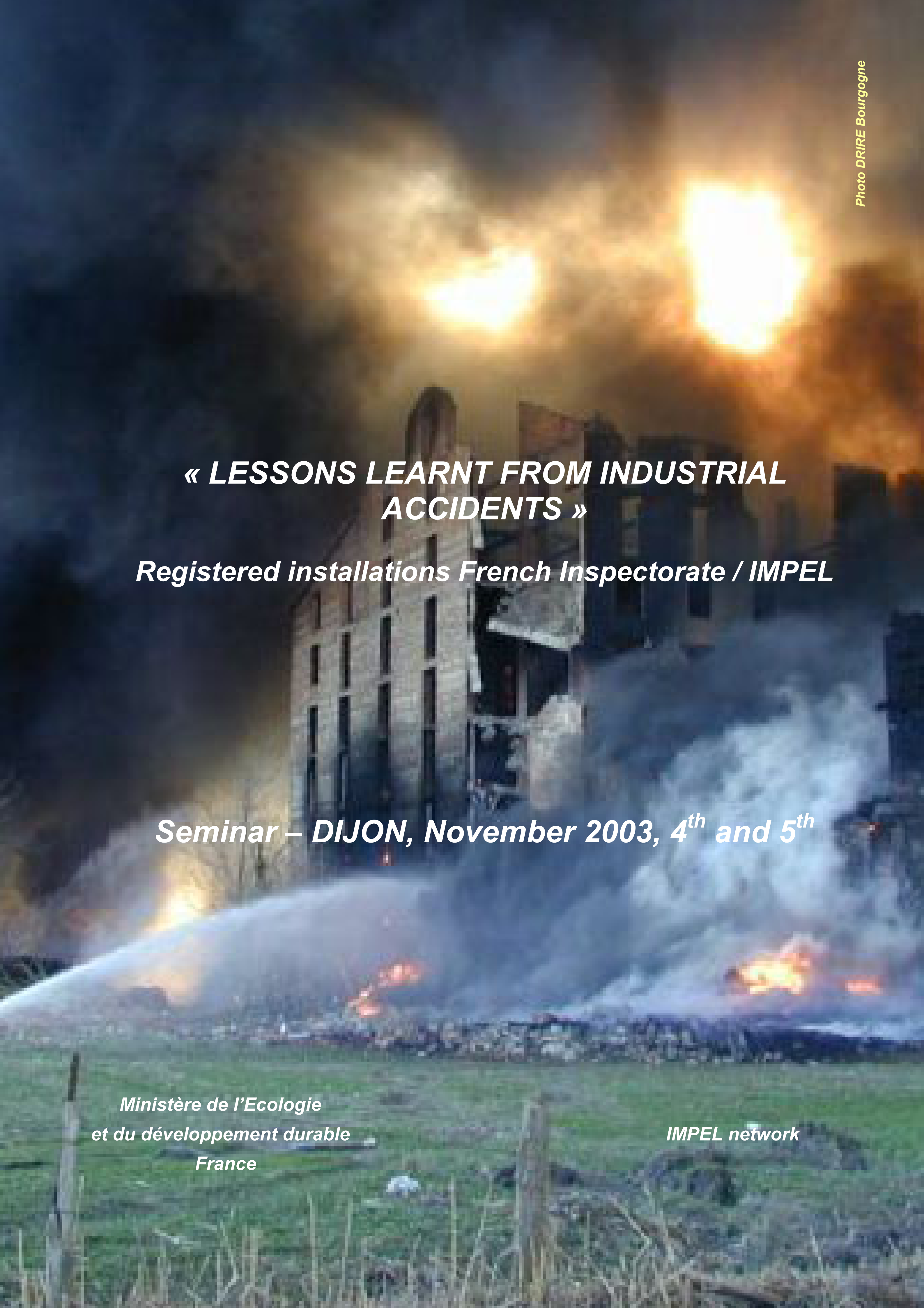

Photo DRIRE Bourgogne

« LESSONS LEARNT FROM INDUSTRIAL ACCIDENTS »

Registered installations French Inspectorate / IMPEL

Seminar – DIJON, November 2003, 4th and 5th

Ministère de l'Ecologie
et du développement durable
France

IMPEL network

Thanks

The conference organizers do thank the participants to the meeting for their presentation and their contribution in the achievement of the following synthesis.

The speakers' names are listed below in alphabetic order (but grouped for each presentation).

- *Monsieur **Guillaume BAILLY** (DRIRE Ile-de-France – France)*
- *Messieurs **Grégory BRASSART** (DRIRE Nord-Pas de Calais - France) et **Daniel CALIPPE** (Inspecteur du travail)*
- *Monsieur **François CHAMPEIX** (DRIRE Provence Alpes côte d'Azur - France)*
- *Madame **Fausta DELLI QUADRI** (APAT- Italie)*
- *Monsieur **Nicolas DENNI** (DRIRE Lorraine – France)*
- *Monsieur **Philippe ENJOLRAS** (DPPR/SEI/BARPI)*
- *Monsieur **Jean-François GAILLAUD** (DRIRE Picardie)*
- *Monsieur **Wim K.KOOIJMAN** (Environment Agency Rijnmond – Schiedam – The Netherlands)*
- *Monsieur **Olivier LAGNEAUX** (DRIRE Poitou- Charente – France)*
- *Monsieur **Yves LIOCHON** (DRIRE Bourgogne - France)*
- *Madame **Hélène MACH** (DRIRE Haute-Normandie - France)*
- *Monsieur **Hubert MENNESSIEZ** (DRIRE Alsace –France)*
- *Monsieur **Sébastien MOLET** (DRIRE Picardie)*
- *Monsieur **Francis MOREAUX** (DRIRE Alsace – France)*
- *Monsieur **Frank PEEN** (Ministère de l'environnement des Pays-Bas)*
- *Monsieur **Christian PRADEL** (DRIRE Auvergne - France)*
- *Monsieur **Olivier RAMACKERS** (DRIRE Nord-Pas de Calais - France)*
- *Monsieur **Norbert WIESE** (Agence de l'environnement du Rhin-Westphalie du Nord – Allemagne)*
- *Monsieur **Bernard YU** (Institut bruxellois pour la gestion de l'environnement - Belgique)*

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Introduction

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Opening speech

Meeting of November, 04th and 05th, 2003

Welcome

Michel Pascal

Regional Director of Industry, Research and the Environment

for the Bourgogne Region

Good morning,

It is a pleasure and an honour for me to welcome you to Bourgogne today for this seminar devoted to discussion and dialogue on the subject of industrial accidents, organised by the French Ministry for Ecology and Sustainable Development and, in particular, by the BARPI ("Bureau d'Analyse des Risques et Pollutions Industrielles", industrial pollution and risk analysis bureau) in Lyon.

Firstly, I would like to apologise for the absence of Mr. Daniel Cadoux, the prefect of the Bourgogne region and the Côte d'Or, who would have been delighted to join us this morning but unfortunately has other commitments. He has asked me to stand in for him and to welcome you; it gives me great pleasure to do so. As you know, Daniel Cadoux will be welcoming us this evening at the Prefecture for a one-hour reception. Indeed, he is very keen to show his interest in this regional event by attending personally.

After choosing two regions that are well-known for their wines – the last two meetings in this category were held in Champagne and the Bordeaux region- this time you have chosen Bourgogne, a region that is no less renowned for the same product – some would say it is even more prestigious – as the venue to share your experiences and discuss industrial risk management.

You are in a European land here. So first, a little history! As you may know, the Dukes of Bourgogne created one of the most powerful empires in the west, in the 14th and 15th centuries, starting with Philippe le Hardi and ending with Charles le Téméraire. We are also in a land that lends itself to reflection and meditation. The Abbey of Fontenay, which is inscribed on UNESCO's world heritage list, and the Abbeys of Citeaux and Cluny and the basilica at Vézelay, are some of the sites that encourage meditative thought. I don't know if our venue will prove to be quite as inspirational, but in any case I do hope that these two days of dialogue will be constructive.

The Bourgogne region is also characterised by the quality of its scientists. To name but four of them: Gaspard Monge, co-founder of the "ecole polytechnique" polytechnic school, which was at that time known as the "Central College of Public Works", Lazare Carnot, Joseph Fourier, who was both a skilled mathematician and physician and, while carrying out his research, was also prefect of the Isère region and prefect of the Rhône region. And also, we have Mr. Buffon, who was both iron-master and a great naturalist.

I am, of course, delighted that you have chosen to come to Bourgogne, as it is a region in which industry and industrial risk management are strongly present, even if we hear a little less about Bourgogne than we do about other more industrialised regions. Bourgogne is first and foremost characterised not only by its industrial history, but also by its present situation, with more than 23% of its salaried employees working in industry. If we compare this to the French average of 19%, it is truly a region with a strong industrial tradition, thanks to its coal-mining activities and the expanding metal-working and iron and steel industry in the basins of Blanzy-Montceau and the Nièvre region.

Today, Bourgogne is best known for its food industry, even though it is not the most important. I have already mentioned its wines, but I would also like to mention its mustard, blackcurrant liqueur and gingerbread, its bovine industry and its "Charolais" cows, as well as its fruit juices…in fact, there are so many things that conjure up Bourgogne! Fortunately, however, these are not the only industries present in the Bourgogne region. We also have mechanical engineering, the iron and steel industry, the electrical and electronics industry, rubbers and plastic materials and plastic processing.

As regards registered installations subject to authorisation, Bourgogne has around 1,500 registered installations subject to authorisation and 34 "SEVESO" installations, out of a total of slightly more than 1,000 overall nationally. These are not large installations or large petrochemical complexes, but rather single-production establishments or depots which can, nevertheless, pose problems.

One example which we will not be dealing with during the coming two days since, I am pleased to say, there have been no accidents, is the considerable work we have carried out on the two petroleum facilities in the Dijon area. There has been much discussion about them, and I believe they have taught us a lot about studying risk reduction. Indeed, for one of the first times in France, we have encouraged operators to carry out danger studies in which the notion of probability has been deliberately introduced. Moreover, the cost of the work aimed at reducing the risks for these two sites - which we ourselves recorded and analysed– amounts to more than 10 million Euros.

I would also like to mention 3 pyrotechnics industries in the region: Nobel, Titanite and Davey Bickford. These 3 establishments in Bourgogne represent more than half of the French explosives production.

Lastly, even though they are not classified SEVESO – and everyone is aware that the establishments at risk are not only the SEVESO establishments – the 55 grain silos in the Bourgogne region, which represent 6% of the nation's silos, call for and justify sustained action on the part of the DRIRE. This action has enabled progress to be made, although it has also met with a lot of resistance, particularly with regard to the most problematic silos, which are those located right in the city. We have two such silos in Bourgogne: one in Dijon, not far from the station, and another in Auxerre, just next to a cathedral.

We have just completed another action in Bourgogne: on Thursday I intend to announce to the Press the results of our campaign of inspection of warehouses. Without revealing too much about that here, the results clearly show the benefits to be gained from a voluntary inspection action, as shown by the important paths of progress that we have identified.

Another special aspect of Bourgogne – and one which was particularly evident this summer – is the question of water. The Côte d'Or was the department that suffered not only the greatest heat but also the greatest drought. For many years now, the quality and availability of water has been a concern for public authorities in this region and the DRIRE in particular. The region is at the head of several hydrological basins, and in particular, the one that irrigates the Paris region, into which transfers are constantly made. As a result, in very hot weather, the regional water supply drops even more: we therefore carried out large-scale actions this summer, in order to encourage industrialists to reduce their water consumption by means of a Water Use Plan, named "EPURE". Fortunately, anticipatory measures to encourage reduction had already been put into action during previous years: these resulted in industrialists reducing their water consumption by 5% each year. The actions taken in 2003 therefore benefited from this anticipatory work.

To bring this short overview of the region's environment to a close, I would like to mention one of the thirteen Class 1 waste disposal sites, whose special characteristic is the extension project that was studied at the end of the 1990's. In fact, no observations were recorded during this public inquiry. This is sufficiently unusual as to be worth mentioning, particularly when you consider the difficulties encountered nowadays with regard to the installation of waste treatment centres in various other locations.

You have chosen Dijon – and once again I would like to say how pleased I am – as the venue for this in-depth discussion and dialogue on which the future depends. You are the representatives of more than 10 European countries, including some outside the boundaries of the European Union, and I would like to express my very great thanks for your presence here today. Naturally, I immediately said "Yes" when I was asked to perform the introductory speech for this seminar, particularly as I firmly believe that benchmarking and feedback on experiences are truly the means by which we can develop our special action. Of course, they bring to life not only information networks and the national government inspection network, but also the European network, which is growing every day in an effort to develop and improve its action.

During the course of these two working days, we intend to provide you with fond memories of the Bourgogne region. I hope that this will encourage you to come and work here perhaps, or simply come back to visit. Once again, I thank you for attending.

Seminar introductory speech

Thierry Trouvé
Director of the pollution and risk prevention branch

Ladies and Gentlemen,

It is with great pleasure and interest that I participate in this seminar which has been organised, for the fifth time, within the framework of the European inspectors' IMPEL network. I am particularly pleased to be here today for two reasons that correspond, in fact, to two of my major concerns, three months and a few days after taking up the post of DPPR and its considerable responsibilities.

My first concern relates to the importance of feedback and how it can be used in order to collectively achieve progress in the system for which we are partly responsible. I asked myself "Why am I so sensitive to this issue?". I am not 100% certain, but I believe that it dates back to my first few years of service. I carried out my national service in a nuclear submarine, after which I went on to work in naval construction management. As you may know, the French navy lost two submarines in the 1960's and the risks to these machines are considerable. The feedback was something that was well organised, and the marines and naval construction engineers were particularly well mobilised: on this kind of installation, peoples' lives are at stake. My first concern is therefore the importance of exploiting feedback.

My second concern is the need to develop dialogue, on both a national and an international level, in order to share our different points of view. The clear objective is to collectively progress and, from this viewpoint, the IMPEL network is a very rich base in which we must continue to invest.

First of all, I would like to thank Michel Pascal who has just spoken and has given us a brief tour of his beautiful region: firstly, for his presence here today, and also for his welcome, for his team's involvement and for his support in the organisation of this event. We are in a magnificent venue. The next time, we shall be able to welcome twice as many participants. Many thanks for this great welcome!

I would also like to welcome the inspectors from the Member States of the European Union, who are growing in number. This year – and I hope I haven't forgotten anyone – we welcome representatives from Germany, Austria, Belgium, Italy, the Netherlands, Portugal, Slovakia and the Czech Republic. I would also like to welcome the experts who are here to participate in these two days devoted to the subject of feedback.

I am also very pleased to welcome to the platform Mrs. Le Gac, who represents the Director of Work Relations and who is going to chair today's discussions. As you know, the DPPR and DRT have, of course, different fields of activity. At the same time, however, the concerns of their inspectors have a number of points in common. With this in mind, I intend to develop and amplify the collaboration process initiated by Mr. Combrexelle and my predecessor, that is to say, between the DPPR and the DRT. I would also like to add that, generally speaking, the relations between our respective managements are traditionally very good. Over and above the human aspect, these relations represent a structural necessity of which you are all aware when in the field.

In particular, this collaboration concerns the examination of dossiers, danger studies and health and safety notices, as well as checks and accident inquiries, a subject with which we are concerned today. I would add that the law dated July 30th, 2003 concerning "risks" reinforces this synergy by an increased involvement of employees and the CHSCT (the committee for hygiene, safety and working conditions) as regards matters of risk. All of this therefore constitutes an additional reason for the collaboration between the DPPR and the DRT. I firmly believe that this two-way dialogue and these different visions of the same industrial reality are extremely fertile and provide us all with elements that will enable us to make progress vis-à-vis our respective responsibilities. I know that, in the field, this practice and this collaboration between our two inspectorates are already a reality. I hope that they will continue to develop even further.

This pooling of our positive and negative experiences, in France, overseas and between Inspectorates, can thus provide a source of development and can encourage the dimension of thought to open up. It is of great benefit, as it encourages a spirit of sharing. In this regard, I would particularly like to mention the short teaching film that has been produced by the BARPI and INERIS ("Institut National de l'Environnement Industriel et des Risques", the National Institute for Industrial Environment and Risks), which draws on the lessons learned from the accident that occurred in France several years ago. This teaching movie will be available in a few months. Similarly, the ARIA ("Analyse et Recherche d'Information sur les Accidents", accident information and research analysis) web site, with which you are all familiar, is a veritable chronicle and an important information vector. Within a few weeks of taking up my post, and after having taken stock of the situation, I asked Denis Dumont to speed up the putting online of the accidents that had occurred on the earliest dates and also to make all of the main rubrics accessible to English speakers.

I would also like to draw your attention to some of the other tools that will be presented to you during this seminar. The new electronic format of the "accident" report and the new version of the industrial accidents scale are both extremely important tools.

I would like to speak for a few moments about the industrial accidents scale: in taking up this post, I have a very strong feeling that we are in need of reference points. When I say "we", I mean everyone, not only the operators and the registered Installations Inspectorate, but also the press and the public. If we look at the nuclear experience, which has been used as a kind of model in this regard, with the INES scale, we can clearly see the need for a tool, and more specifically, a communications tool. Moreover, considerable work has been carried out on this subject lately and it will be presented to you tomorrow – I would encourage you to pay close attention to it.

In addition, the Registered Installations Management Committee has given its approval for an "appropriation" of the new presentation of the European scale by both operators and the Inspectorate. . It remains to be seen whether the tool as it exists today is the "right" one, or whether there is still progress to be made. For oral communication with the press, after an accident, I would rather the display of a unique indicator. But I believe that it is only by using this scale and experimenting with a coherent indicator to communicate after a crisis that we will be able to judge the appropriateness of the tool presented. In any case, a tool like this appears to me to be an absolute necessity. So I would therefore encourage you to experiment with it and report your feedback on this operation.

With regard to risk prevention management devices in general, as I said in my introductory remarks, feedback appears to me to be something that is extremely important for the prevention of accidents and pollution, and in order to avoid history repeating itself in a painful manner. For years now, many steps have been taken but, as you would no doubt agree, there is still much that remains to be done.

In this field, I would see at least 5 orientations, in which our efforts should be directed:

✓ The first is, quite simply, the collection of information, whether it be technical or organisational. They are primordial for prevention. In this respect, the operators are an essential cog in the information chain. In this field, we must show no indulgence whatsoever towards operators who fail to report accidents or incidents. The submission of accident reports is obligatory in terms of the regulations, as I am sure I need not insult you by reminding you, and one which figures in the ministerial order of 1977. Failure to submit an accident report must systematically give rise to the instigation of proceedings. This had already taken place before I arrived at my new post. Since my arrival, a certain number of cases of this type have come up: it came to the Inspectorate's knowledge that an operator had forgotten to inform us of one thing or another. In each case, I requested that the appropriate sanctions were imposed.

✓ The second path concerns danger studies: in the unfortunate case where an accident occurs, the Inspectorate must make sure that the operator re-examines the contents of his danger study. These documents are not simply an administrative obligation or an essential document…for steadying a storage cabinet. On the contrary, they are, and must remain, a "living" tool. Thus, *a fortiori* after the occurrence of a notable event on a site, the danger study must necessarily be reviewed in the light of the accident.

✓ The third point I would insist on is the necessity of circulating information concerning accidents or incidents: the usual procedure, although it is sometimes forgotten – and in any case, I believe that it must not be forgotten – consists of systematically reporting it to the BARPI as soon as it comes to the Inspectorate's knowledge. The BARPI then registers the information in the ARIA database, which I mentioned a few moments ago, so that it can be accessed by everyone, including the Inspectorate, the operators and the experts. The vector for this transfer is, in particular, the new accident report format which I already mentioned, and which will be presented to you tomorrow.

✓ The fourth element concerns the operators' appropriation of this feedback and, in particular, the lessons that can be learned from the past. I would therefore encourage you to make sure, when analysing danger studies, that the feedback, especially that coming from professional bases and the ARIA database, has been exploited.

✓ The final orientation in which I think we must all progress collectively – and it is undoubtedly the most difficult – is the treatment of near accidents or incidents. I feel that it is absolutely essential to encourage operators to better exploit and benefit from these "near accidents", which very often remain within the company, or may even remain within the teams: they are not always reported to the site manager, and even less so outside the company. Nonetheless, I would stress the fact that all deviations are not necessarily reported outside the site. What is important is that these events, which are often, as you know, extremely instructive, can prevent a major accident from occurring: this material must truly be exploited. Consequently, I can only encourage you to be vigilant in this respect, notably when you are carrying out periodic checking of security management systems in SEVESO establishments. I would ask you to make sure that the exploitation of data concerning near accidents is organised and effective.

A few moments ago I reminded you of the need for sanctions when information is not reported after an accident. However, I would modify this slightly with regard to minor operating incidents. With a view to making collective progress, a delayed information could be allowable. This provision, like others, can constitute a kind of firewall against some operators' fears that the Inspectorate may exploit this type of information and, possibly, impose sanctions. In this regard, the objective is clearly not to sanction but rather to progress. As you see, the idea is to integrate faint signals into security management and, in this respect, data concerning near accidents is extremely important.

We must remember that safety is first and foremost the responsibility of the industrialists. It is also, as a second "line of defence", our responsibility as an Inspectorate. A kingly activity is therefore indispensable. On this point, I continue to act in a direct line with my predecessor. Nevertheless, making industrialists responsible remains a priority. For several years, the DPPR and the Inspectorate have been taking action in this respect. The work we can carry out as a network, within the Inspectorate, within the DRIREs, between inspectors, poles, risk cells, the risk office, the BARPI and, moreover, with our Work Inspectorate colleagues, is of primordial importance if we are to progress.

To develop this idea further, communication and information seem to be an important lever. An intelligent use of this lever, such as is already practised by some DRIREs, which use it as a tool for making industrialists responsible, can be provide enormous benefits. DRIREs which are already making public, within the framework of their annual report, a certain number of cases of good or bad students, explore an extremely interesting path. I have therefore requested that a survey be carried out at a national level, in order to proceed in an identical way.

Lastly, I need not remind you that the explosion at the AZF plant has definitively marked the history of industrial safety. It has still to lead to radical modifications in the methods for analysing and managing risks. The law of July 30th last opened up a number of regulatory projects for the DPPR. Tomorrow, Bruno Cahen will talk to us about the first series of consequences for the Inspectorate's daily work. It is a veritable challenge for the Inspectorate's future, as regards both organisation and work methods. We will be taking up this challenge in the months and years to come.

Thank you very much.

Welcome

Michel Pascal

Regional Director of Industry, Research and the Environment

for the Bourgogne Region

Good morning,

It is a pleasure and an honour for me to welcome you to Bourgogne today for this seminar devoted to discussion and dialogue on the subject of industrial accidents, organised by the French Ministry for Ecology and Sustainable Development and, in particular, by the BARPI ("Bureau d'Analyse des Risques et Pollutions Industrielles", industrial pollution and risk analysis bureau) in Lyon.

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Seminar introductory speech

Thierry Trouvé
Director of the pollution and risk prevention branch

Ladies and Gentlemen,

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My first concern relates to the importance of feedback and how it can be used in order to collectively achieve progress in the system for which we are partly responsible. I asked myself "Why am I so sensitive to this issue?". I am not 100% certain, but I believe that it dates back to my first few years of service. I carried out my national service in a nuclear submarine, after which I went on to work in naval construction management. As you may know, the French navy lost two submarines in the 1960's and the risks to these machines are considerable. The feedback was something that was well organised, and the marines and naval construction engineers were particularly well mobilised: on this kind of installation, peoples' lives are at stake. My first concern is therefore the importance of exploiting feedback.

My second concern is the need to develop dialogue, on both a national and an international level, in order to share our different points of view. The clear objective is to collectively progress and, from this viewpoint, the IMPEL network is a very rich base in which we must continue to invest.

First of all, I would like to thank Michel Pascal who has just spoken and has given us a brief tour of his beautiful region: firstly, for his presence here today, and also for his welcome, for his team's involvement and for his support in the organisation of this event. We are in a magnificent venue. The next time, we shall be able to welcome twice as many participants. Many thanks for this great welcome!

I would also like to welcome the inspectors from the Member States of the European Union, who are growing in number. This year – and I hope I haven't forgotten anyone – we welcome representatives from Germany, Austria, Belgium, Italy, the Netherlands, Portugal, Slovakia and the Czech Republic. I would also like to welcome the experts who are here to participate in these two days devoted to the subject of feedback.

I am also very pleased to welcome to the platform Mrs. Le Gac, who represents the Director of Work Relations and who is going to chair today's discussions. As you know, the DPPR and DRT have, of course, different fields of activity. At the same time, however, the concerns of their inspectors have a number of points in common. With this in mind, I intend to develop and amplify the collaboration process initiated by Mr. Combrexelle and my predecessor, that is to say, between the DPPR and the DRT. I would also like to add that, generally speaking, the relations between our respective managements are traditionally very good. Over and above the human aspect, these relations represent a structural necessity of which you are all aware when in the field.

In particular, this collaboration concerns the examination of dossiers, danger studies and health and safety notices, as well as checks and accident inquiries, a subject with which we are concerned today. I would add that the law dated July 30th, 2003 concerning "risks" reinforces this synergy by an increased involvement of employees and the CHSCT (the committee for hygiene, safety and working conditions) as regards matters of risk. All of this therefore constitutes an additional reason for the collaboration between the DPPR and the DRT. I firmly believe that this two-way dialogue and these different visions of the same industrial reality are extremely fertile and provide us all with elements that will enable us to make progress vis-à-vis our respective responsibilities. I know that, in the field, this practice and this collaboration between our two inspectorates are already a reality. I hope that they will continue to develop even further.

This pooling of our positive and negative experiences, in France, overseas and between Inspectorates, can thus provide a source of development and can encourage the dimension of thought to open up. It is of great benefit, as it encourages a spirit of sharing. In this regard, I would particularly like to mention the short teaching film that has been produced by the BARPI and INERIS ("Institut National de l'Environnement Industriel et des Risques", the National Institute for Industrial Environment and Risks), which draws on the lessons learned from the accident that occurred in France several years ago. This teaching movie will be available in a few months. Similarly, the ARIA ("Analyse et Recherche d'Information sur les Accidents", accident information and research analysis) web site, with which you are all familiar, is a veritable chronicle and an important information vector. Within a few weeks of taking up my post, and after having taken stock of the situation, I asked Denis Dumont to speed up the putting online of the accidents that had occurred on the earliest dates and also to make all of the main rubrics accessible to English speakers.

I would also like to draw your attention to some of the other tools that will be presented to you during this seminar. The new electronic format of the "accident" report and the new version of the industrial accidents scale are both extremely important tools.

I would like to speak for a few moments about the industrial accidents scale: in taking up this post, I have a very strong feeling that we are in need of reference points. When I say "we", I mean everyone, not only the operators and the registered Installations Inspectorate, but also the press and the public. If we look at the nuclear experience, which has been used as a kind of model in this regard, with the INES scale, we can clearly see the need for a tool, and more specifically, a communications tool. Moreover, considerable work has been carried out on this subject lately and it will be presented to you tomorrow – I would encourage you to pay close attention to it.

In addition, the Registered Installations Management Committee has given its approval for an "appropriation" of the new presentation of the European scale by both operators and the Inspectorate. . It remains to be seen whether the tool as it exists today is the "right" one, or whether there is still progress to be made. For oral communication with the press, after an accident, I would rather the display of a unique indicator. But I believe that it is only by using this scale and experimenting with a coherent indicator to communicate after a crisis that we will be able to judge the appropriateness of the tool presented. In any case, a tool like this appears to me to be an absolute necessity. So I would therefore encourage you to experiment with it and report your feedback on this operation.

With regard to risk prevention management devices in general, as I said in my introductory remarks, feedback appears to me to be something that is extremely important for the prevention of accidents and pollution, and in order to avoid history repeating itself in a painful manner. For years now, many steps have been taken but, as you would no doubt agree, there is still much that remains to be done.

In this field, I would see at least 5 orientations, in which our efforts should be directed:

✓ The first is, quite simply, the collection of information, whether it be technical or organisational. They are primordial for prevention. In this respect, the operators are an essential cog in the information chain. In this field, we must show no indulgence whatsoever towards operators who fail to report accidents or incidents. The submission of accident reports is obligatory in terms of the regulations, as I am sure I need not insult you by reminding you, and one which figures in the ministerial order of 1977. Failure to submit an accident report must systematically give rise to the instigation of proceedings. This had already taken place before I arrived at my new post. Since my arrival, a certain number of cases of this type have come up: it came to the Inspectorate's knowledge that an operator had forgotten to inform us of one thing or another. In each case, I requested that the appropriate sanctions were imposed.

✓ The second path concerns danger studies: in the unfortunate case where an accident occurs, the Inspectorate must make sure that the operator re-examines the contents of his danger study. These documents are not simply an administrative obligation or an essential document…for steadying a storage cabinet. On the contrary, they are, and must remain, a "living" tool. Thus, *a fortiori* after the occurrence of a notable event on a site, the danger study must necessarily be reviewed in the light of the accident.

✓ The third point I would insist on is the necessity of circulating information concerning accidents or incidents: the usual procedure, although it is sometimes forgotten – and in any case, I believe that it must not be forgotten – consists of systematically reporting it to the BARPI as soon as it comes to the Inspectorate's knowledge. The BARPI then registers the information in the ARIA database, which I mentioned a few moments ago, so that it can be accessed by everyone, including the Inspectorate, the operators and the experts. The vector for this transfer is, in particular, the new accident report format which I already mentioned, and which will be presented to you tomorrow.

✓ The fourth element concerns the operators' appropriation of this feedback and, in particular, the lessons that can be learned from the past. I would therefore encourage you to make sure, when analysing danger studies, that the feedback, especially that coming from professional bases and the ARIA database, has been exploited.

✓ The final orientation in which I think we must all progress collectively – and it is undoubtedly the most difficult – is the treatment of near accidents or incidents. I feel that it is absolutely essential to encourage operators to better exploit and benefit from these "near accidents", which very often remain within the company, or may even remain within the teams: they are not always reported to the site manager, and even less so outside the company. Nonetheless, I would stress the fact that all deviations are not necessarily reported outside the site. What is important is that these events, which are often, as you know, extremely instructive, can prevent a major accident from occurring: this material must truly be exploited. Consequently, I can only encourage you to be vigilant in this respect, notably when you are carrying out periodic checking of security management systems in SEVESO establishments. I would ask you to make sure that the exploitation of data concerning near accidents is organised and effective.

A few moments ago I reminded you of the need for sanctions when information is not reported after an accident. However, I would modify this slightly with regard to minor operating incidents. With a view to making collective progress, a delayed information could be allowable. This provision, like others, can constitute a kind of firewall against some operators' fears that the Inspectorate may exploit this type of information and, possibly, impose sanctions. In this regard, the objective is clearly not to sanction but rather to progress. As you see, the idea is to integrate faint signals into security management and, in this respect, data concerning near accidents is extremely important.

We must remember that safety is first and foremost the responsibility of the industrialists. It is also, as a second "line of defence", our responsibility as an Inspectorate. A kingly activity is therefore indispensable. On this point, I continue to act in a direct line with my predecessor. Nevertheless, making industrialists responsible remains a priority. For several years, the DPPR and the Inspectorate have been taking action in this respect. The work we can carry out as a network, within the Inspectorate, within the DRIREs, between inspectors, poles, risk cells, the risk office, the BARPI and, moreover, with our Work Inspectorate colleagues, is of primordial importance if we are to progress.

To develop this idea further, communication and information seem to be an important lever. An intelligent use of this lever, such as is already practised by some DRIREs, which use it as a tool for making industrialists responsible, can be provide enormous benefits. DRIREs which are already making public, within the framework of their annual report, a certain number of cases of good or bad students, explore an extremely interesting path. I have therefore requested that a survey be carried out at a national level, in order to proceed in an identical way.

Lastly, I need not remind you that the explosion at the AZF plant has definitively marked the history of industrial safety. It has still to lead to radical modifications in the methods for analysing and managing risks. The law of July 30th last opened up a number of regulatory projects for the DPPR. Tomorrow, Bruno Cahen will talk to us about the first series of consequences for the Inspectorate's daily work. It is a veritable challenge for the Inspectorate's future, as regards both organisation and work methods. We will be taking up this challenge in the months and years to come.

Thank you very much.

Sheets of the accidents presented

Chlorine production

Electrolysis

Hydrochloric acid

Liquid seal

Modification management

Release of a chlorine gas cloud in a chemical plant

January 12, 2003

Saint Auban

(04 – Alpes de Haute Provence) - France

THE INSTALLATIONS IN QUESTION

The site:

The St Auban chemical plant synthesises three types of products from chlorine manufactured on site: polyvinyl chloride (PVC), chlorinated solvents (trichloroethane, trichlorethylene, javel water…) and acids (hydrochloric acid, monochloroacetic acid…).

This complex facility is classed as a "High Threshold" SEVESO establishment for the use and/or fabrication of chlorine, bromine, hydrochloric acid, vinyl chloride monomer, and solvents… Its special intervention plan covers a radius of 5 km and its 2 urban planning control zones extend over radii of 350 and 700 m, respectively.

The unit concerned:

The chlorine manufacturing facility includes 141 mercury electrolysis cells, through which 120 kA of current passes. It can produce chlorine (21 t/h), hydrogen and soda. The chlorine extracted by a network under a slight vacuum, is then cooled, dried and used directly, or liquefied and stored.

THE ACCIDENT, ITS BEHAVIOUR, EFFECTS AND CONSEQUENCES

The accident:

On January 12, 2003 at 1 pm, the high pressure alarm on the chlorine production shop's brine regeneration tank went off. As a safety precaution, the residual chlorine was automatically directed to the javel water network via the tank's vent.

At 2 pm, an increase in pressure on the chlorine intake systems of the electrolysis room lead to successive drops in the load until the electrolysis room shut down completely on the high pressure safety threshold.

At 2.25 pm, the chlorine detection alarm in the drying building next door was triggered. Two PBA-equipped agents reported turbulence in a liquid seal and chlorine cloud formation.

At 3.10 pm, the chlorine detection alarm outside the building was triggered.

At 3.30 pm, the foam operations conducted by the firemen in the drying facility enabled the alert to be called off one half hour later. The site nevertheless remained under surveillance until 6 pm.

Consequences:

Approximately 2 kg of chlorine was released into the atmosphere, i.e. approximately 600 L of chlorine gas.

The establishment's internal contingency plan was initiated. Informed by the operator, the French national railway company "SNCF" (with a rail station located 200 m from the site) decided to delay the Briançon-Marseilles train 50 minutes.

European scale of industrial accidents

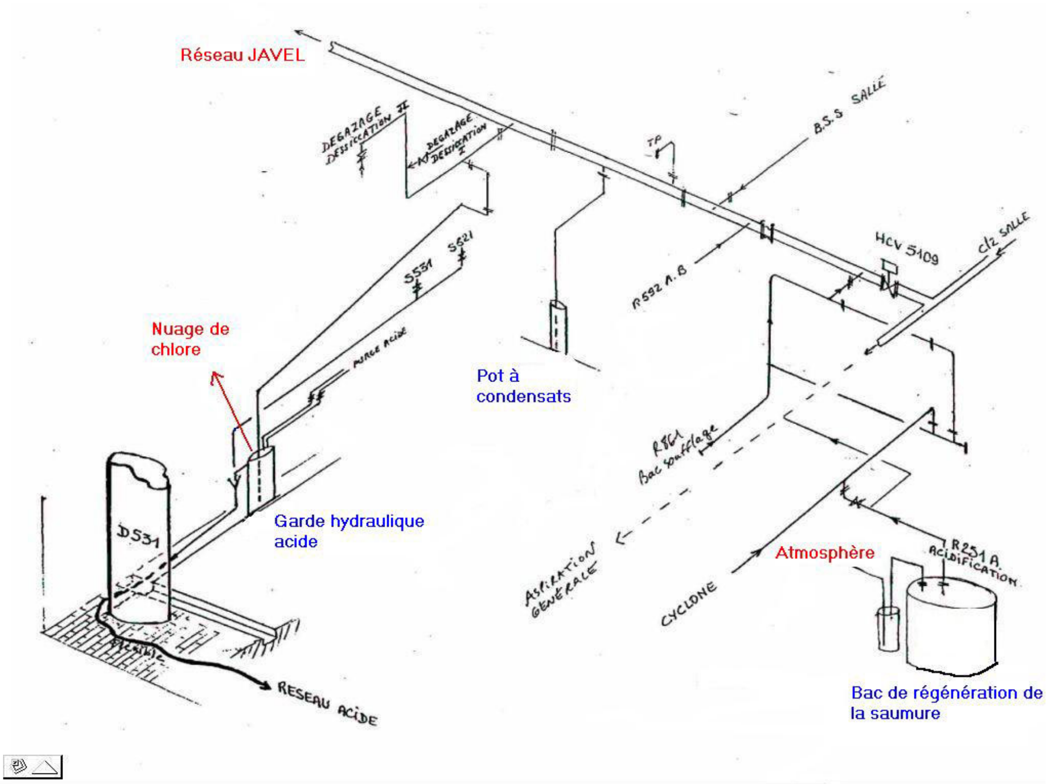
By applying the rating rules of the 18 parameters of the scale made official in February 1994 by the Committee of Competent Authorities of the Member States which oversees the application of the 'SEVESO' directive, the accident can be characterised by the following 4 indices, based on the information available.

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

Quantities of dangerous substances	■ □ □ □ □ □
Human and social consequences	■ ■ □ □ □ □
Environmental consequences	□ □ □ □ □ □
Economic consequences	□ □ □ □ □ □

ORIGIN, CAUSES AND CIRCUMSTANCES OF THE ACCIDENT

The accident was caused by an unexpected influx of air into the tank used to regenerate the brine coming from the mercury electrolysis cells. This influx of air, resulting from an insufficient water level in the liquid seal protecting the tank, lead to pressure fluctuations in the installation and triggered a high pressure alarm in the tank. The excess pressure lead to the regeneration unit being secured and particularly the automatic connection of the tank valve on the javel water network collecting all of the residual chlorinated gaseous effluents (see diagram below).



One hour after the first incident, an increase in pressure on the chlorine manifolds connected to the electrolysis cells lead to a pressure drop, then the automatic shutdown of the cells, with a very significant amount of chlorinated water entering the javel water system. The start-up of the fans, enabling the rapid degassing of the electrolysis cells, caused a sudden peak flow in the network also disrupting the discharge of chlorinated condensates in the manifolds.

Furthermore, heavy condensation of the water vapour contained in the chlorinated effluents released in the javel water system, condensation associated with the temperature difference existing between the inside of the pipes and the workshop, promoted the formation of solid chlorine hydrate. As the formed hydrate deposited, it blocked the branch connection connecting the javel water network to a condensate collection drain, thus preventing it from fulfilling its function. The surplus of condensate, water + chlorine was thus evacuated via a liquid seal located in the drying facility and containing 98% sulphuric acid (H_2SO_4). The water/acid exothermic mixture promoted the vaporisation of the residual chlorine that spread through the workshop and the surrounding area.

ACTION TAKEN

The malfunction of the liquid seal, protecting the brine regeneration tank, was repaired only a month later after the incident happened again, although this time without consequence. The operator will now ensure that it is supplied on a permanent basis.

The branch connection on the condensate tank and the associated pipework was cleaned.

The seal pot containing sulphuric acid, rendered unnecessary by a previous modification, was removed.

The electrolysis facility's procedures and shut-down operations were reminded to all of the operating crews.

LESSONS LEARNED

A few years earlier, an insufficient liquid seal in one of the group's other plants had already lead to the release of chlorine into the atmosphere. It appears that this first accident was not sufficiently developed in terms of feedback; the operator must undertake in-depth reflective thinking on all of the liquid seals within its establishment and revise the danger study of the installation concerned based on this reflective thinking process.

Furthermore, the collection and processing of residual effluents toward safety equipment installed in the plant must for the subject of specific studies.

Beyond this, this accident illustrates the need to systematically consider all installation or process modifications, even minimal, in the danger studies and safety files (see. "Les recommandations dans la chimie fine" (*Recommendations in the field of fine chemistry*), by the UIC, available at the internet site www.aria.environnement.gouv.fr).

Failure of an ortho-cresol storage tank

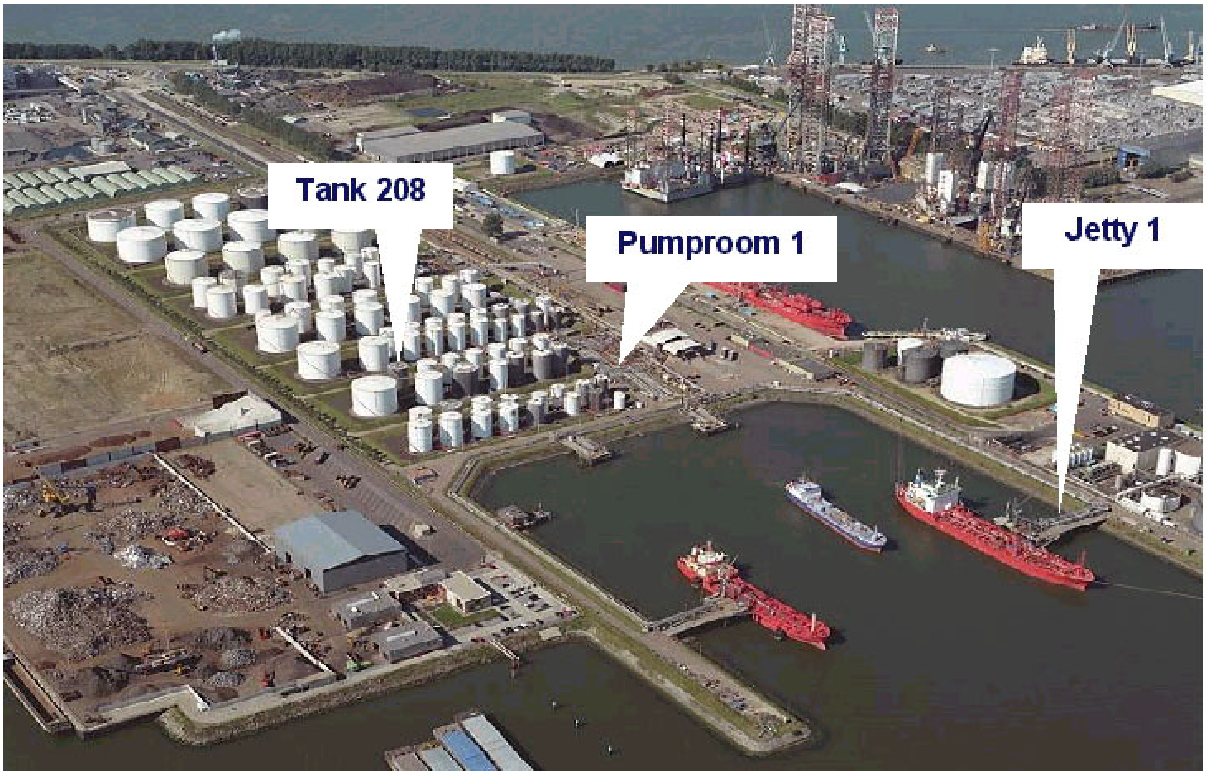
January, the 16th ,2003

Rotterdam – The Netherlands

Hazardous liquid farm
Leak
Collapse of tank
Ortho-cresol
Weld
Steam-coil

THE INSTALLATIONS IN QUESTION

The site involved is a liquid chemicals storage. It is located and set as shown on the photo here under. Two jetties enable loading and discharging operations between ships and the terminal.



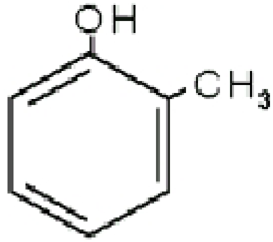
The storage tank was built in 1968 according to the standards of a big petroleum group. It is isolated and internally and externally coated. It is heated with a steam-coil whose diameter is 2” and which is 119m-long. This steam-coil is coated. The tank is equipped with a steam-regulator with bi-metal set at 52°C.

THE ACCIDENT, ITS BEHAVIOUR, EFFECTS AND CONSEQUENCES

The accident :

On the 16h of January, a ship is discharging ortho-cresol into tank 208. At 11h48, the tank fails and 1 700 t of ortho-cresol flow out of it. As a consequence, a vapour cloud rises toward the Vlaardingen urban area located in the vicinity.

This substance is corrosive, toxic and causes offensive smells at low concentrations.



The consequences :

There is no one seriously injured. The authorities take charge of the terminal.

Neighbouring companies have to stop their activities. Furthermore, in the city of Vlaardingen, the sirens are operated, public transport is stopped and the authorities ask people to shelter in place that is to keep “windows and doors closed”.

The River Nieuwe Maas traffic is interrupted and rail-traffic in Rotterdam - Hoek van Holland is stopped as well.

European scale of industrial accidents

By applying the rating rules of the 18 parameters of the scale made official in February 1994 by the Committee of Competent Authorities of the Member States which oversees the application of the ‘SEVESO’ directive, the accident can be characterised by the following 4 indices, based on the information available.

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

Quantities of hazardous substances	■ ■ ■ ■ ■ □
Human and social consequences	■ ■ □ □ □ □
Environmental consequences	□ □ □ □ □ □
Economic consequences	□ □ □ □ □ □

ORIGIN, CAUSES AND CIRCUMSTANCES OF THE ACCIDENT

Facts:

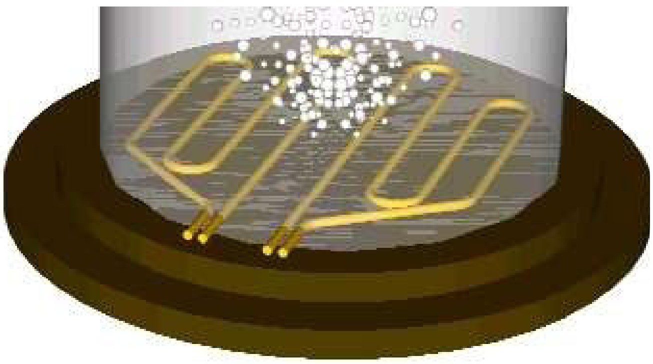
No one was near the tank at the moment of the accident so no witnesses of actual tank-failure testimony was available. But factual elements were recovered:

- The outer shell of the tank vibrated
- A cloud (described as a steam cloud) was seen around the top of the tank
- A large wave (launched by the dike) was seen. It was also noticed that the liquid streamed at a high velocity through an intersecting street towards pump room 1.
- Hose in pump-room 1 moved fiercely.
- Sudden increase in steam consumption was noticed.An internal investigation had been carried out under the guidance of an external expert. The group used the TRIPOD BETA analysis method. The authorities (public prosecutor) investigated the accident as well. They collected elements through interviews, document analyses, technical investigation and above all materials testing.

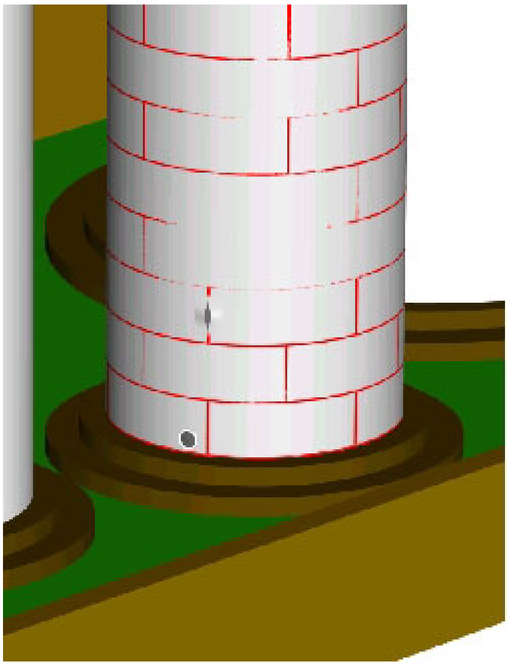
Scenario:

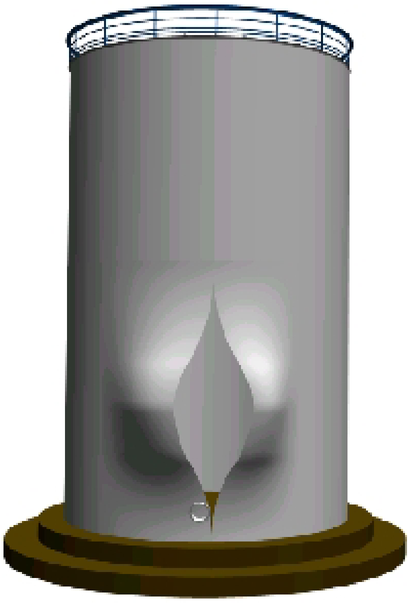
According to these facts around the incident, it had been possible to set up the following scenario:

- First, failure of steam coil in the tank due to :
  - ✓ Different material thickness over 10 cm-length (remind: total length is 119 m)
  - ✓ Corrosion of the steam coil but visually noticeable
  - ✓ Inspections recently carried out : In 2001, a pressure test and ultrasonic measurements had been done.



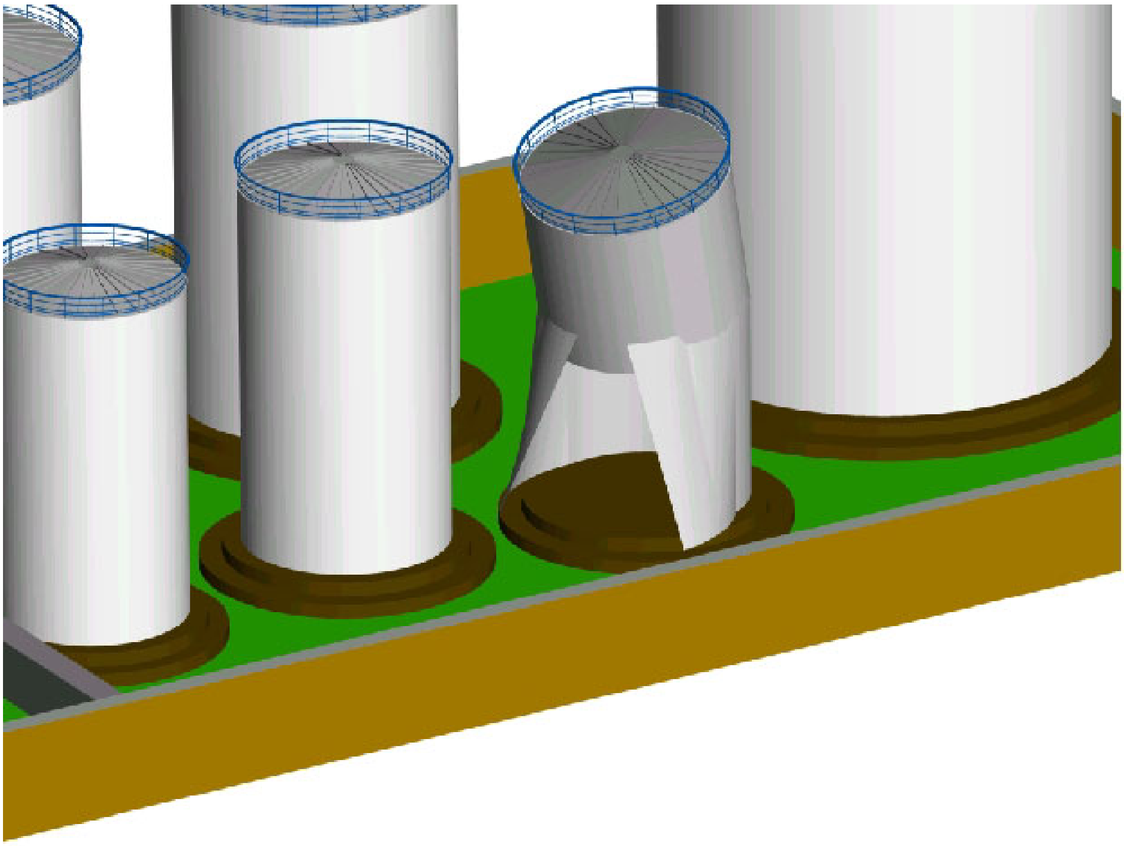
- Steam pressure rose to 7 bar; steam expanded in the tank, involving turbulences inside it and developing pressure waves. At this time, the tank was 96%-full.



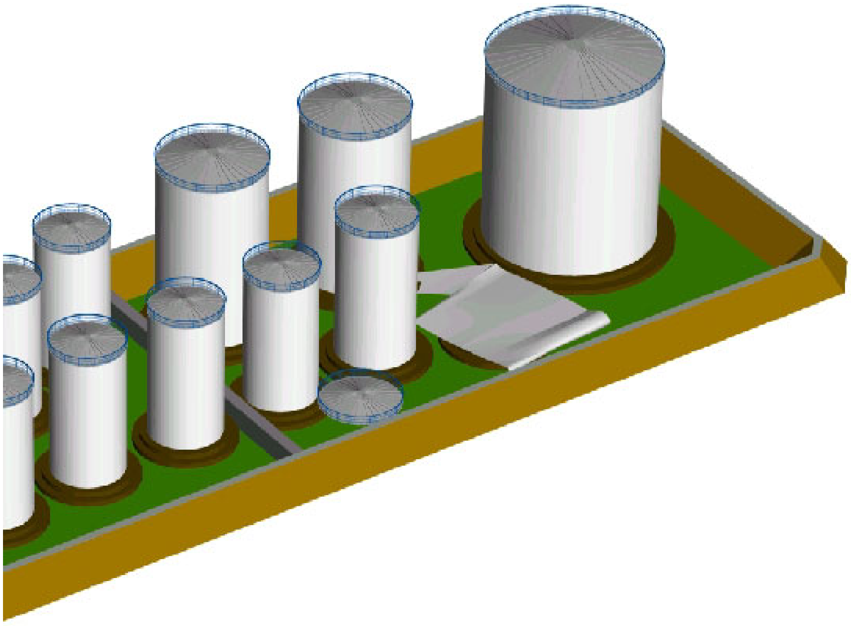


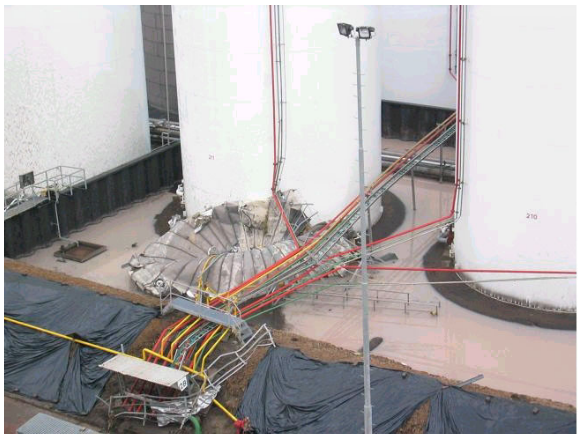
- Due to weakest spot in the hoop, the tank failed because of an inferior quality of one of the welds. In fact, the tank was able to withstand the extra pressure caused by expansion of vapour but not the pressure waves.

- The tank fails in a few seconds and the product flows through the tankpit.



The tank turns on its side and the roof ripped off and moved. Ortho cresol spread over 3 ha.





Conclusions of the investigation:

- Direct operational activities are excluded as cause. It is clear that the accident is due to the failure of the steam-coil. Indeed, 10 cm piece of coil is from thinner material and is internally corroded.

- Tank could take the overpressure caused by the expansion of steam but it collapsed due to dynamic pressure.

- Furthermore a weak weld was found in third ring of the hoop.

ACTIONS TAKEN

The first priority was to clean-up the site and reduce the stench in the surroundings and also to communicate with population. Thus, the following operations were carried out :

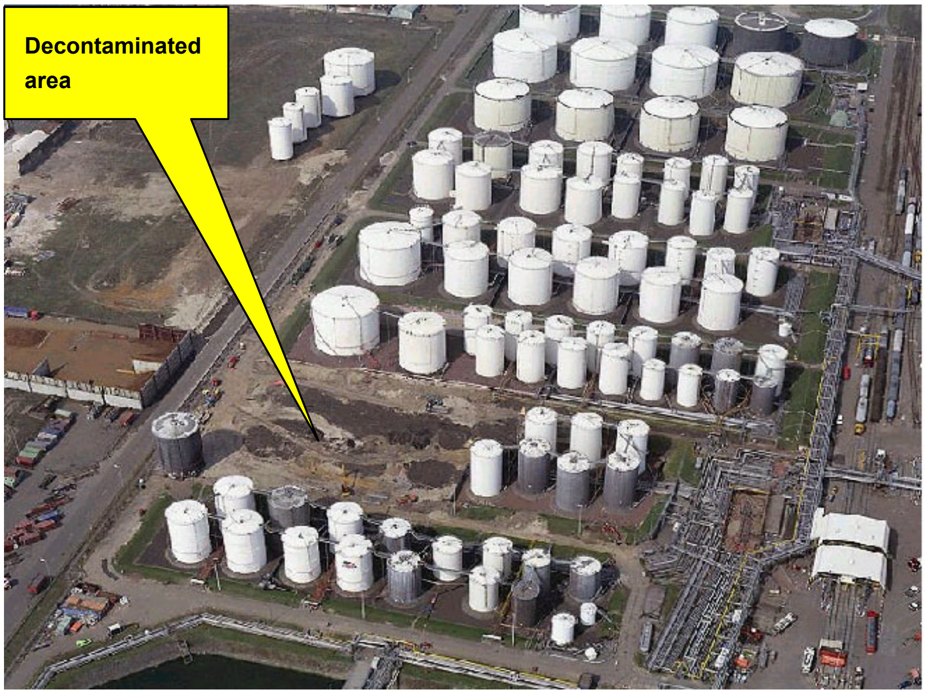
- 1 - Empty surrounding tanks and clean up outside tankpit : the liquid is stored in iso-containers.

- 2 - Removal of solidified product by digging off solidified o-Cresol.

- 3 - Create access to remains and strip remains in order to enable the inspection of these parts of the tank by a technical investigation service. A selection of evidences had to be carried out.

- 4 - Removal of remains of tank. Moreover, other 6 tanks were also dismantled.The total amount of contaminated soil is 17.000 tons.

The picture gives an idea of the site 4 months after the accident.



LESSONS LEARNED

Preventive measures:

Most of them are listed here under:

- Measures on the steam-heating
  - Improvement of the inspection methods for steam-coils,
  - Consider the use of other heating medium
  - Reduction of steam pressure
- Investigation by environmental control agency at other locations,
- Reconsideration of regulations used.

Emission of dangerous substances in a surface treatment facility

March, 20th, 2002

Issoire (63 – Puy de Dôme), France

Surface treatment
Exothermic reaction
Fluoronitric acid
Aluminium
Equipment breakdown

THE INSTALLATIONS IN QUESTION

The site:

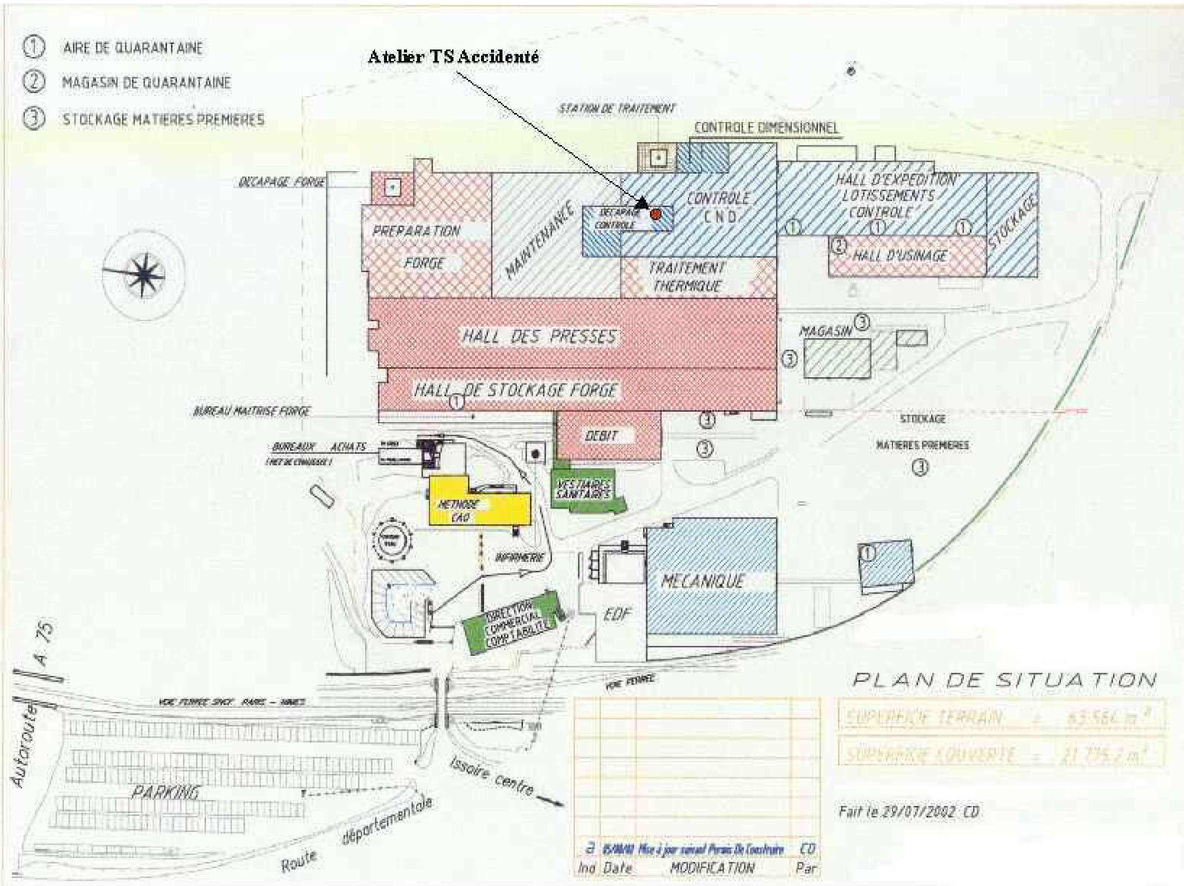
In 1939, the company located on the outskirts of the city of Issoire, in the extreme northern part of the industrial estate, along the Paris - Nimes rail line and the A75 motorway.

The company specialises in the die-forging of titanium and light aluminium alloy parts.

The site currently employs 350 individuals and produces approximately 2,000 tons of parts per year.

The plant primarily includes the following equipment:

- The forge: cutting of the metal, die-forging or forging of the products, heat treatments,
- Machining: pre-machining of the parts produced and die making,
- Inspection: final pickling and anodising (aluminium alloys), inspections and shipments.



The unit concerned:

The accident took place on one of the two surface treatment lines, and more precisely on the control pickling line which is made up of 21 tanks made of stainless steel or composite material, each having a capacity of 6 m³ with a useful volume of 4.6 m³.

This line features specialized modules for:

- treating aluminium alloys: pickling parts after heat treatment (for the removal of the silica based product favouring this operation); the aluminium alloy parts undergo 3 successive pickling operations;
- treating titanium alloys: final pickling after heat treatment, one single pickling operation is foreseen for this type of part;
- the chrome anodising treatment for detecting faults (cracks) in aluminium alloy parts (entirely finished parts).

The treatment tanks are aligned and served by a travelling crane that transports the parts to be treated in baskets, for the small parts, or specific supports for the long parts. During the process, the treatment tanks are covered and connected to a single manifold connected to 4 stacks, each equipped with a 24,000 m³/h suction unit.

THE ACCIDENT, ITS BEHAVIOUR, EFFECTS AND CONSEQUENCES

The accident:

On March 20th, around 10:30 am, an operator was stripping aluminium aircraft fishplates (parts designed to connect the wing to the fuselage) in a cold aqueous solution of 15% pure nitric acid and 5% fluorohydric acid (by volume)[1]. The 4 parts, weighing 200kg each and measuring 2.50 m long, were placed on their special support and immersed into the treatment bath using the travelling crane. Upon attempting to remove the parts from the bath 10 minutes later, the operator noted that one of the two hoists did not operate. A maintenance technician intervened using a platform on the traveling crane's electrical control cabinet, located above. His action on the synchronization of the hoists did not repair the faulty equipment. The part support structure became unbalanced and the 4 fishplates became blocked in the bottom of the tank preventing the partly immersed load from being lifted out of the fluoronitric acid solution.

Under the responsibility of foremen, operators from the Inspection Department, equipped with appropriate protective gear (masks, overalls, gloves and boots), began transferring the bath to a mobile backup tank designed to hold spent solutions. The pumping speed turned out to be insufficient and, while only 1,600 l had been transferred, an exothermic reaction began between the treatment solution and the aluminium, generating a significant gaseous release into the workshop. The operators attempted to control the reaction by cooling the bath with a fire nozzle; this action proved inefficient.

At 11.00 am, the facilities were evacuated and the public emergency services were informed.

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[1] *Bath volume 4,630 l, containing: 1,200 l of 60% HNO_3, 580 l of 40% HF, and 2,850 l of water*

At 11.30 am, the evacuation procedure was expanded to all personnel at the establishment and an safety perimeter was set up at the request of the firemen.

Around 12 pm, a mobile chemical intervention unit arrived at the site.

Around 1 pm, the neighbouring plant (company restaurant, shops and services, involving approximately 450 people) located downwind was evacuated; traffic on the A 75 motorway was simultaneously restricted.

At roughly 3 pm, the firemen of the chemical unit donned hermetic suits in order to handle the incident. The temperature of the acid batch rose to 102° C. After diluting and lowering its temperature by adding water to the tank, the firemen continued the transfer operations started by the plant employees. The operation was completed at 4.30 pm.

Atmospheric pollution measurements conducted by the emergency services using Draegger equipment in the immediate area surrounding the shops and on the neighbouring plant site, then around 5.30 pm in the pickling shop were negative. The pickling line's air extractors remained operational, without creating dangerous fluoride or nitrous concentrations on the exterior on the facilities.

At 5.40 pm, the personnel of the neighbouring plant returned to their facilities and the A 75 was reopened.

At 9 pm, the establishment's stamping activity started up again, except for the Inspection Pickling shop.

Consequences:

Three of the company's employees were slightly effected and were admitted to the Issoire hospital; they were released around 8.00 pm.

From the environmental standpoint, all of the checks conducted by the firemen showed that there were no gaseous emissions harmful to the air quality of the surrounding area. Furthermore, the cooling of the treatment tank did not cause it to overflow and there was no consequence of the quality of the water released. The natural environments, fauna and flora were not effected by this incident.

In terms of equipment, the accident caused only minor damage. Only the treatment tank was damaged due to temperature increase. The fluoronitric solution transferred to the back-up tank was treated in the site's treatment plant. However, the operating losses of both the establishment and the partially evacuated facility next door were evaluated at approximately 305,000 €.

European scale of industrial accidents

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Quantities of dangerous substances	□ □ □ □ □ □
Human and social consequences	■ ■ ■ □ □ □
Environmental consequences	□ □ □ □ □ □
Economic consequences	□ □ □ □ □ □

ORIGIN, CAUSES AND CIRCUMSTANCES OF THE ACCIDENT

At the request of the labour inspectorate, a verification of the travelling crane was conducted by an approved organisation, different from the organisation that habitually performs the operation. A brake failure on hoist No. 2 was diagnosed. This malfunction, followed by the blocking of the load in the acid treatment bath during intervention by the maintenance department, caused the subsequent exothermic reaction and gaseous emissions.

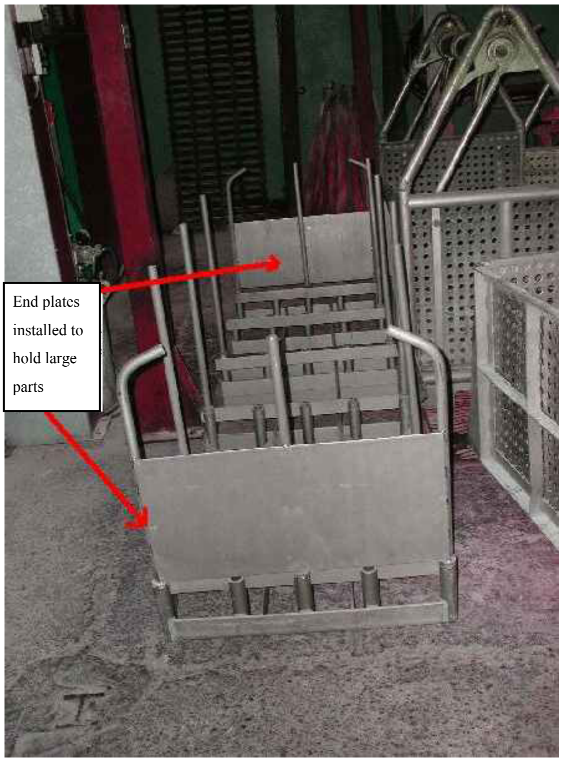
ACTION TAKEN

The day following the accident, the labour inspector and the CRAM engineer attended a meeting of the establishment's CHSCT (committee for hygiene, safety and working conditions).

The operator modified the specific load supports of the same type that were used when the incident occurred, by equipping them with axial stops preventing parts from shifting should the load become unbalanced.

The surface treatment line was authorised to continue operations on March 25, following the repair of the travelling crane and the tank.

A Prefectoral order of June 27 required the manufacturer to update its danger study, particularly in terms of the following points:



- the modifications made in the design of the units and in their operation since the initial authorisation,
- the physical and chemical characteristics of the products used or stored, while integrating the last known studies, particularly for hydrofluoric acid,
- the analysis of significant accidents involving this type of installation,
- the type and consequences of a possible accident on the units, with the definition of precise reference scenarios,
- specific measures to reduce the probability and the effects of accidents.

Measures to prevent and minimise the risks

Following this study, in addition to the modification of the baskets, the operator agreed to undertake the following actions:

- periodic verification of the hoists (internally and by an approved organisation),
- installation of a visual and audible alarm when the normal operating temperature is exceeded,
- installation of a system to ensure gravitational bath drainage of nitric and fluorornitric acids into an underground tank, thereby preventing a runaway,
- use of a trolley with telescopic forks and a rotating hook to mitigate possible failure of the basket handling hoists,

Furthermore, in terms of the part removal incidents, the operator defined a maximum intervention time beyond which the workshops are to be evacuated and the public emergency services are alerted.

Additional analysis

After the accident of March 2àth and the protective measures taken at the time – the evacuation of company employees and those of the neighbouring facility, stopping traffic on the A 75 motorway – the danger study, despite the safety features implemented, also evaluated the potential impact of this type of chemical accident on the surrounding area, without the intervention of the personnel (the subsequent impossibility to remove the parts from the acid bath or to drain the treatment tank).

In order to characterise the maximum danger potential, the most penalising scenario, that is the thermal decomposition of the bath's acid compounds (disregarding the quantities of acid used to attack the metal, side reactions with the air, oxidations or local reductions) were examined.

The exothermic reaction of the fluoronitric acid bath would lead to the emission of 345 Nm^3 (710 kg) of NO_2 and 307 Nm^3 (274 kg) of HF. The following characteristics of the releases taken into account:

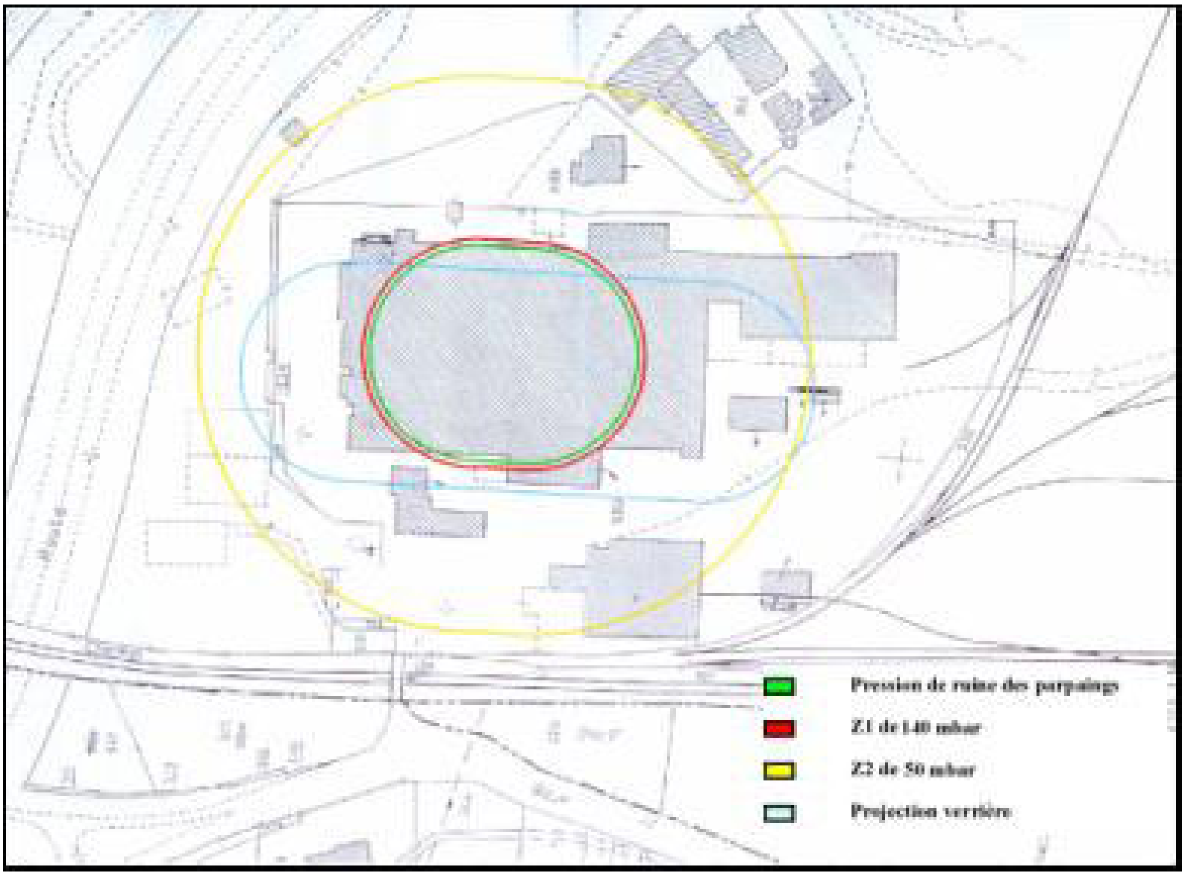
Pollutants	Total mass flow	Emission type
NO2	65.7 g/s (i.e. 16.42 g/s per stack)	Recording over 3 hours
HF	25.4 g/s (i.e. 6.35 g/s per stack)	Recording over 3 hours

The modelling of the atmospheric dispersion of these untreated effluents, which take the topography and the nature of the ground into account as well as the meteorological conditions that may be encountered on the site, has shown that the maximum concentrations, greater than 2 mg/Nm^3 for NO_2 and 1 mg/Nm^3 for HF, will be within a radius of approximately 250 meters around the stacks. The homes that are the closest to the site will thus be subjected to NO_2 concentration levels between 1 and 3 mg/m^3 and HF levels between 0.5 and 1 mg/m^3. *(See Appendices 1 and 2)*

In terms of toxicity, the reference threshold limit value (TLV) for nitrogen dioxide in the air of the occupational setting is 3 ppm (6 mg/m^3), that of hydrofluoric acid is 3 ppm (2.5 mg/m^3), for a period of 15 min. *(Refer to the INRS toxicological data sheets).*

According to the danger study, the threshold for irreversible effects for hydrofluoric acid, as it may be extrapolated (as per the Haber law) for a duration of 3 hours, is not reached both on the inside and on the outside of the stamping plant.

Beyond the chemical hazard potential, the study also estimated the risks presented by the explosion of the high pressure compressed air tanks (5 m^3 at 250 bar). The modelling particularly shows that nearly all of the manufacturing shops are within the overpressure zone (55 m) of 140 mbar (lethal effects) and that the 50 mbar zone extends up to 120 m from the source.



LESSONS LEARNED

In the metal surface treatment sector, a runaway reaction due to a part being in a bath for an extended period of time is not exceptional (fallen part, handling error, bath error…). Besides providing specific training to treatment line operators, the technical solutions proposed by the operator following the accident of March 20th must be able to be implemented on many units where the type of treatment bath and metals treated could lead to significant exothermic reactions and releases to the atmosphere.

It would appear essential that the operator evaluate the impact of releases resulting from a part being blocked in a treatment bath. The dispersion study conducted for the Issoire plant shows that the area immediately surrounding the unit in question (200 to 250 m) could be significantly effected in the case of violent thermal decomposition. *A posteriori*, the measures taken at the time of the accident, including the evacuation of plant employees and those of the company next door, and the shut-down of motorway traffic were a wise precaution in anticipation of a change toward this type of scenario.

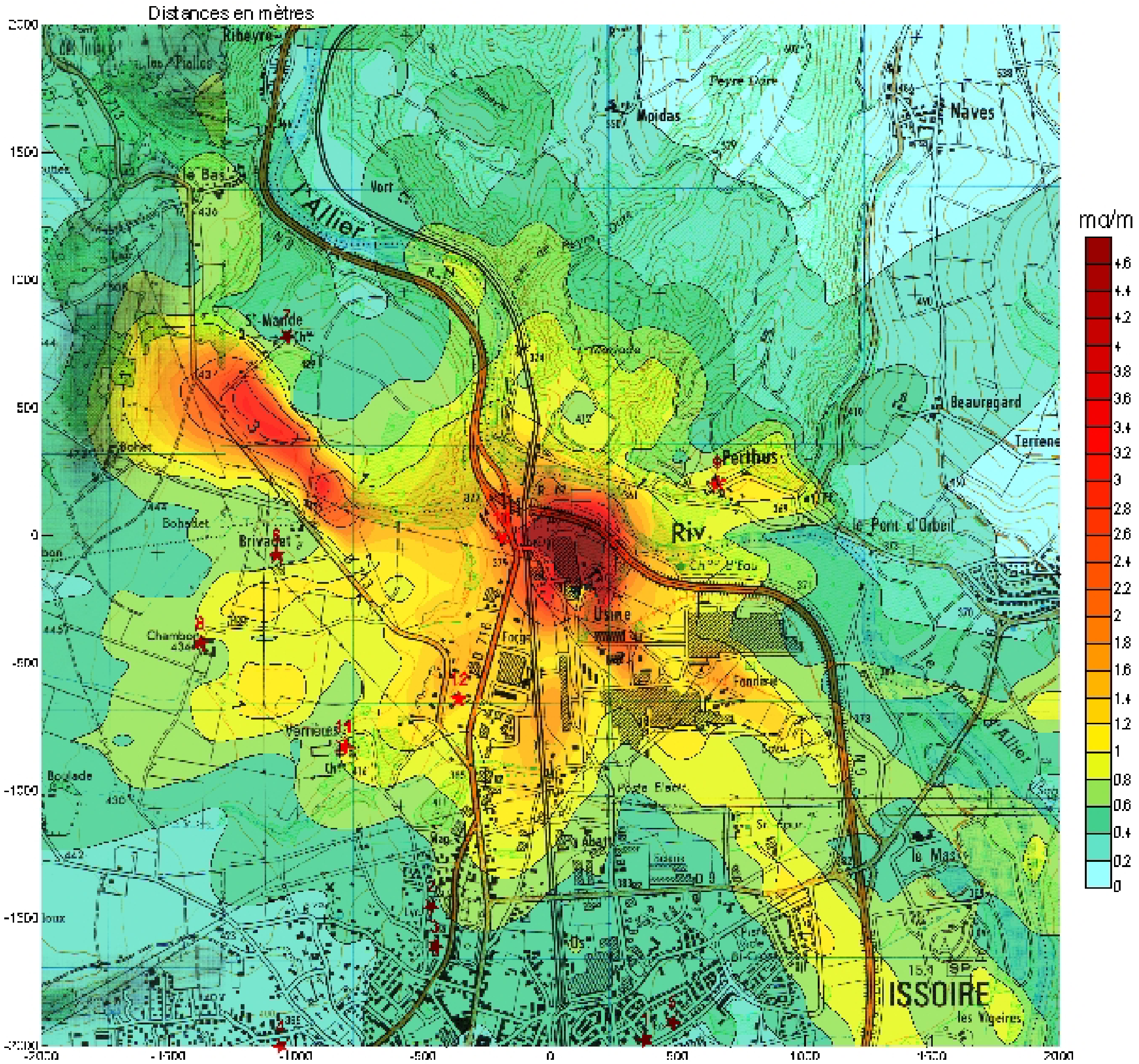
Furthermore, the danger study's evaluation of the effects of an explosion of the compressed air tank demonstrates the importance of not neglecting any scenario even those that concern equipment operating at regulated pressure.

Appendix 1:

Accident in a surface treatment facility
Issoire (63 - Puy-de-Dôme), France
March 20th, 2002

Simulation of the atmospheric dispersion of the accidental release of NO_2 vapours

Maximum NO_2 concentrations

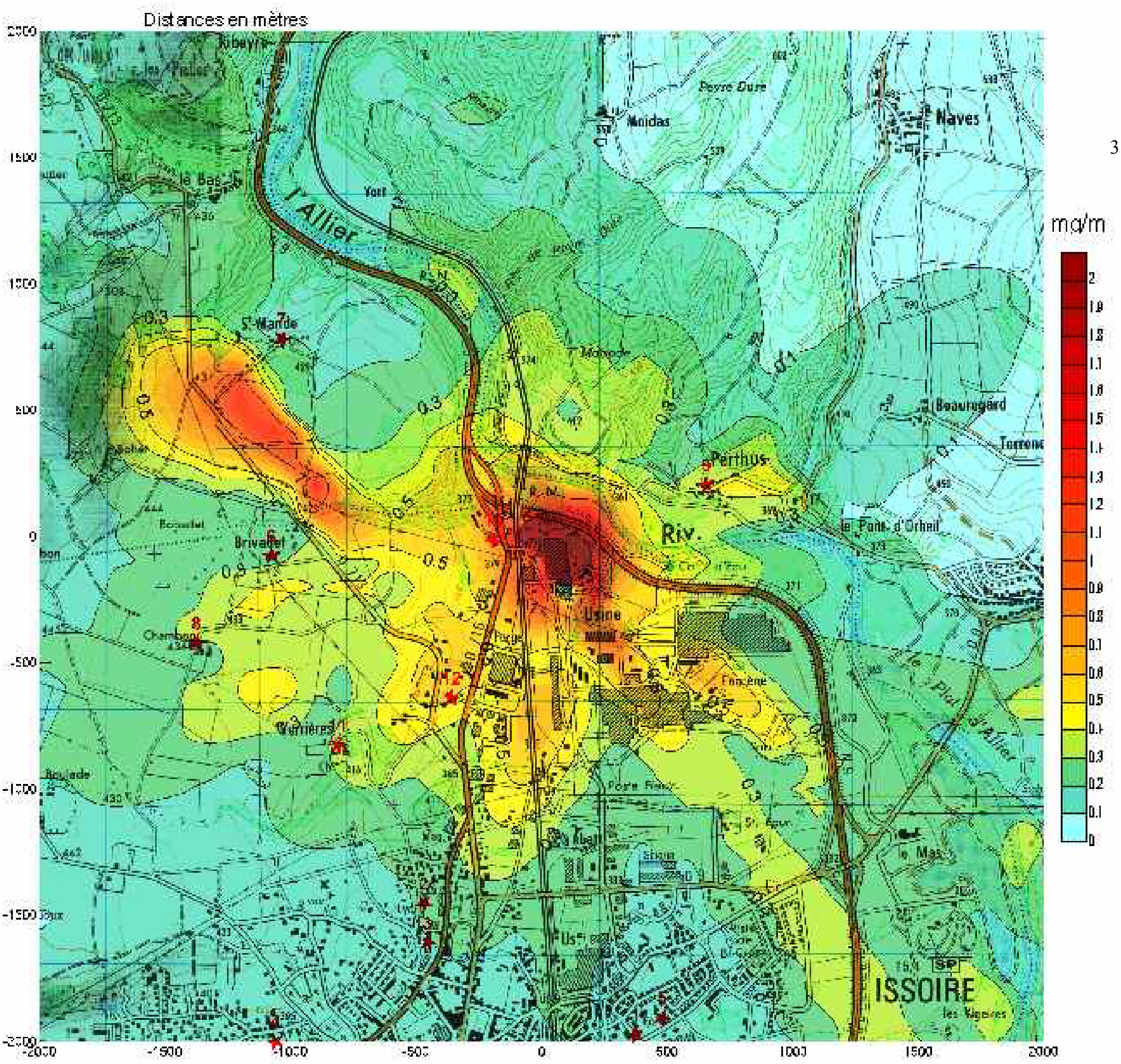


Appendix 2:

Accident in a surface treatment facility
Issoire (63 - Puy-de-Dôme), France
March 20th, 2002

Simulation of the atmospheric dispersion of the accidental release of HF vapours

Maximum HF concentrations



Fire

Chemical wastes

Incompatible substances

Communication

Administrative coordination

Fire in a collecting chemical waste centre

May, 12th, 2000

Drachten – The Netherlands

THE INSTALLATIONS IN QUESTION

The activity of the site consists in collecting, sorting and sorting chemical wastes before their transports and further treatments. It constitutes a big centre. The city where it is located is a 30 000 inhabitant-one and is located in an agricultural and watery surrounding.

On an administrative level, the facility has got a new brand environmental permit.

THE ACCIDENT, ITS BEHAVIOUR, ITS EFFECTS AND CONSEQUENCES

The accident :

The waste-shed stored 480 tons of various wastes.

Furthermore, during the crisis, a lot of different authorities were involved :

✓ Mayor with its own departments : fire-brigade ; police ; local medical service

✓ Provincial governor

✓ Legal authorities:

× Province : it gives the regular environmental permits

× Waterschap : it gives permits for draining waste-waters

✓ National ministry of agriculture

✓ National environmental Inspectorate

✓ RIVM : National Institute for public health and environmental questions.

The consequences :

The waste-shed is destroyed, the fire-brigades did not succeed in extinguishing it but used a strategy consisting in preventing an eventual spread to other premises.

As so far as the substances stored were not well-known, it was difficult for fire-brigades to adapt themselves to the circumstances: violent fire, quick propagation, possibly hazardous substances stored, …

European scale of industrial accidents

By applying the rating rules of the 18 parameters of the scale made official in February 1994 by the Committee of Competent Authorities of the Member States which oversees the application of the 'SEVESO' directive, the accident can be characterised by the following 4 indices, based on the information available.

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

Quantities of hazardous substances	□ □ □ □ □ □
Human and social consequences	■ ■ □ □ □ □
Environmental consequences	□ □ □ □ □ □
Economic consequences	□ □ □ □ □ □

ORIGIN, CAUSES AND CIRCUMSTANCES OF THE ACCIDENT

Chemical heating-brew and incompatible combination of "sorted" chemicals caused fire in the storage-shed.

When the accident occurred, the fire-extinguish installation failed :

- ✓ Hi-ex inside air installation seemed to be inappropriate for the kind of chemical stored
- ✓ Ventilation-grids did not close automatically
- ✓ Insufficient amount of foam
- ✓ Adding foam by the fire-brigade did not work out;

Fire-extinguish installation was approved by an acknowledged private inspector.

ACTIONS TAKEN

Measures in the acute stage :

- ✓ The Mayor declared an emergency regulation for the immediate surroundings : emergency teams closed the area and evacuated the other industries located in the vicinity.
- ✓ The sewer was cut-off to collect extinguish-waters.
- ✓ Indicative measurements were carried out by fire-brigades with dräger-tubes : they indicated that there was no risk for public health and, as a consequence, they decided to take no measures toward civil population because surveillance showed that they were not exposed to the smoke.

- ✓ Air, grass and milk samples were supposed to have been contaminated by dioxines so :
  - × Cattle were sheltered in,

  - Grass was cut and destroyed
  - Milk was treated separated

Measures in controle stage / after-care

- ✓ Risk-assessment based on air, grass and milk samples (RIVM):
  - No risk for public health (not acute nor in the future)
  - Emergency-regulation and agricultural measures were ended
- ✓ Further inquiry because of public anxiety (province):
  - Soil
  - Water (swimming, drinking waters for cattle, fish-consumption)

Political implications :

- ✓ Criminal inquiry to possible illegal activities by the operator causing the fire (police)
- ✓ Discussion about the position of the Mayor
- ✓ Discussion about the way the Province operated as legal authority
- ✓ Questions asked in the national Parliament

LESSONS LEARNED

Technical level :

- ✓ Regulations for storage of chemicals are to complicated choices
- ✓ Several inspection standards
- ✓ Approval by a acknowledged private inspector is no guarantee for :
  - Selection of the right fire-extinguish installation
  - Good functioning installation
  - Hi-ex inside air installation:
  - Suitable for liquid chemicals
  - Not suitable for solid products that are sensitive to brew

Management level :

- ✓ Cross-over from acute stage to control stage must be clearly marked (responsibilities)
- ✓ Careful communication; (Avoid saying immediately that there is no risk!)
- ✓ Regular authorities should be involved directly during the acute stage

- ✓ Risk-assessment in the acute stage should be based on precaution instead of air measurements
- ✓ Inquiries in the control stage /after-care should be well coordinated.

Fine chemistry
Explosion
Enamelled reactor
Corrosion
Hydrogen
Blow-out disc

Blast in a reactor on a fine chemicals site

September 3, 2002

Marans (17 – Charente Maritime), France

THE INSTALLATIONS IN QUESTION

The site

The establishment, located in Marans, in the Charente Maritime *département*, was created in 1959 to manufacture medical imagery products – and fine chemistry specialty products (iodine based chemistry). In 2002, it had 90 salaried employees and reported turnover of 16 million Euros, distributed among two main activities:

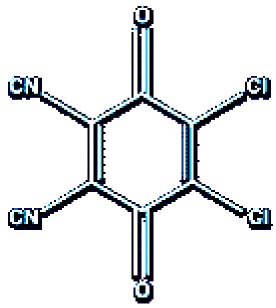
- ✓ 60% for group products, medical imagery,
- ✓ 40% for custom-made chemical specialty products.

The site operates various reactors with enamelled walls, with capacities ranging from 50 litres to 6.3 m^3.

This establishment is an installation subject to authorisation. it is classed as low level "SEVESO" for the products that it uses. The last prefectoral order authorising the establishment to operate dates back to February 20, 1990.

The unit concerned:

The plant's manufacturing unit No. 1 is regularly used to produce 2,3 DICHLORO 5,6 DICYANO BENZOIQUINONE (D.D.Q.). This product is most commonly manufactured by the company and used in the field of medical imagery (MRI): the selective reduction of this product allows certain ailments to be detected (cancers).



The reduced form (DDQH) may also be regenerated by oxidation at low pressure (2 bar) in a reactor with enamelled walls: the DDQH is put in solution with nitric acid, gaseous oxygen and a solvent, dichloromethane (CH_2Cl_2). The reaction temperature is between 20 and 32°C. The DDQ produced is then dried and packaged.

The accident occurred during the regeneration reaction in a 1,500 l reactor. It also involved the transfer line after the blow-out disc and the upline crash tank. Prior to the accident, the operator had performed more than 200 regeneration cycles without any particular difficulty.

THE ACCIDENT, ITS BEHAVIOUR, EFFECTS AND CONSEQUENCES

The accident:

On September 3, 2002 at 9 pm, the hydrogenated DDQ (DDQH) regeneration reaction was launched in the enamelled reactor.

At 9.30 pm, the mixture displayed abnormal behaviour: the operators were required to degas twice in order to mitigate the increases in pressure in the reactor.

At 9.55 pm, the reactor slowly began to increase in pressure, an operator was ready to degas. While his hand was on the vent control valve, a blast occurred in the reactor and in the associated crash tank via the vent pipes and valves.

A second operator at the scene evacuated his co-worker and sounded the alarm. The site was secured after the firemen and standby crews arrived. The alert was lifted at **11 pm**. The neutralisation of the process began at **00.30 am** by slowly pouring in diluted hydrochloric acid, and was completed at **1.30 am.**

Consequences:

The first operator suffered superficial burns to this forearms, a nose injury, enamel fragments in the hands, eye irritation and a sore eardrum.

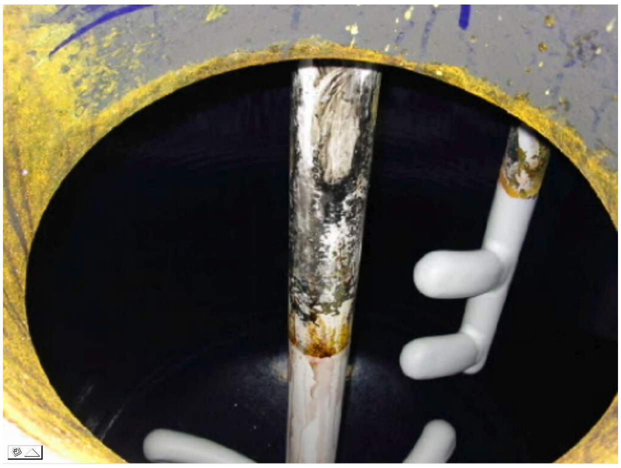
In terms of equipment damage, at the building level:

- ✓ Twenty square meters of the ceiling were blown out, mainly on the span of clear sheeting (the sheeting was folded although it remained in place),
- ✓ The siding on the upper part of the building, to the west and to the north, was blown out over 5 m with partial tearing away of the sheeting,
- ✓ Traces of product projection was visible on the northern part of the wall, up to heights of 2 m,
- ✓ Impact holes (possibly due to pieces of PVDF) were observed on the clear siding.

At the level of the crash tank zone, located outside the building:

- ✓ The crash tank's plastic cover was completely ripped away, as well as all of the connecting pipework,
- ✓ 30 cm of liquid is present in the tank,
- ✓ A piece of broken plastic was projected through a window in the administrative office.

At the reactor level



- ✓ Several gaskets exited their seats (manhole, cover and vent outlet), and their metal reinforcements are were partially torn,
- ✓ Yellow traces indicate that product exited by the cover gaskets and manhole,
- ✓ A change in appearance of the PVDF piping and the valve was noted,
- ✓ Numerous enamel fragments were present on the reactor and in its immediate proximity
- ✓ The lower part of the metallic protection of the mixing shaft is caved in.

On the outside of the site,

- ✓ A flange weighing approximately 1.2 kg was found by a neighbouring resident 70 m from the building in question,
- ✓ Several other elements of the installation (PVDF valve, crash tank cover…) were found at different locations around the site (other workshop, administrative building…)

The blast effect was limited to the immediate vicinity of the building, although the explosion was heard up to 300 m away. Projections of DDQ were observed in the immediate environment of the building and in the establishment. Local residents reported neither a cloud (although it was night time), or deposits of DDQ.

European scale of industrial accidents

By applying the rating rules of the 18 parameters of the scale made official in February 1994 by the Committee of Competent Authorities of the Member States which oversees the application of the 'SEVESO' directive, the accident can be characterised by the following 4 indices, based on the information available.

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

Quantities of dangerous substances	□	□	□	□	□	□
Human and social consequences	■	□	□	□	□	□
Environmental consequences	□	□	□	□	□	□
Economic consequences	□	□	□	□	□	□

ORIGIN, CAUSES AND CIRCUMSTANCES OF THE ACCIDENT

Various investigations were conducted on the products and the process in order to determine the causes of the accident. All of the checks made on the materials used for the synthesis showed no sign of anomaly. Laboratory tests in similar conditions showed no particular instability or abnormal reaction behaviour.

Searches conducted after the accident proved that the blast concerned only the gaseous phase of the reaction environment. The gaseous phase was significantly oxygen-enriched in relation to the habitual mixture owing to the successive degassing operations conducted by the operator to control the increase in pressure.

This research did not provide formal proof as to the exact origin of the phenomenon that initiated the blast. The most probable hypotheses are as follows:

The combustion of the dichloromethane (CH_2Cl_2) / oxygen (O_2) pair was initiated by an electrostatic discharge. A static electricity initiation point was observed on a Teflon-coated valve located on a tube of the cover that may have acted as an insulated conductor.

The self-detonation of an oxygen (O2) / hydrogen (H2) mixture, the hydrogen being produced by the acid corrosion of an unprotected metal surface. A corrosion spot was observed at the top of the mixing shaft. This defect on the coating of the enamelled surface of the reactor's mixing shaft happened when the mixer was being installed after inspection, an impact to which the operators did not pay any attention. As such, a gaseous mixture of dichloromethane and oxygen, sufficiently enriched with hydrogen in order to be self-detonating, may have formed in a recess of the reactor, created by the tube. The results of the tests, the extent of the damage associated with the blast and the observation of an enamel corrosion spot, backs the hypothesis of hydrogen being present in the environment.

In addition, it should be noted that if the rupture valves and discs had functions as intended, they were not designed for such a blast; the same is true for the transfer pipes leading toward the crash tank.

ACTION TAKEN

The operator suspended this manufacturing process pending the results of the various expert evaluations conducted. It was then decided that the process be abandoned all together. Studies were conducted to find alternative solutions to this process.

LESSONS LEARNED

A process, even very often implemented, may still be at the origin of the accidents.

Further to post-accident investigations, the operator determined that a process conducted in a gaseous oxygen and CH_2Cl_2 solvent environment required that the following conditions be controlled:

- ✓ Do not reach the explosive limits of the solvent/O_2 mixture in the gaseous phase,
- ✓ Guarantee the strict absence of hydrogen resulting from acid corrosion of a metal surface in the reactor's gaseous phase,
- ✓ Control all risk of static electricity discharge in the reactor, particularly at the gaseous phase level,
- ✓ Avoid all possibility of nitration of the sealing fluid (alcohol or glycol) in the mixing system's seal packing.

The enamelled walls are very efficient in terms of corrosion protection, but they are also very fragile: they are sensitive to mechanical and thermal shocks. The process evaluation studies must consider the risk of damage to the protection of these walls and regular inspections must be conducted (by analysing with high voltage current, for example).

Finally, the dimensioning of the protection accessories of the reactors and the associated pipework must be adapted. In this manner, the rupture disc / safety valve assemblies must be designed and dimensioned to also take the pressure increase dynamics into account, primarily during thermal runaway or the formation of significant quantities of gaseous sub-products. It is also recommended to take into account the risks of vesicular entrainment or condensation in the connections equipped with safety devices of this type (see "Les recommandations de la chimie fine" (*Recommendations in the field of fine chemistry*) by the UIC, available on the internet site www.aria.environnement.gouv.fr).

Explosion in an empty chemical reactor

January 29, 2002

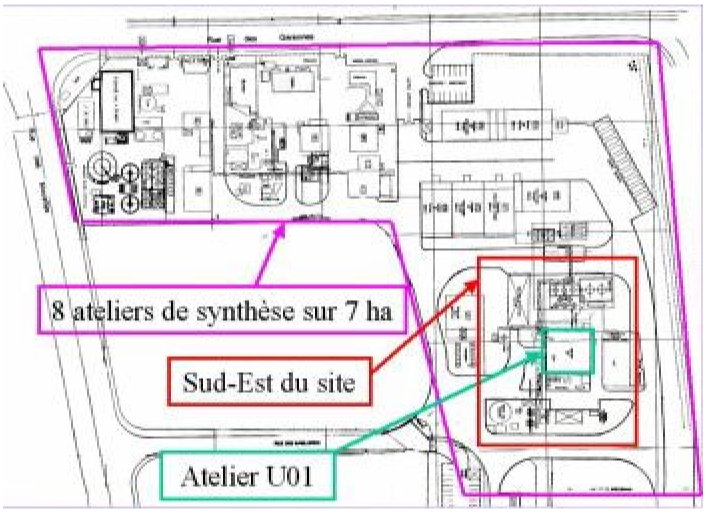
Calais (62 – Pas de Calais) - France

Explosion
Fine chemistry
Washdown
Nitrogen inerting

THE INSTALLATIONS IN QUESTION

The site:

Involved in the fine chemistry industry, the company operates 8 shops specialising in the synthesis of intermediate products for the pharmaceutical industry. It was created in 1976 and employs 125 people. The site (covering approximately 7 ha) is located to the northeast of the city of Calais, in the Dunes industrial estate, and to the south of the Hoverport terminal.



The establishment is subject to the "Seveso II" directive: it was declared "High Level" Seveso in application of the additivity rule of the substances. Its last Prefectoral authorisation order is dated April 22, 1998.

The site has a production capacity of 140 m^3 for reagent ranging from 1,500 to 8,000 litres. Annual production is in the order of 1,200 tons.

The unit concerned:

The reactor (R404) involved in the accident is located in shop U01, to the southeast of the plant. With a capacity of 2,800 l, it was new and in service less than one month.

THE ACCIDENT, ITS BEHAVIOUR AND CONSEQUENCES

The accident:

On January 27th at 1 pm, a hydrogenation operation was completed in reactor R404 (this manufacturing formula is relatively infrequent, even rare, as the last series was performed more than 6 years ago). Six washdown operations with water were conducted to eliminate traces of reaction catalyst (Palladium) as well as two hot methanol stripping operations (30°C) to eliminate traces of organic compounds still contaminating the reactor.

On January 28 at 2.40 pm, reactor R404 was allowed to drain. **At 9 pm**, it was heated empty to 80°C for a period of 8 hours.

On January 29 at 5 am, the operator, before leaving his work station, shut down the heating, re-established the pressure with nitrogen and opened the air vent to allow the reactor to cool down naturally.

On January 29 at 10 am, the foreman cooled reactor R404 for its subsequent examination. An hour later, the foreman noted that the inside of the reactor was "a bit tarnished and a bit humid with a residual trace on the bottom". **At 5 pm**, following this assessment, the shop supervisor requested that the reactor be washed again. Analyses of the methanol wash solution confirmed that the previous washdowns were inefficient: synthetic and intermediate product was detected.

On January 29, 2002 at 6.45, an explosion occurred on R404 during the additional washdown operation that was requested during the day. A manhole had been opened to conduct the requested rinsing operation.

Consequences:

An operator was found lying next to reactor R404, and his face seriously burned.

The reactor and the related installations showed no signs of visible damage. The reactor's gasket had been ejected a few metres away. The reactor was immediately closed and injected with nitrogen.

European scale of industrial accidents

By applying the rating rules of the 18 parameters of the scale made official in February 1994 by the Committee of Competent Authorities of the Member States which oversees the application of the 'SEVESO' directive, the accident can be characterised by the following 4 indices, based on the information available.

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

Quantities of dangerous substances	□	□	□	□	□	□
Human and social consequences	■	□	□	□	□	□
Environmental consequences	□	□	□	□	□	□
Economic consequences	□	□	□	□	□	□

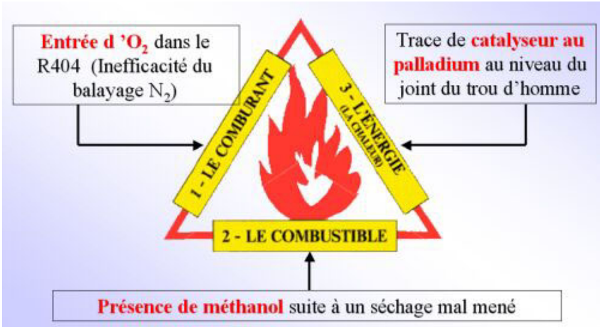
ORIGIN, CAUSES AND CIRCUMSTANCES OF THE ACCIDENT

The origin of the accident was most certainly due to the sudden combustion of an explosive gaseous mixture inside the reactor.

Following what appears to be a poorly executed drying operation, traces of methanol were still present in the reactor. While evaporating, these traces lead to a concentration of vapour consistent with the explosion. Confirmed by post-accident measurements, the nitrogen bubble output only partially fulfilled its role and did not prevent oxygen from entering the reactor when the manhole was opened.

The last reaction that took place in the reactor was a hydrogenation reaction involving a Palladium catalyst, which is a substance that spontaneously ignites in contact with the oxygen in the air when it is dry. The presence of traces of this catalyst in the reactor is suspected, particularly around the reactor seal.

The combination of these 3 elements (Combustible – Oxidant - Energy) lead to the explosion.



ACTION TAKEN

Prior to the re-start of the unit, the Registered Installations Inspection requested the following:

- ✓ Identification of the accident's exact causes and circumstances,
- ✓ The determination of the measures to be taken to prevent such an event from happening again,
- ✓ The verification of the integrity of the installations by repeating a reactor hydraulic test.

LESSONS LEARNED

Locally, the operator took the following measures to prevent an accident of this type from reoccurring:

- ✓ Implementation of a specific washdown procedure of the gasket specific to reactor R404,
- ✓ Modification of the nitrogen system, with increased output for the manhole opening and a nitrogen presence indicator,
- ✓ New written instructions and procedures displayed at the workstation,
- ✓ End of sequence by use of distilled water to clean the reactors following a reaction implementing a pyrophoric catalyser,
- ✓ A new awareness campaign among the personnel concerning the importance of the inerting operation and the strict respect for strict adherence to instructions (completion of operating logs and reactor drying procedures),
- ✓ New explosive atmosphere training for all operators.

The modifications proposed by the operator, and in particular the change of the procedure for cleaning the R404, as well as the new gasket cleaning and inerting procedures, must ensure that operations take place in improved safety conditions.

In relation to this and with the same concern for safety, the operator also installed loading hoppers operating by nitrogen thrust on several reactors. A new drier operating under the nitrogen inerting principle was also purchased.

Explosion in an additive tank in an oil and bitumen refinery

May 18, 2002

Dunkerque (59 - Nord) – France

Explosion
Inerting
Decomposition
Storage
Additive

THE INSTALLATIONS IN QUESTION

The establishment is a lubricating oil refinery located in the Port of Dunkerque since the early 1950s. The installation is classed as a "High Threshold" SEVESO establishment under the terms of section No. 1131 of the classified installations nomenclature – *storage and use of toxic substances.*

The refinery was in-status. The site's activities are primarily regulated by a Prefectoral authorisation order dated March 8, 1994. The plant employs 260 people.

At its Dunkerque site, the establishment produces base oils, bitumen and derivative products from atmospheric residues and hydrocracking residues from petroleum refining units.

It features an industrial blast-type bitumen production facility and a paving asphalt and polymer bitumen production unit that uses a mixture of bases and specific additives.

The bases and additives are stored at the site prior to use.

THE ACCIDENT, ITS BEHAVIOUR, EFFECTS AND CONSEQUENCES

The accident:

The accident occurred Saturday, May 18, 2002. At 3.30 pm, there was an explosion in the bitumen tank zone (there was no eye witness). The explosion took place on a tank containing a bitumen additive. The roof of the tank was thrown next to the tank. The explosion was followed by a fire in the tank (with flames rising to heights of 10 meters). The internal contingency plan was put into action. The operator was able to bring the fire under control within the next 10 minutes, using 2 fire nozzles. No one was injured.

The firemen of the SDIS (Service Départementale d'Incendie et de Secours", fire and emergency services), who were called immediately after the fire alarm was activated, arrived at the site but their firefighting means were not employed. The DRIRE alert officer was contacted by the *Prefecture* of the *Nord* department at 4.40 pm. A press release compiled by the sub-prefecture was sent to the regional press the same day.

The accident claimed no victims or significant property damage, except for the tank itself.

At the time of the accident, the wind was not blowing in the direction of the local residents, but toward the docks. The quantity of material lost in the fire was estimated to be 1 m³. Almost all of the material remaining in the tank was transferred to another recipient, prior to being eliminated in an external industry as the remaining product could not be used as it had become mixed with firefighting foam.

Following the accident, the active orders for product were cancelled. The tank involved in the fire was the only storage unit for this type of product at the site. The lack of product did not jeopardize normal operation of the remaining installations as it was only required for a small part of the site's production activity.

European scale of industrial accidents

By applying the rating rules of the 18 parameters of the scale made official in February 1994 by the Committee of Competent Authorities of the Member States which oversees the application of the 'SEVESO' directive, the accident can be characterised by the following 4 indices, based on the information available.

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

Quantities of dangerous substances	☐	☐	☐	☐	☐	☐
Human and social consequences	☐	☐	☐	☐	☐	☐
Environmental consequences	☐	☐	☐	☐	☐	☐
Economic consequences	☐	☐	☐	☐	☐	☐

ORIGIN, CAUSES AND CIRCUMSTANCES OF THE ACCIDENT

The tank that caught fire contained an additive used to manufacture bitumens and consisted of 2 polymers with a high flashpoint. The tank had a capacity of 185 m^3 (diameter: 6 m – height: 6.5 m) and was able to contain 140 tons of product. At the time of the incident, the tank was nearly full.

The tank was heat lagged and equipped with a mixer and heating coil to maintain the product at a uniform temperature of 150° C (below a certain temperature, the product becomes too viscous and cannot be transferred or pumped). In terms of safety equipment, the tank was equipped with a temperature indicator (with just one reading possible, at the equipment console), a nitrogen inerting system and vents. The tank was associated with a retaining catchpit having a volume greater than 185 m^3.

Subsequent inquiries showed that the 2 polymers, which made up the additive in question, could decompose at a temperature below that of the storage temperature. The first decomposes into a substance having a flash point less than 50°C and into a highly flammable monomer with a flashpoint below 0°C. The second can release highly flammable gases.

The origin of the accident was due to the slow decomposition of the additive's 2 components that could, in the presence of air, produce organic peroxides or other substances liable to ignite spontaneously. These components, stored over a long period of time (there was little product movement in the months preceding the accident), accumulate a large amount of static electricity. Nitrogen flushing was insufficient to prevent air from entering the tank.

ACTION TAKEN

Following the accident and on the Inspectorate's proposal, the *Prefect* signed an emergency order requiring the operator to respect the following provisions:

- ✓ Submittal of a detailed accident report within 8 days (product, storage conditions, the circumstances of the accident, an initial hypotheses relative to the causes of the accident…) (art.1),
- ✓ The submittal of a detailed report within a period of one month concerning the causes of the incident and the proposal of measures to prevent it from reoccurring (art. 2),
- ✓ Immediate suspension of the establishment's procurement of the additive until the measures stipulated in article 2 of the order have been implemented (art. 3).

Following the examination of the various elements submitted by the operator, the Inspectorate proposed to the *Prefect* that continued use of the additive storage tank, for which product procurement had been suspended, be contingent on the implementation of the following additional safety devices:

- ✓ Automatic temperature control (with shut-down at high temperature threshold) to prevent the thermal degradation of the polymer regardless of storage duration,
- ✓ A device for continuous measurement (direct or indirect) of product temperature, with "high level" alarm in the control room,
- ✓ A continuous mixer motor current meter, with remote malfunction alarm in the control room,
- ✓ A nitrogen inerting system based on a pressurisation slaving and control system,
- ✓ A device for continuous measurement of the tank's gaseous atmosphere, with "low level" alarm in the control room,
- ✓ A valve type vent system preventing the influx of air, or other system providing equivalent guarantees (pressure/vacuum valve with explosion trap…).

Since, the operator has continued stocking the additive, at a temperature below the storage temperature established prior to the accident, and after having installed the additional equipment requested.

LESSONS LEARNED

The examination of the causes of the accident highlighted malfunctions or insufficiencies with several equipment: automatic temperature control and mixer operation and temperature control devices, nitrogen inerting and associated devices (vents, pressure measurement of the gaseous atmosphere...).

These analyses lead to various lessons that could be transposed to other storage containers. In addition, the operator made sure that no other product stored on the site was capable of thermally decomposing under current storage conditions. Also, the Inspectorate proposed that the *Prefect* require the operator to document the site's flammable liquid storage tanks equipped with a vent an/or a gauging pit with characteristics identical to that of the additive storage tank on the day of the incident of 05/18/2002 and a nitrogen flushing inerting system. For the tanks identified, a technico-economic study was requested in light of the installation of the safety devices required for the bitumen additive storage facility.

Leaks of gasoil and pollution of waterway / Pollution of the site

August, the 22nd and December, the 13th, 2002

Brussels (Brabant) - Belgium

Hydrocarbons/ gazole

Leak

Surface water pollution

Management / procedure compliance

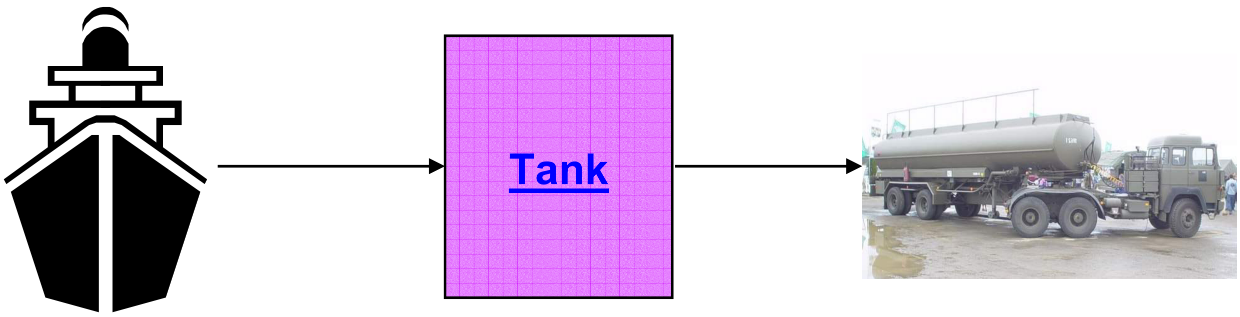
THE INSTALLATIONS IN QUESTION

The two cases of accidents happened on two sites belonging to the same company. The permit holder is a fuel oil company specialized in the storage and distribution for wholesale companies. Both sites must comply to the SEVESO II obligations for lower tier establishments (lower threshold = 5 000 t). Their two sites in Brussels are entirely automated and require only one person to supervise both. Furthermore, they are fairly closed (distance about 1,5 km).

Both cases do not need to be notified according to Seveso II directive (Annex VI) but the nature and circumstances of the accidents deserve a moment of attention. The first case is about a pollution in the canal of Brussels and the second one is about a pollution contained within the company site.

At the time of the accidents, ground pollutions had already been established for both sites. A safety assessment was on-going. The SEVESO inspections that took place also pointed out several deficiencies.

In the case of these installations, the process involved is quite simple: Boats come to fill the big tanks of the company and trucks come to fill up their own tanks.



The amount of Site 1 storage capacity is 6 000m3 for heating gasoil, Site 2 capacity is 8 225 m3 for heating gasoil and type C fuel.

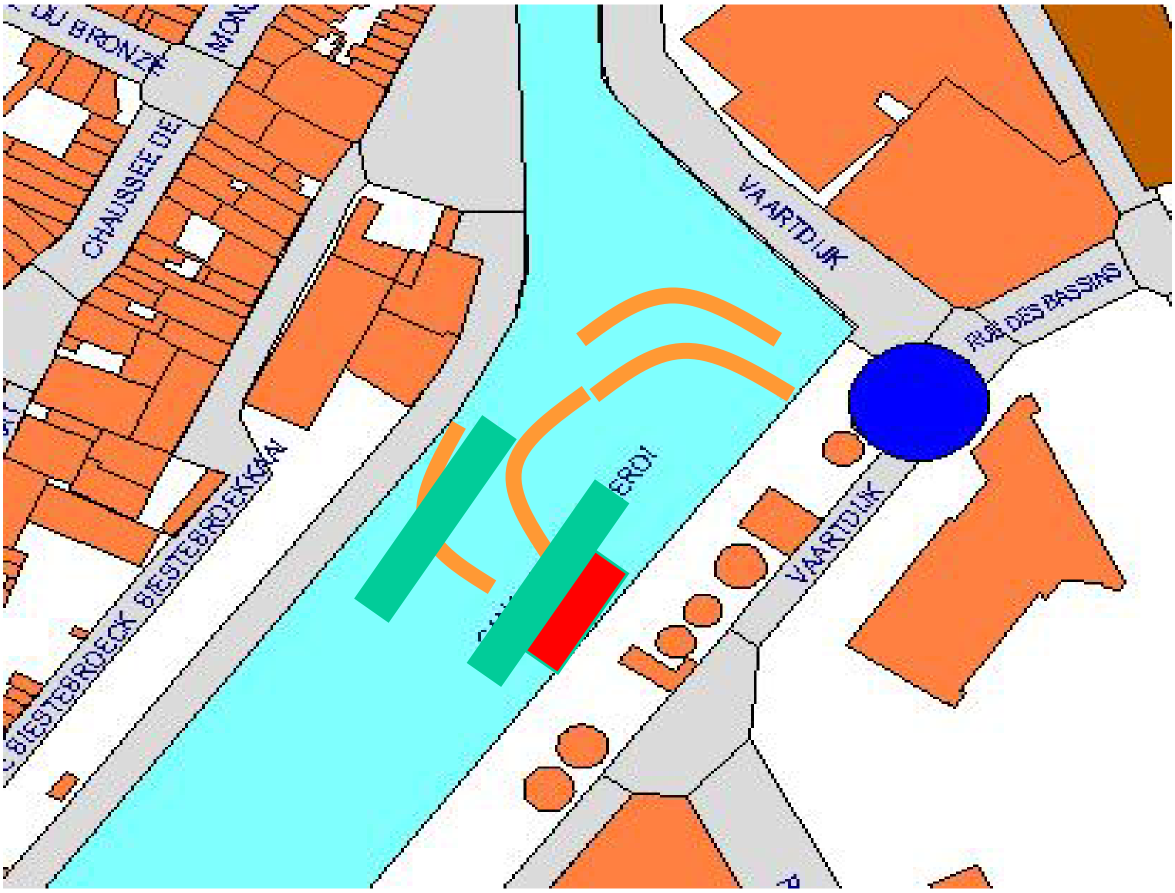
THE ACCIDENT, ITS BEHAVIOUR, EFFECTS AND CONSEQUENCES

The accident on August, 22nd, 2002 (site 1):

The call originated from a regular plaintive living across from the company. He alerted the local TV station and the authorities. When the BIME inspector arrived on site, the police was already questioning the witnesses.

The accident involved the « Georges » (boat in red on the schema) which was responsible for a fuel oil spill in the canal. The « Marguerite » (boat in green), moved next to the Georges in an attempt to contain the spill, but the wind and the current were working against them. The firefighters put two floating dams to prevent further spreading of the spill. Since they did not have the equipment to pump the fuel oil out of the water, they called for the Civil Protection.

Two agents from the Harbor of Brussels (Environmental Service) stopped the navigation on the canal and used two more floating dams to contain the spill. The Civil Protection came afterwards with a floating pump to eliminate most of the spill and spread some detergent over the remaining traces of fuel oil that could not be pumped out of the canal.



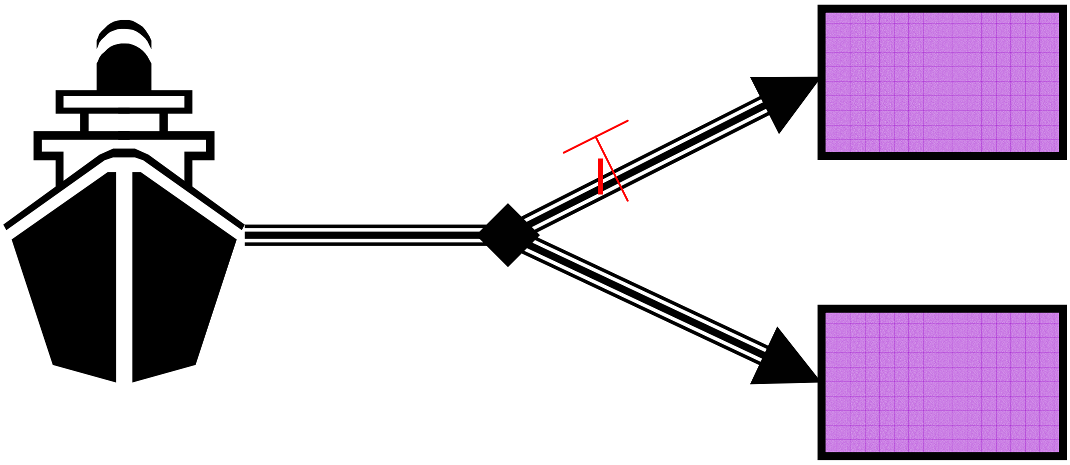
The consequences :

The accident resulted in a spill in the waterway of about 2 m3 of fuel oil. The major part had been pumped by the firefighters and civil protection.

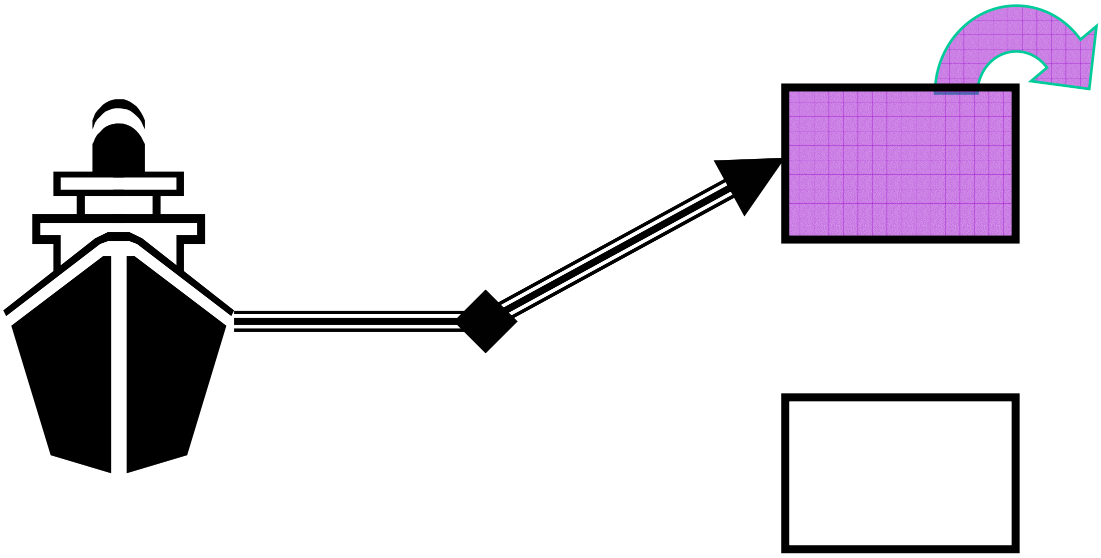
The accident on December, 13th , 2002 (site 2):

The second accident occurred only a few months after the first one, but this time, on the other site of the company.

In this case, normally, the boat starts to unload into the first tank. The capacity of the boat usually exceeds that of the tank. When the first tank is almost full, a timer tells the site manager when it is time to make the switch and start filling the other tank.



This time, the boat was unloading into the tank normally but the operator was distracted by other duties on site and did not hear the timer go off. He did not make the switch and, therefore, the tank overflowed.



When the inspection arrived on site, the firefighters and the agents from the Harbour of Brussels had already left. The accident was thought to be confined within the walls surrounding the tanks, so, according to them, there was no threat for the environment outside of the company site.

Seeing how close the walls were to the tanks, the inspectors decided to pursue their investigations a little further.

At the top of the tank that overflowed, the inspectors were able to see that the fuel oil overflowed over the containment walls. The walls themselves were not watertight either.

The consequences :

The quantity of fuel oil lost was estimated at 3m3 within the walls and 2 m3 outside of the walls. It had been pumped and then eliminated by the company.

European scale of industrial accidents

By applying the rating rules of the 18 parameters of the scale made official in February 1994 by the Committee of Competent Authorities of the Member States which oversees the application of the 'SEVESO' directive, the accident can be characterised by the following 4 indices, based on the information available.

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

Quantities of hazardous substances	☐ ☐ ☐ ☐ ☐ ☐
Human and social consequences	☐ ☐ ☐ ☐ ☐ ☐
Environmental consequences	☐ ☐ ☐ ☐ ☐ ☐
Economic consequences	☐ ☐ ☐ ☐ ☐ ☐

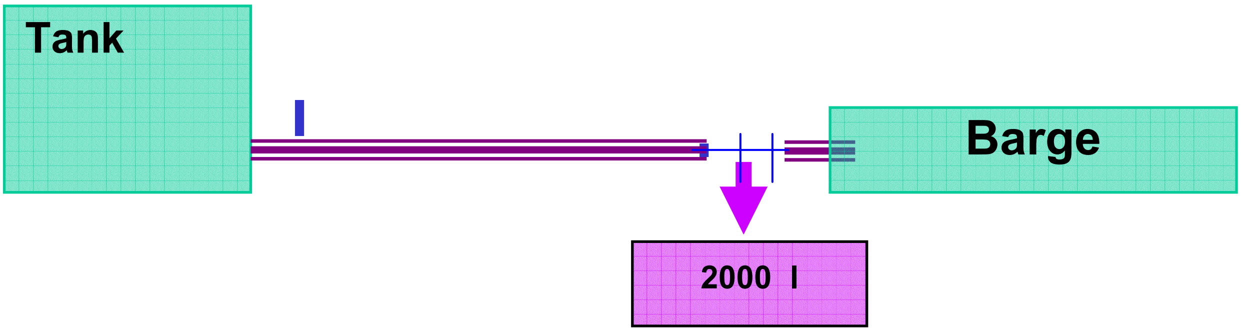
ORIGIN, CAUSES AND CIRCUMSTANCES OF THE ACCIDENT

The accident dated August, the 22nd, 2002 (site 1):

After filling a tank, it is standard procedure to push a little air inside the hose to empty its content into the tank. Then the boat has to notify the site manager so that he can turn off the valve on the tank, and the boat can uncouple its hose.

The « Georges » uncoupled its hose, assuming that the valve from the tank was already closed. The strong odour from the fuel oil rushing out of the tank alerted the sailor, but he could not close the valves in time.

Identified causes lay into the lack of clear indications on the procedures, which were not posted nearby, and the lack of communication for the loading operation.



The accident dated December, the 13th 2002 (site 2):

In this case, the lack of a strict compliance of the operating procedures is at stake, the use of devices that did not seem to be appropriate as well.

Indeed, apart from the fact that the tanks were very closed to the containment walls, the valves enabling the permutation of the tanks were located in rather deep peephole, so that the access was uncomfortable.

ACTIONS TAKEN

The accident dated August, the 22nd , 2002 (site 1):

Following this accident, the Inspectorate fined the company for infringements with the law of 1971 on the protection of surface waters and with the ordinance of 1997 on the environmental permits.

Seeing that the local television did not air the afternoon's events, the plaintive appealed against the company to have their environmental permit suspended… Each time it has been ruled « unfounded ».

The accident dated December, the 13th, 2002 (site 2):

Although the fuel oil did not reach the canal, the company was still in infringement with the ordinance of 1997 regarding the environment permits. (Did not comply with the requirements of the permit).

After these 2 accidents occurred, the Inspectorate required that the company implements the following devices or materials:

- ✓ Floating dams (2x perimeter of the largest barge)
- ✓ Absorbing products at hand
- ✓ Bilingual instructions concerning loading procedures.
- ✓ Safety pictograms and identification of the pipes
- ✓ Watertightness of the feeding area pit and setting up of a connection from it toward a hydrocarbon separator.
- ✓ Setting up of an non-overflowing device on each tank.
- ✓ Replacement of the damaged pit, in compliance with safety distances.
- ✓ Setting up of anti-run-on valves
- ✓ Building of a new feeding pit area (connections with the barges)
- ✓ Radar detection implemented inside the tanks to check their level during feeding operations plus visual and auditory alarms in connection with these devices.

LESSONS LEARNED

Following these accidents, the environmental permits of both sites were modified and updated.

The company hired a prevention adviser to bring all his sites in Belgium up to par, at the same safety level. Furthermore, the company also concluded several contracts to have their normal equipments and their prevention equipments regularly checked. The operator is also finalizing a new action plan to comply with the SEVESO obligations (work safety and environmental).

In conclusion, neither of those accidents were « SEVESO accidents », but they do raise a few questions that can be applied to other cases :

- ✓ This kind of operations needs to work with third party companies: the problems to face up are how to control the work of someone who is not an employee of the company and how to make sure that everyone coming to the site is well aware of all the site procedures, especially as far as safety is concerned.

- ✓ For this kind of activity (barges), the language used by the different actors can also be a problem, especially when dealing with foreign third parties, since the only obligation for the practice of languages in Brussels is French and Dutch…

- ✓ The minimum distance between the containment wall and the tanks should be of half the height of the tank.

- ✓ The operating procedures that a company develops should be easy, simple and the same for all its sites.

- ✓ Even though some companies have a very good prevention system, there should always be adequate means of intervention nearby that can be readily used in the case of an accident.

Torch fire
Refinery
Internal Contingency Plan
Property damage
Equipment failure
Organisation/
Checks
Works

Enflamed leak in a gasoline hydro-treatment unit of a refinery

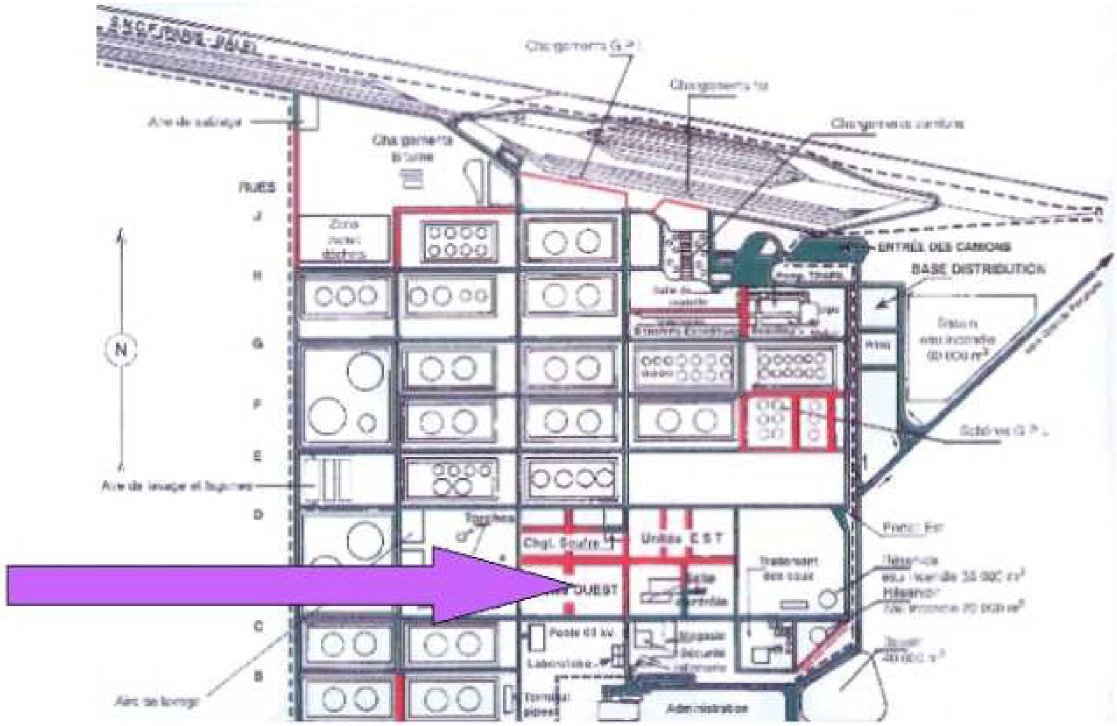
November 17, 2002

Grandpuits Bailly Carrois
(77 – Seine et Marne) -
France

THE INSTALLATIONS IN QUESTION

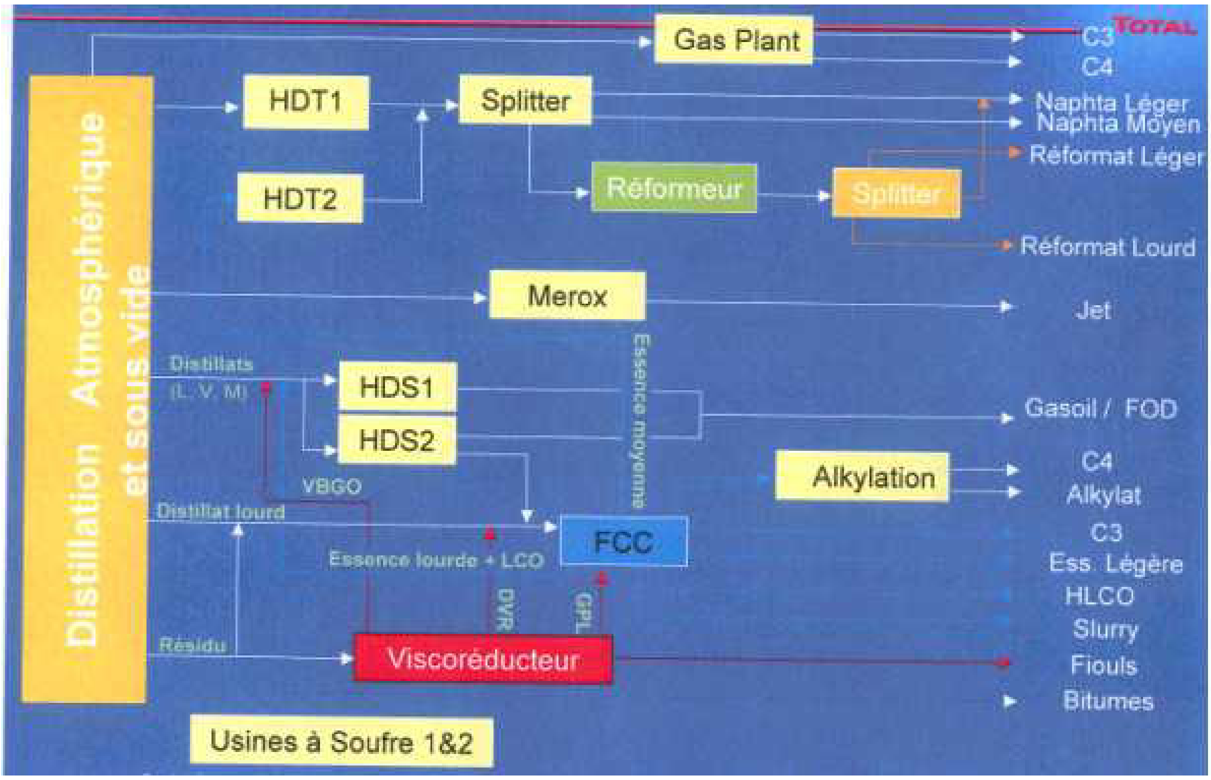
The refinery is located 57 km from Paris and is spread over 153 ha. It produces the entire range of habitual petroleum products (LPG, kerosene, gasoline, diesel fuel, domestic fuel oil, bitumens, …). The facility was commissioned in 1966. It has a production capacity of 4,800,000 t/year and a storage capacity of 1,243,000 m^3. 355 people work at the site.

The fire occurred at the level of the hydrotreatment and catalytic reforming units located to the west of the refinery.



The hydrotreatment unit is designed to eliminate the sulphur, nitrogen and oxygen compounds in stabilised gasoline derived through atmospheric distillation. The purpose of this operation is to protect the reactor's catalyst from catalytic reforming, located downstream, for which these types of compounds are sources of poisoning.

The catalytic reforming unit is designed to produce a gasoline blending stock with a high octane index (the reformate) from a load with a mediocre octane rating. It also produces the hydrogen required for the hydrotreatment and hydrodesulfurization units. The diagram below shows the 2 units in the general operation, after atmospheric distillation.

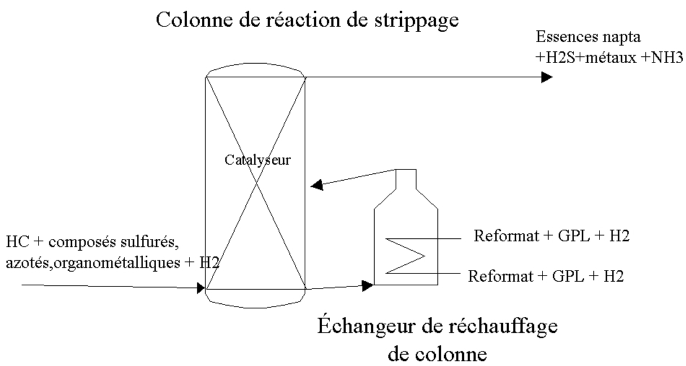


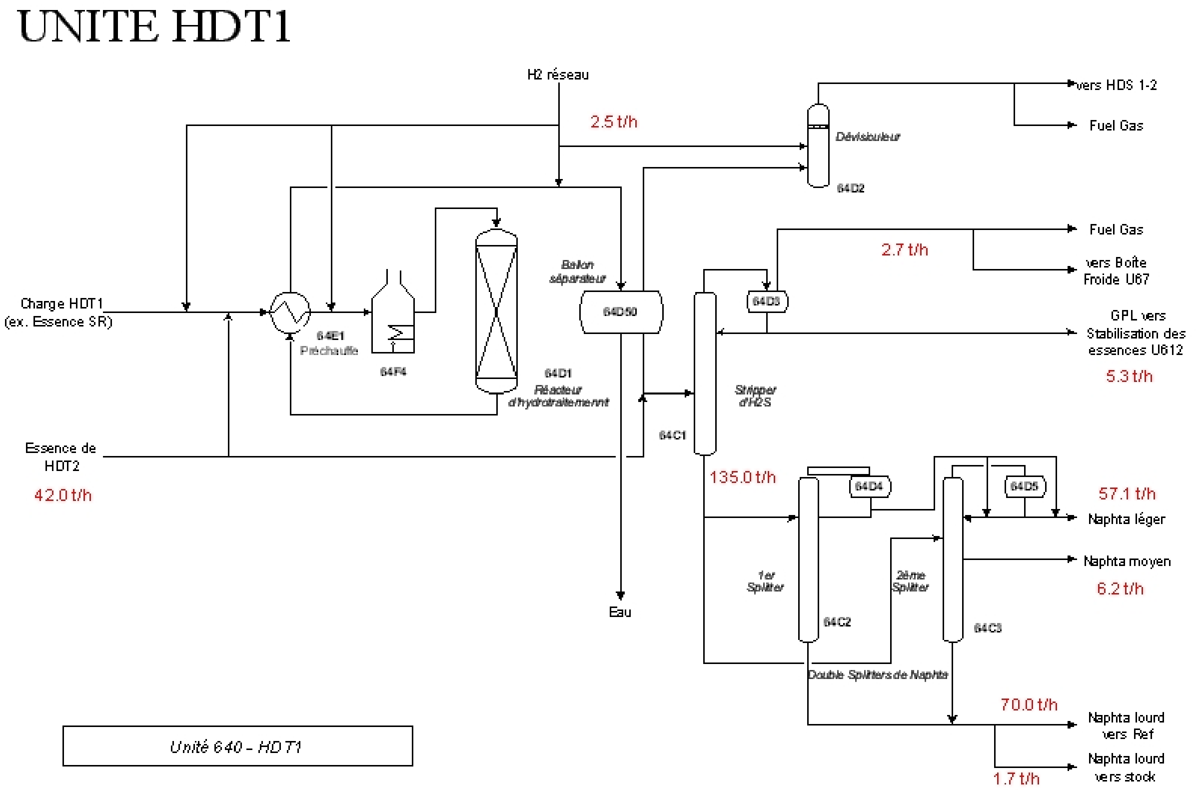
THE ACCIDENT, ITS BEHAVIOUR, EFFECTS AND CONSEQUENCES

The accident:

The leak occurred on the gasket plane of the reboiler, on the hot fluid side, and immediately burst into flames producing a nearly vertical flame cone roughly ten meters in length.

The reboiler is designed to supply the energy required for column operation, which includes the pre-treatment stripper, on which the hydrotreatment unit depends. This is a preparation phase for the reformer load. The reboiling energy is furnished by the reformer's effluent. The complete diagram of the unit, including the loop shown opposite, is represented on the following page.





Chronology:

Analysis of the parameters (pressure and associated flow rates) on both systems, conducted after the accident, show that the leak occurred on the hot fluid side (thus containing effluent from the reformer). The chronological description is as follows:

- 8.23 pm: Outbreak of fire,

- 8.25 pm: Call of western units for fire. The site's siren is triggered.

- 8.30 pm: Departure of the intervention crews.

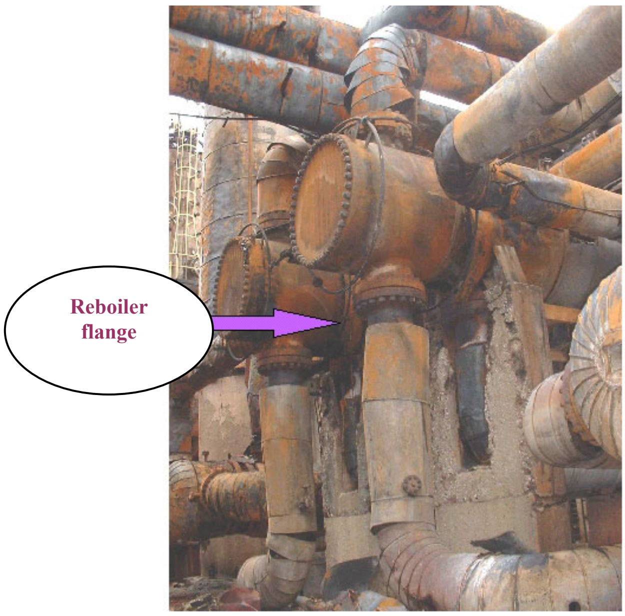
  Emergency shut-down of the reformer – closure of damaged shut-off valves – Start of decompression in the assembly – gas directed to the flare stack

- 8.32 pm: Standby management called and in-home call triggered (1st step)

- 8.34 pm: Standby management called and in-home call triggered (2nd step)

- 8.50 pm: Arrival of the security department manager.

- 8.55 pm: Arrival of the firemen from Nangis (1 truck +5 men) → mission: installation of a second nozzle on the west side.



- 8.56 pm: Call received from the SDIS (Service Départementale d'Incendie et de Secours", fire and emergency services) signalling the dispatching of reinforcements.

- 9.00 pm: Arrival of the firemen from Mormant (5 men) → mission: preparation of two 1,000 l/min nozzles.

- 9.10 pm: Application of a foam blanket.

- 9.11 pm: Water curtain with nozzle on the west side of the fire zone.

- 9.35 pm: The gendarmerie set up a detour on the RN19 national highway.

9.45 pm: Prepositioning of a 4th nozzle, which would not be used.

11.21 pm: Fire is out and 3 nozzles stopped – 2 nozzles would be maintained for a certain amount of time on each side of the equipment.

11.25 pm: Detour called off on the RN 19.

11.30: Withdrawal of the emergency services – Inerting of the installations with nitrogen.

1.00 am: End of alert.

As far as the external rescue services are concerned, they were called by people driving by the site. Subsequently, 20 fire trucks were parked in front of the refinery as the establishment allowed only 2 trucks to enter the site due to safety reasons. The 18 trucks remained parked outside the site until the end of the alert.

Consequences:

The accident resulted in a slight injury: the back of one of the rescue team was injured while installing the water cannons.

There was significant property damage: Property damage was estimated at 4.3 MEuros. Furthermore, the main units damaged (hydrotreatment and reforming) were shut down for several weeks. Finally, considering the extent of the damage, the equipment requalification programs and zone rehabilitation operations were extensive. Operating losses totalled 1.7 MEuros.

Owing to the extent of property damage, the accident has to be reported in accordance with the criteria of appendix VI of the Seveso directive.

European scale of industrial accidents

By applying the rating rules of the 18 parameters of the scale made official in February 1994 by the Committee of Competent Authorities of the Member States which oversees the application of the 'SEVESO' directive, the accident can be characterised by the following 4 indices, based on the information available.

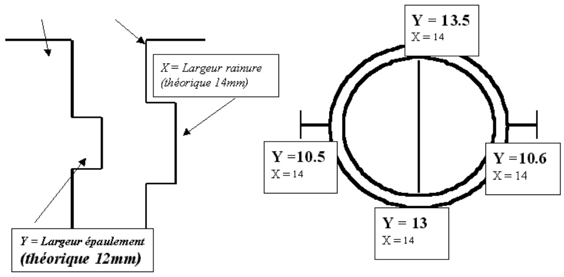
The parameters which comprise these indices and the corresponding rating method are indicated in the appendix hereto and are available at the following address: http://www.aria.environnement.gouv.fr

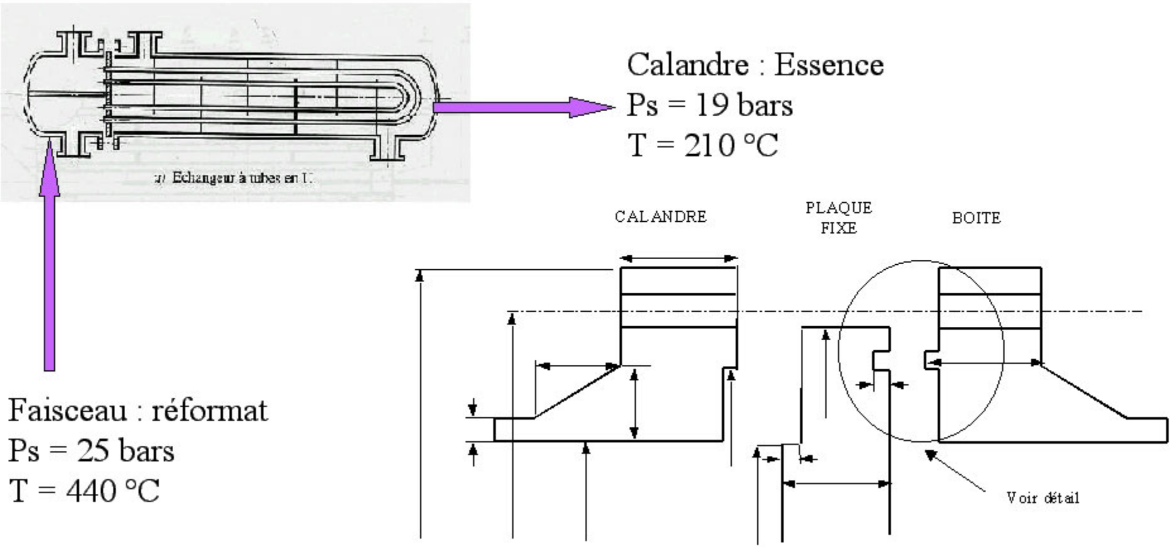
Quantities of dangerous substances	□ □ □ □ □ □
Human and social consequences	■ □ □ □ □ □
Environmental consequences	□ □ □ □ □ □
Economic consequences	■ ■ ■ □ □ □

ORIGIN, CAUSES AND CIRCUMSTANCES OF THE ACCIDENT

According to the initial reports and appraisals, the leak was caused to a fault in the exchanger: the latter showed a dimensional circularity fault on the throat of the gasket housing. This made reassembly of the device very delicate during the maintenance shut-down prior to the accident. The various parts were apparently poorly fitted together.

The seal, obtained by cold tightening of the metal parts between themselves, would have ruptured while increasing toward high temperatures. The accident occurred during this transition.





ACTION TAKEN

In addition to the repair stipulated by the Institut de Soudure (*Welding Institute*), the operator has finally implemented a rehabilitation program for the zone in question by following the recommendations of American standard "API RP 570 – section 11 – Assessment of fire damage".

The following actions were undertaken, in particular:

- ✓ Cartography of the sectors effected,
- ✓ A rehabilitation protocol including a visual inspection, ultra-sonic thickness checks, hardness tests, and replicas taken for metallographic inspections,
- ✓ Replacement of valves in the zone,
- ✓ Overhaul of valves in the zone.

LESSONS LEARNED

The **notable points** are as follows:

- ✓ There was no UVCE (Unconfined Vapour Cloud Explosion) phenomenon. The product was at a temperature above its self-ignition temperature.

✓ The damage was able to be limited due to the resistance of the lines and heat-lagged reactors, and this, despite the rapid absence of a load circulating inside the tanks and piping, an element that contributes to cooling the equipment in which it circulates.

✓ The accident did not spread owing to the position of the water curtains.

✓ The positioning of the curtains was adequate and very important: owing to the location of the nozzles and the direction of the flame cone (vertical), the accident did not result in a domino effect although the scenario was perfectly possible owing to the configuration of the site (units separated by spans of roughly fifteen meters).

Technically speaking, the improvements aimed at limiting the consequences of a similar leak are as follows:

✓ An increase in the decompression speed of the reaction section of the reformer by changing a gas discharge valve toward the fuel-gas network.

✓ Modification of a valve that is currently slaved to a pressure threshold and that will be controlled from the control room console.

From the organisational standpoint, the operator has set up procedures for checking the dimensions of exchanger seal bear surfaces.

✓ Specific certification is now required for the personnel conducting this type of operation, together with appropriate training,

✓ For the external companies performing these operations, systematic dimensional inspection reports are to be compiled for the gasket bearing surfaces and shut-down points are foreseen after the upgrading, prior to installing assemblies, when reassembly operations are performed.

N°ARIA 26983

Fire
Refinery
Paraffin isomerisation
Compressor
Domino effect
Material failure
Material losses

Fire in an isomerisation unit and domino effects on a benzene saturation unit, in a refinery

December, 2002

Italy

THE INSTALLATIONS IN QUESTION

The refinery started its operation in 1965. The current plant asset is the result of an important reconditioning and technological modernization that was completed in 1995. The refinery produces a wide range of petroleum products with a capacity of over 5 million tons per year, and 130 storage tanks with a total storage capacity of 1300000 m^3.

The establishment covers an area of about 100 ha and is located in a high density industrial area, near a river. The plant is under Seveso II Directive (upper tier plant).

A map and a general functional flow-scheme of the refinery are showed respectively in fig. 1 and fig. 2.

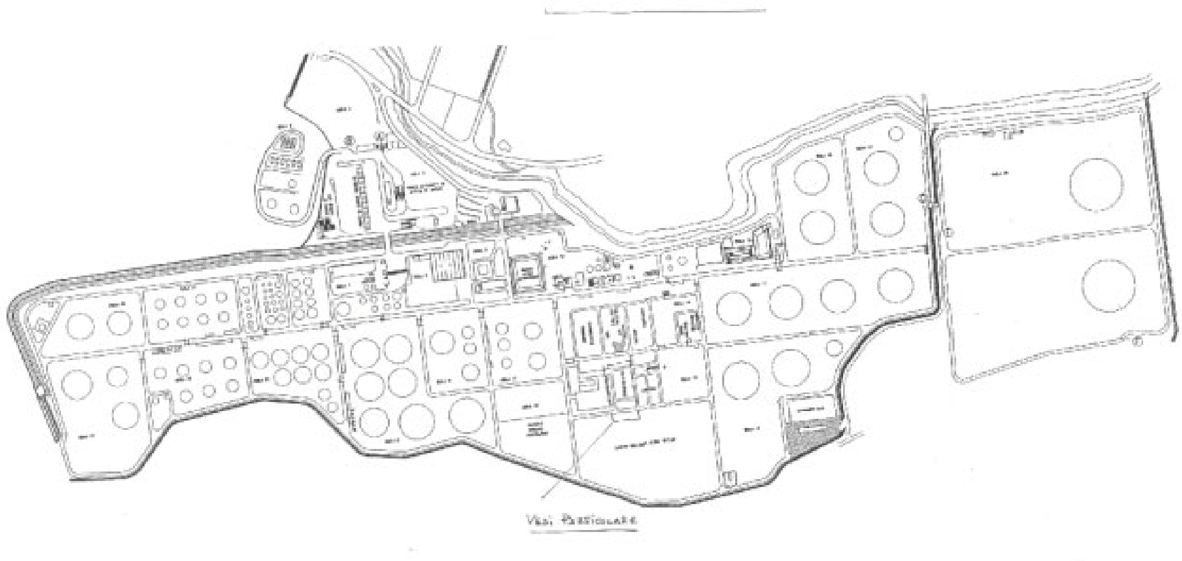


Fig. 1

The main steps of the process are detailed in the following diagram and correspond to classical units of a refinery.

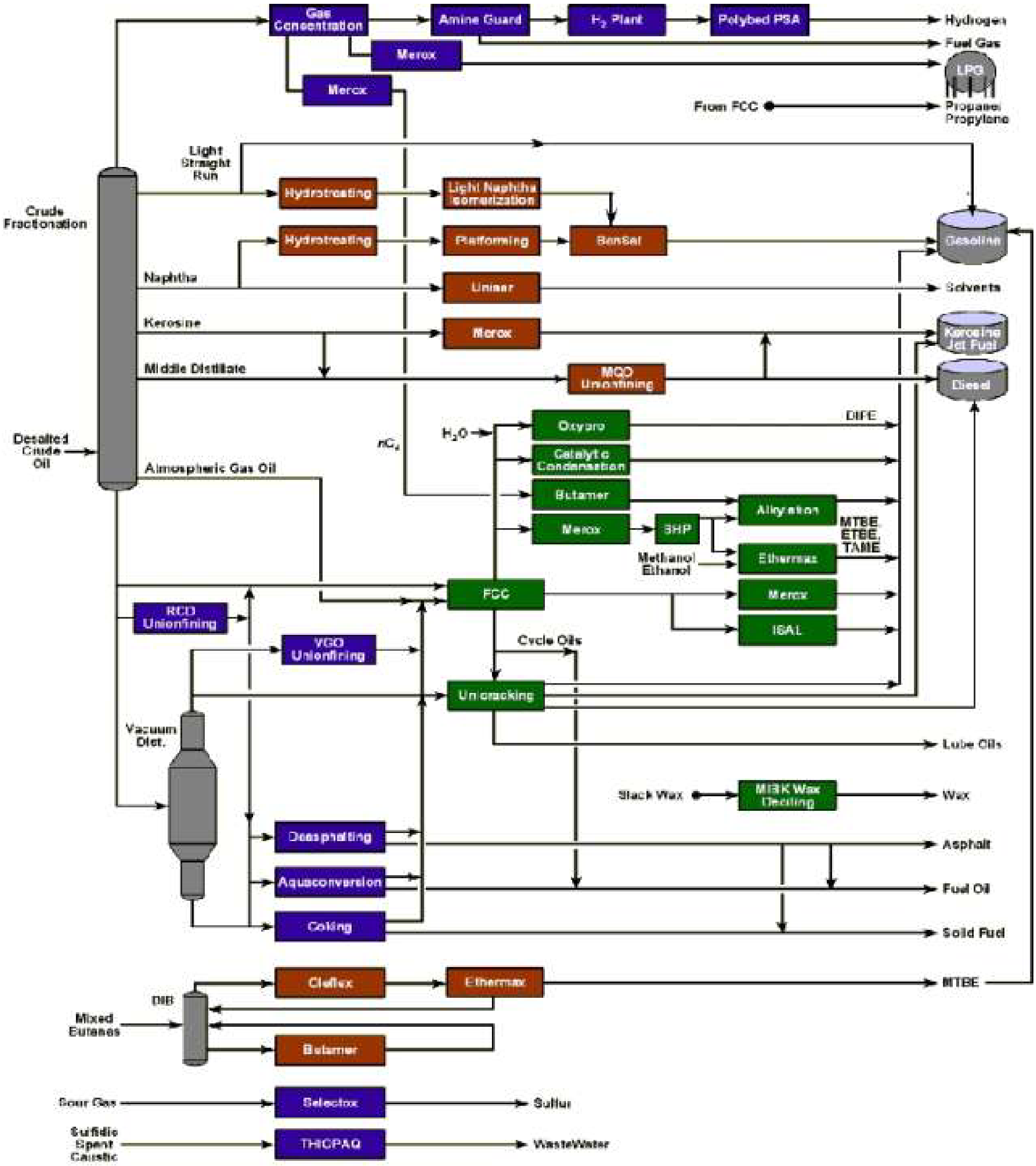


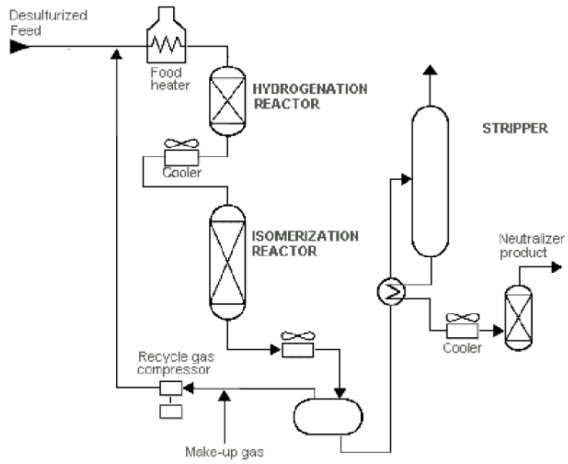
Fig. 2

In the accident, two units were involved : the isomerisation unit (TIP), used for the pentanes and hexanes transformation, and the benzene saturation unit (bensat), that converts aromatics to saturated compounds. The initiating event occurred in the TIP unit and extended to the near benzene saturation unit (BenSat). Both the sections belong to the isle 129 of the plant.

TIP unit :

In the isomerisation unit N-paraffins are transformed into iso-paraffins, with a higher octane number. The reaction takes place at temperatures in the range of 250 - 300 degrees C, in presence of a catalyst, and at pressures in the range of 15-22 bar. The catalyst requires an atmosphere of hydrogen to minimize coke deposits (hydro-isomerisation process). The unit produces light naphtha with a C5/C6 content about 97% or better, relative to the feeding, and octane upgrading between 8 and 10 points.

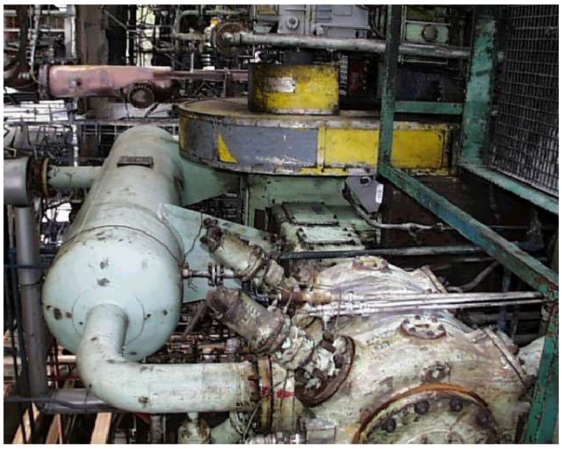
The liquid feedstock is pentane/hexane from light naphtha. The light naphtha (C5/C6) is combined with the recycle gas/ fresh gas mixture. The resultant combined reactor feed is routed to a feed/ effluent heat exchanger, where it is heated and completely vaporised by the effluent of the reactor. The vaporised combined reactor feed is further heated to the desired reactor inlet temperature in the reactor charge heater. The hot charge enters the isomer reactor at the top and flows downwards through the catalyst bed, where a portion of normal and mono-branched paraffins is converted into higher branched (high octane) components. Temperature rise from the heat of reaction release is controlled by a cold quench gas injection into the reactor. Reactor effluent is cooled and subsequently separated in the product separator into two streams: a liquid product (isomerate) and a recycle gas stream returning to the reactor via the recycle gas reciprocating compressor. A technical scheme of the process is showed in the scheme here beside.

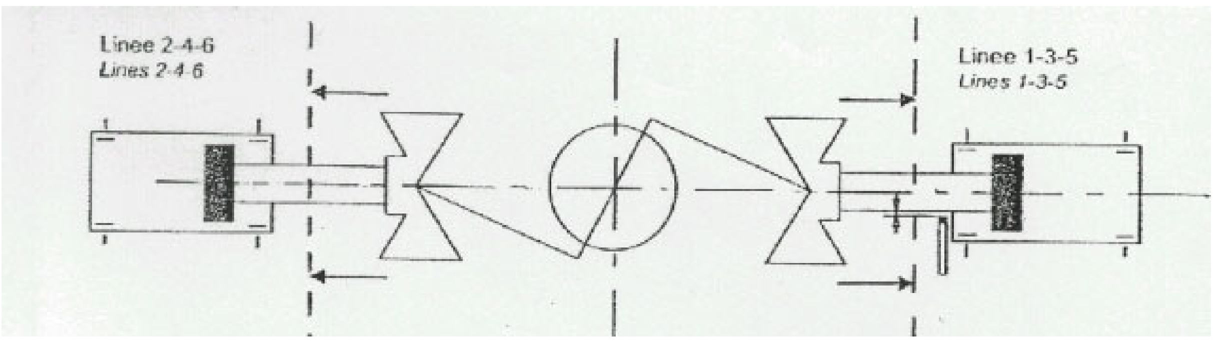


Reciprocating compressor K-2901B:

The accident was originated by one of compressor of the recycle gas compressors group (reciprocating compressor K-2901B), located in isomerisation unit, used to recycle a gas mixture to the isomerisation and Bensat units.

The compressor works in parallel with a twin compressor (K-2901A), at pressures from 15 to 21 bar and a thermal range from 40 to 60 Celsius degree. The gas mixture recycled consists mainly in hydrogen (70% vol), with the remaining part of methane, ethane, propane and butane.





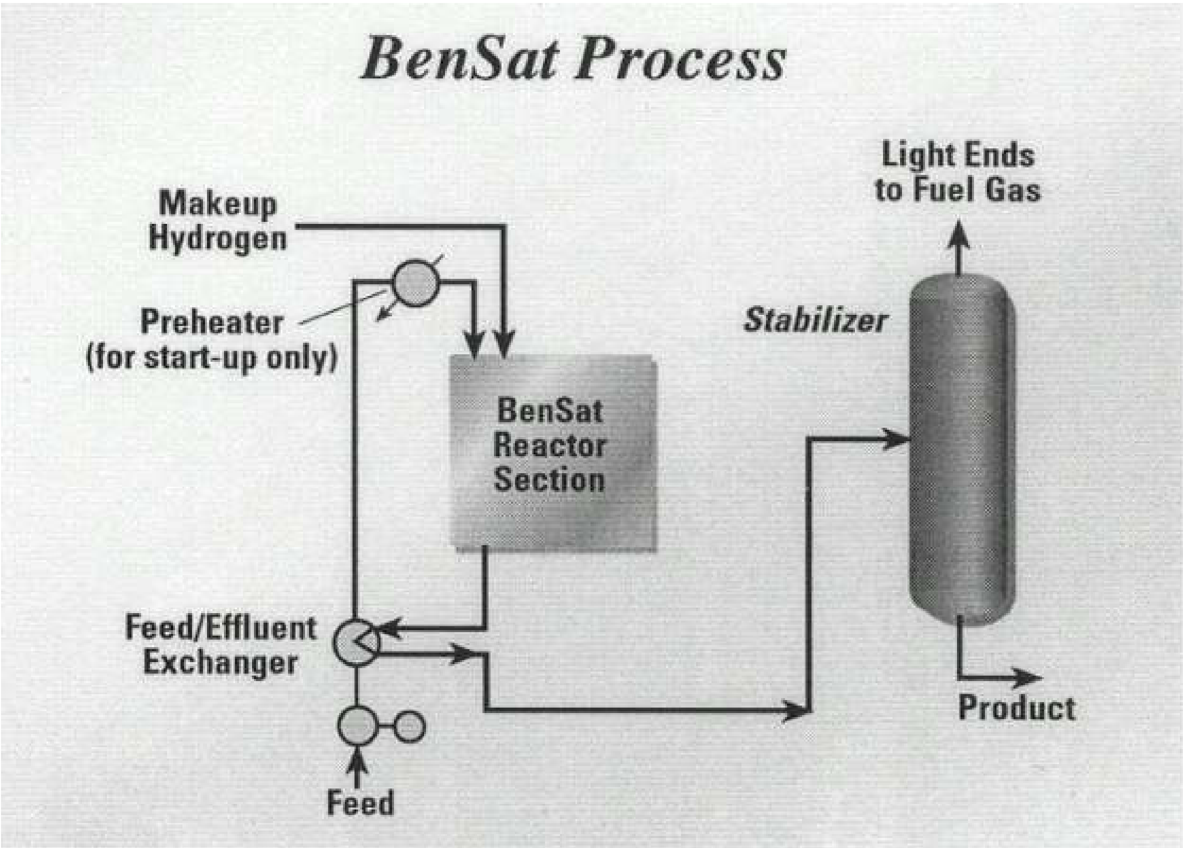
The reciprocating compressor (cf scheme here above) with horizontal balanced opposed cylinders is designed to handle gas mixture complex. The packings are lubricated. The gas is compressed in one stage by two cylinders. The cylinders are of double acting type. The crank mechanism has two opposed cranks in order to completely balance all inertia forces. The compressor is driven by an electric asynchronous motor. The rotation is anticlockwise facing the compressor from non driving end.

Bensat process :

This process consists in aromatics saturation catalysts to reduce the benzene contained in the distillate, in order to avoid product contamination and catalyst poisoning.

It is realised to complete the C5-C6 isomerisation, to remove the natural benzene concentrated by aggressive reformer feed pre-fractionation, and also to remove the benzene that has been produced in the reformer.

The process handles up to 30 vol-% or more benzene in the feed. Benzene is saturated to C6 naphthenes so that the reactor effluent contains less than 0.5 vol-% benzene. The catalyst used in this process is highly selective. The unit receives about 12 ton/h of gasoline from the plat-former. The heat of reaction from benzene saturation is carefully managed to control the temperature rise across the reactor.



Makeup hydrogen to the BenSat process is provided in an amount slightly above the stoechiometric level required for benzene saturation. The liquid feed stream is pumped to the feed-effluent exchanger and then to the pre-heater, used only for start-up purposes. Once the unit is operating, the heat of reaction provides the required heat input to the feed via the feed-effluent exchanger.

Benzene is saturated to C6 naphthenes in the presence of hydrogen using a noble metal catalyst. The effluent passes through the feed effluent exchanger and is then sent to a stabilizer for removal of light ends.

THE ACCIDENT, ITS BEHAVIOUR, ITS EFFECTS AND CONSEQUENCES

The accident :

In December 2002, at 03.00 p.m. a strong abnormal noise from the reciprocating compressors area was heard by the field operators in the TIP unit. The operators recorded a high temperature alarm in the 2nd cylinder of the compressor K2901B and a low pressure oil alarm in the crankshaft. Field operators went near the compressor, where the noise was increasing. One of them pushed the stop-emergency button of the compressor on the local control panel. At the same time, a strong burst was heard, followed by a jet-fire starting from the compressors area of the TIP unit (at the bottom of K2901B compressor), impinging the near bensat unit (14 m apart).

A big quantity of highly flammable gas mixture was released and immediately found ignition. Under the effect of the jet-fire, parts of the bensat unit failed causing the release of gasoline and hydrogen, which led to the extension of the fire.

TIP and bensat units were isolated. The TIP unit was immediately shut down and depressurised and the fuel gas was drained to the net. The emergency alarm started and the internal emergency measures, cooling and spread-foam systems activation, were immediately applied. After 25 minutes from the internal emergency alarm, the external Fire Brigades arrived. All the plants of the refinery were put in safety shut down condition. After about 1 hour the fire was controlled, and at about 30 minutes later the emergency was closed.

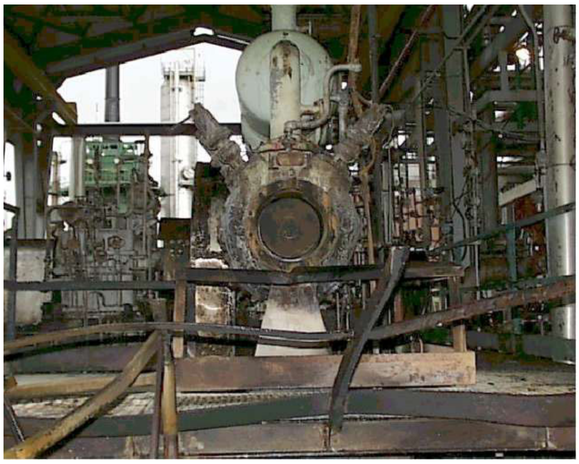
The consequences :

The accident did not cause effects to people or to environment. The estimated damage to property was about 3 million euros, corresponding to the total rebuilding of the bensat unit and to the substitution of the compressor K2901B. The damages are listed here under :

TIP unit

✓ About 3 tons of gas mixture rich in hydrogen and about 6 tons of gasoline were released.

✓ The cylinder liner and the bottom-head of the compressor were found at distances of respectively 8 and 14 m from the compressor. Some of the structures near the compressors area were damaged by the fire and the direct impact of parts of the compressors.



Bensat unit

✓ Most of the structures invested by the jetfire were protected by a fire-proofing layer; they were damaged but didn't have mechanical failure. Pipe connections and process units lost their sealing and released some gasoline and hydrogen that contributed to the extension of the fire and the destruction of the unit.

✓ About 0,3 tons of gas mixture and 6 tons of gasoline were released.

The total quantities of flammable substances released were estimated as follows:

- 3,3 tons of gas mixture (70% hydrogen, 30% methane, ethane, propane and butane);
- 12 tons of gasoline.

Seveso II directive – Annex VI

The accident has been considered a 'major accident' according to the criteria set in Annex VI of the Seveso II Directive, in particular:

✓ Substances involved

- Any fire or explosion or accidental discharge of a dangerous substance involving, a quantity of at least 5 % of the qualifying quantity laid down in column 3 of Annex I.

=> About 3,3 tons of highly flammable gas mixture have been released through the compressor and from the bensat unit, so exceeding the limits for the highly flammable substances according to the Annex VI: 2,5 tons (5% of 50 tons).

✓ Damage to property

- Damage to property in the establishment at least ECU 2 million,
- Damage to property outside the establishment; at least ECU O,5 million.

⇨ Damage to property was estimated more than 3 millions Euros, exceeding the 2 millions Euros that represents the limit in Annex VI.

European scale of industrial accidents

By applying the rating rules of the 18 parameters of the scale made official in February 1994 by the Committee of Competent Authorities of the Member States which oversees the application of the 'SEVESO' directive, the accident can be characterised by the following 4 indices, based on the information available.

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

Quantities of hazardous substances	■ ■ ■ □ □ □
Human and social consequences	□ □ □ □ □ □
Environmental consequences	□ □ □ □ □ □
Economic consequences	■ ■ ■ □ □ □

ORIGIN, CAUSES AND CIRCUMSTANCES OF THE ACCIDENT

The first phase of the accident consisted in the mechanical failure of the bottom of one of the cylinders of the compressor K2901B.

Nevertheless, the original causes of the event are not yet well identified. One of the hypothesis is the rupture of the crankshaft-rod mechanism in the compressor, with a consequent hitting action of the piston on the bottom of the cylinder 2. The combined effects of hitting-action with the internal pressure (20 bar) led to the failure of the nuts, which hold the bottom.

The relevant last maintenance operations on the compressor unit were:

- Pumping part revision in October 1999
- Substitution of 9 valves in July 2001
- Substitution of valve of cylinder 1 East side in September 2001
- Pumping part revision, substitution of speedy joint in November 2001
- Compressor general revision in May 2002
- Revision of sealing packages in November 2002
- Revision of pumping part of cylinder 2 West Side, in December 2002

The maintenance operations of the compressor, according to registers, were regular.

After the accident, in order to make a detailed assessment on the causes of the failure, a careful examination of the damage compressor has been planned.

ACTIONS TAKEN

Internal Emergency Plan

3 minutes after the loud noise, field operators, who were near the compressor to check the situation, pushed the stop-emergency button of the compressor on the local control panel. They isolated the 2 units and activated the emergency systems. The TIP unit was immediately shut down and depressurised, and the fuel gas was drained to the net. The emergency alarm started.

The internal Emergency Control Centre immediately organized and activated cooling and foam systems in the involved units and in the near ones. The actions were coordinated with the Internal Advanced Control Centre.

The internal team faced the fire from South-East, through a fixed high-flow monitor, two fire-hoses UNI45 from south, another fixed monitor in south-west site, a truck with monitor jets and two fire-hoses UNI70 from north west.

External Emergency Plan:

At 03.16 p.m. the general emergency shut down of the establishment was disposed, and the actions for the activation of the external emergency plan were started.

After 25 minutes from the internal emergency alarm, the external Fire Brigades arrived, taking charge of the coordination of the emergency actions.

Before the arrival of the external fire brigades, also the Major of the town, police and prefect were informed of the accident. An ambulance immediately arrived at the refinery and doctors were available for first aid if needed.

With the arrival of the external fire brigades, the fire was soon (after 20 minutes) under control. After 25 minutes the fire was completely extinguished and at 04.50 the emergency was closed.

Official Actions taken:

A detailed investigation to understand the causes of the accident is still in course. A consultant, nominated by the civil law-court, is working together with the compressor provider and the maintenance team of the refinery. The investigation will focus on the causes and the dynamic of the mechanical failure, also through labs tests and analysis of the materials of the mechanical parts found broken.

LESSONS LEARNED

It is not clear if there is a direct link between the real causes of the accident and possible Safety Management System procedure deficiencies, in particular for those related to inspections, controls and maintenance of installations.

However, the accident put in evidence some issues that, even if general and already identified in other cases, still had an important role in the event occurred:

Equipment / devices issues:

- Improvement of lay-out of installations
- Definition of appropriate control parameters precursor of anomalies/failures in the installations (malfunction status)

Management:

- Performance of the emergency devices (flow and autonomy of water stock , number and position of water/foam suppliers and monitors, etc.)
- Accessibility of the critical areas to the emergency teams / fire Brigades (in terms of adequate ways-spaces for adequate devices, and of number of intervention points)
- Improvement of communications during the emergency actions.

The establishment, in consideration of the experience matured and of the up-to-date studies in course, intends to adopt the following plant-management measures:

- Substitution of the current reciprocating compressors by a single centrifugal compressor in order to potentiate the TIP unit.
- Use of interception electro commanded valves in suction lines, to be inserted near the compressor in order to limit strongly possible gas release (currently these valves are hand-commanded).
- Improvement of the location of hydrants and fixed monitors.
- More frequent personnel training for the emergency situation, to improve the response to accident.
- Revision of the emergency procedures in order to better define the emergency tasks of teams and the operators involved.
- Revision of the shut-down procedures of plants and of electrical systems.
- Up-date of safety analysis in safety report, in particular for aspects relative to potential domino effects.
- Start of the needed procedures to specialize the internal emergency plan for the incidental scenarios individuated in safety report.

The inspection Commission found that in the risk analysis conducted for the establishment a jetfire scenario in the TIP unit was considered, but the parameters used in the analysis were not such to cause damage to the near units. In particular, the timing of the real accident caused a domino effect with the involvement of the bensat unit 14 m apart.

Thank to the internal emergency team intervention and the Fire Brigades, the release of flammable substances was limited with almost no damages to the other units. The bensat unit was anyway completely destroyed.

The Commission suggested that a revision of the risk analysis, with the adoption of more 'realistic' hypothesis (timings, duration, intervention, etc.), should be done.

In addition and following the risk analysis, the criteria for the identification of critical units should be revised as well, and the process of their optimisation for reduction of risks should be better defined.

Operative procedures should also be revised, with particular reference to instructions in normal, abnormal and emergency conditions.

In consideration of the difficulties encountered during the intervention in emergency, the Commission also suggested:

- A review of the internal emergency procedures with particular attention to the detailed definition of role and responsibilities of personnel;
- More frequent training of personnel for the emergency situation, in order to improve their response to the accident.

Silo

Cell rupture

Concrete ageing

Inappropriate modification of a cell

Rupture of silo storage cells

September 20, 2002 and October 20, 2002

Vailly sur Aisne (02 - Aisne) and Jussy (02)

THE INSTALLATIONS IN QUESTION

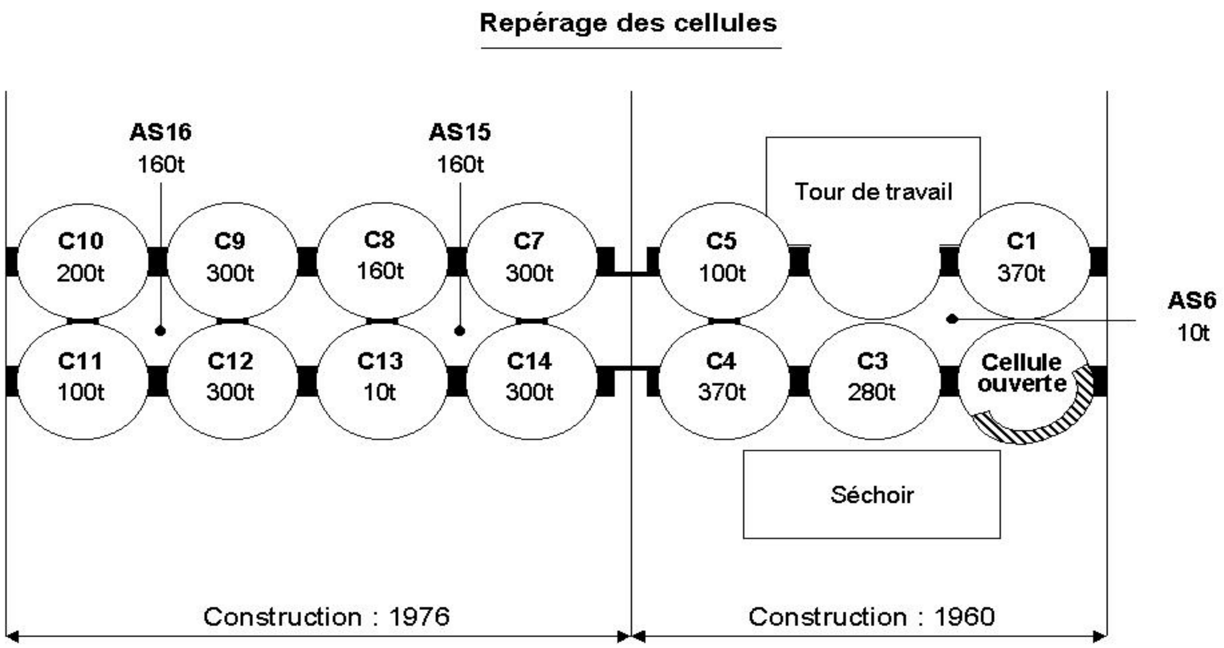
Vailly sur Aisne site:

The silo was built in 1960 near the town centre of the *commune*; the first homes are located a distance of approximately 50 m. The facilities mainly include:

- ✓ A 6,500 m³ grain storage silo consisting of vertical concrete cells,
- ✓ A 40-ton depot for agro-pharmaceutical products,
- ✓ An 42 m ³ above-ground heating fuel storage tank.

The silo was built in 2 phases, one in 1960 with the installation of 5 cells, the workhouse and drier, and the other in 1976 with the construction of 8 additional cells.

The establishment is an installation subject to authorisation, governed by an "Acknowledgement of Declaration" dated July 15, 1993.



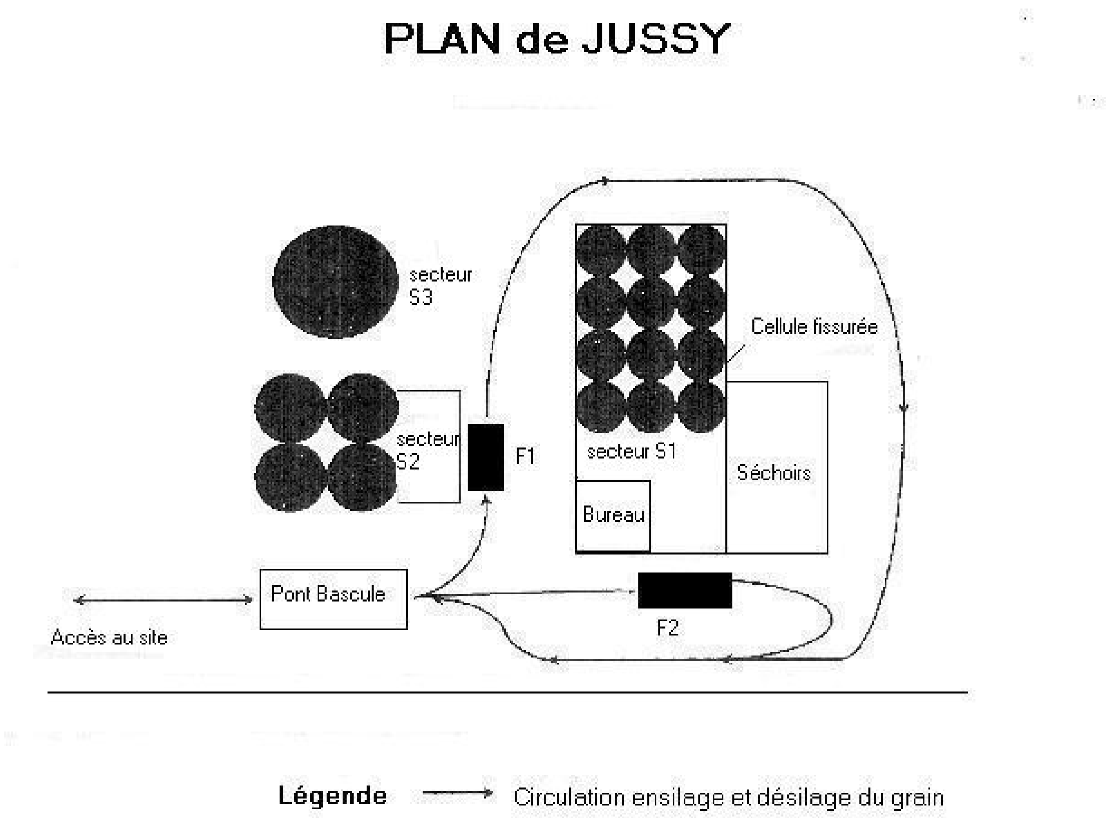
Jussy site:

Located on the *commune* of Jussy since 1963, the silo, which has been enlarged over time, is divided into 3 zones of vertical storage cells interconnected by transport equipment:

- ✓ Sector S1 (1963): 12 cells with a total capacity of 5,520 m³
- ✓ Sector S2 (1971): 4 cells with a total capacity of 2,920 m³
- ✓ Sector S3 (1982): 1 5,330-m³ cell

The installations also include driers, grading installations, and bagging equipment… with power of 80 kW and a 150-m³ liquid fertilizer depot.

The establishment is governed by a Prefectoral order of March 22, 1989 for the storage of fertilizer.

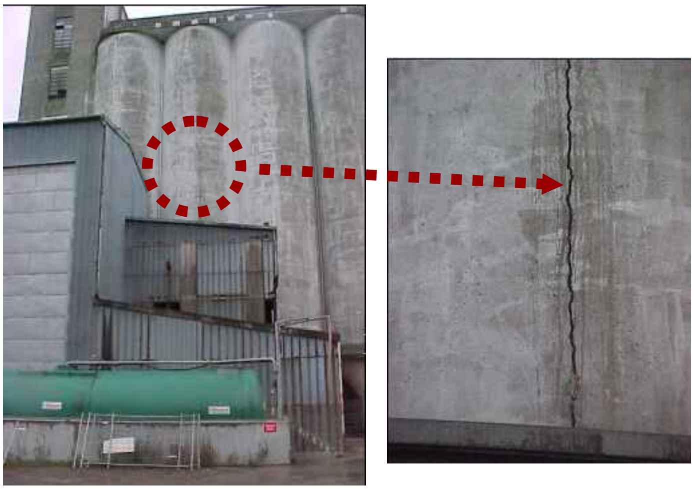


THE ACCIDENT, ITS BEHAVIOUR, EFFECTS AND CONSEQUENCES

The Vailly sur Aisne accident: (ARIA No. 23182)

On September 20, 2002 around 11.50 am, a driver of a truck being loaded by the side unloading system of C2 noted that pieces of concrete were falling into the trailer bed. He informed the silo operator performing the unloading operation and both employees immediately moved away from the area. A few instants later, a block weighing approximately 3 tons fell into the truck. 300 t of wheat spilled onto the ground, destabilizes the drier and is blocked by the wall separating the cooperative and the yards of the residences next door.

Jussy accident: (ARIA No. 23368)



During a security round on October 20, 2002 around 10 am, the silo manager was alerted by the sound of material falling onto the drier roof. He noted a crack along the entire height of a 25 m tall cell. Roughly a ton of corn had spilled out, damaging a wall allowing access to the control installations located at ground level, under the outflow cones forming the base of the cells.

Consequences of both accidents:

The accident claimed no victims although 6 individuals had to be temporarily to the Vailly sur Aisne site. Property damage was extensive in both cases (amounts not available).

European scale of industrial accidents

By applying the rating rules of the 18 parameters of the scale made official in February 1994 by the Committee of Competent Authorities of the Member States which oversees the application of the 'SEVESO' directive, the accident of Vailly can be characterised by the following 4 indices, based on the information available.

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

Quantities of dangerous substances	□ □ □ □ □ □
Human and social consequences	■ ■ □ □ □ □
Environmental consequences	□ □ □ □ □ □
Economic consequences	□ □ □ □ □ □

For the Jussy accident, the indices are as follows:

Quantities of dangerous substances	□ □ □ □ □ □
Human and social consequences	□ □ □ □ □ □
Environmental consequences	□ □ □ □ □ □
Economic consequences	□ □ □ □ □ □

ORIGIN, CAUSES AND CIRCUMSTANCES OF THE ACCIDENTS

The ageing of the reinforced compounded by corrosion of the reinforcement is at the origin of the Vailly cell rupture and that of the cracking at Jussy, built in 1960 and 1963, respectively. The expert assessments conducted showed that, since 1975, the structure of the recently built cells was reinforced with two levels of steel hoops as opposed to one before. In addition, in the Vailly silo accident, the installation of a side drainage system on the cell attributed to the weakening of the structure, thus aggravating the phenomenon and causing the structure to collapse.

ACTION TAKEN

Vailly sur Aisne site:

Following the accident, the site was secured and a safety perimeter was set up around the installations, cracks observed in the neighbouring cell C1 were marked, the site's electrical power supply was disconnected, the grain spilled on the ground was recovered and the drier stabilized. A crisis meeting was held in the town hall's facilities in mid-afternoon in the presence of the mayor of the *commune*, the operator, a concrete expert, firemen, the gendarmerie and representatives from the DRIRE. Following the discussions, the mayor issued a temporary evacuation order for the residents living closest to the establishment.

The Registered Installations Inspectorate proposed that the *Prefect* issue an emergency measures order requiring:

- ✓ That the site be secured
- ✓ An expert evaluation in order to evaluate the overall stability of the silo and the possible measures required to repair or demolish the structure
- ✓ That a new Acknowledgement of Declaration be obtained prior to placing the installations back into service.

Following the expert's report, the Inspectorate proposed in February 2003 that the *Prefect* issue an order of additional requirements aimed at obtaining guarantees relative to the stability of the second phase (built in 1976) and precise information relative to the action plan for repairing the 1st phase structures. This order would never get signed as the entire installation was demolished in May 2003.

Jussy site:

The site was also secured with a safety perimeter; deliveries from farmers were suspended, the progressive unloading of the 12 cells of zone S1 and the disconnection of the drier's gas and electrical power supplies. As the cause of the cracking was similar to the rupture of the Vailly silo, the Inspectorate proposed an order similar to the one signed by the *Prefect* on October 31, 2002. The operator decided to stop operating cells S1 and S3 and to suspend the activity of the S2 cells until 2004. The expert's report must be submitted before the establishment continues operations.

LESSONS LEARNED

If the collapse of the silo can result from an internal explosion, it is not immediately obvious that cells can be damaged under the weight of the material stored. There are numerous causes for these structural ruptures and can, in certain cases, be cumulative: design fault, construction fault, modifications and work without sufficient prior engineering, corrosion and ageing of the materials. Both of these accidents confirm the risks of cracking and cell rupture resulting from the ageing of the reinforced concrete, particularly for cells built prior to 1975, when the second level of steel hoops were installed to reinforce the structure. The collapse of part of the storage facility wall at Vailly also showed the need for thorough evaluation of the cells when modifications are made.

A certain amount of vigilance would seem necessary particularly concerning older installations. Operators should locate the construction drawings of their installations and have the civil engineering, the conformity of the construction and possible modifications thoroughly checked. If these elements are not available or, if there is a doubt relative to safety margins, an expert evaluation by a specialised organisation would seem highly desirable.

Warehouse
Fire
Flashover
Property damage
Smoke control
Automatic extinguishing
Domino effect risks

Fire in an archival storage warehouse
January 28, 2002
Roye (80 - Somme) - France

THE INSTALLATIONS IN QUESTION

The site:

The warehouse concerned is operated by a service providing company that ensures the computerised management, preservation and statute of limitations storage of its customer's "hardcopy" archives. It is located to the east of the Somme *département* on the Amiens-Lille highway where the presence of a cloverleaf intersection promoted the installation of numerous other storage warehouses.

The facility was commissioned in 1992-1993 without authorisation. The company was authorised to operate the warehouse following an accrual request by prefectoral order dated January 14, 2002 under the terms of section 1510 of legislation governing installations registered for the storage of combustible materials in quantities exceeding 500 t in covered warehouses.

The warehouse prior to the fire of January 28, 2002.

The warehouse concerned:

The warehouse was designed to store archives (paper, cinematographic and medical archives…), and had a capacity of up to 63,200 m³. According to the accrual request file, it consisted of two adjacent buildings of 1,838 m² and 3,630 m², erected on a metal framework of 8.5 m and 12 m in height, with the sub-structure consisting of metal panel siding. A two-level administrative facility was attached to their north facade. The separation between the two buildings is made of masonry blocks in which a non-fire door is built.

The authorisation file indicates that the roofing was made of noncombustible materials (M0) except for an internal covering on the existing M1 class part.

Standardised cardboard boxes are arranged on metal shelving which spans the entire useful height of the building. These "racks" are placed on each side and perpendicularly to a central aisle measuring 2.25 m wide. The personnel access the various storage locations, along the entire length of the rack, by means of side aisles (0.80 m wide) placed at several levels (up to 5) and made up of platforms consisting of metal grating. The levels are served by a freight elevator and by a spiral staircase. A side aisle (0.87 m wide) is located on the ground floor along the entire inside periphery of the buildings to allow access to the emergency exits.

The storage facilities were equipped with a hose station network and an automatic fire extinguishing installation featuring intermediate layers, protected against freezing temperatures and connected to two 630 m³ and 30 m³ reserve tanks via pumps capable of delivering 17.5 l/min/m² over a surface area of 260 m² (that is, the equivalent of 1,130 boxes of archives for 2 hours). There was also a "firemen's" reserve of 120 m³. Two fire hydrants were available at less than 200 m from the site.

THE ACCIDENT, ITS BEHAVIOUR, EFFECTS AND CONSEQUENCES

The accident:

Monday**, January 28, 2002, around 10 am**, when the response centre was called, the ignition sources located by the personnel were in the building's fifth bay and the fire had already reached the second level accessible via a spiral staircase and was menacing the upper levels.

According to the firemen, the remote monitoring system had noted the fire at **10.03 am**, and at this time the first sprinkler heads were activated.

The firemen arrived at the scene at **10.13 am**.

They noted white smoke released at gutter level along the roof of the two 8.5 m cells and 14 m at the parapet wall. The firemen entered the building and located the first ignition source in the 5th bay; several fires were located at the back of the warehouse at ground level. The emergency services still had good visibility. The smoke was confined at the upper levels between the 3rd and 4th level.

The firemen set up nozzles to confine the fires, several of which were rapidly brought under control. It appears that the sprinklers were not in operating when the firemen entered the warehouse. The main pump's motor apparently did not come on. Only a few sprinkler heads were operating.

The warehouse was then engulfed in smoke. The configuration of the warehouse's aeraulics would have promoted the downwash of smoke coming from the cell's entrance thus encircling the firemen present in the building At around **10.20 am,** the firemen were confronted with a sudden flashover of smoke and the warehouse. The very hot smoke, loaded with flammable gases caused by the pyrolysis of the paper and cardboard boxes stored must have self-ignited (a phenomenon referred to as flashover).

Following the flashover of this zone, the firemen evacuated the cell in complete darkness as the lighting in the cells had gone out.

Under the pressure of the cell's increase in temperature due to the combustion of flammable gases in the smoke, two explosions occurred causing the smoke control systems to open. The cylinder rods were thrown roughly twenty meters.

During the following thirty minutes, the smoke reduced the visibility to just a few meters. The emergency vehicles that arrived to reinforce the crews already at the site were unable to approach the warehouse due to the zero visibility. The firemen from the first rescue team walked to meet the reinforcements.

At **11 am**, the external structure of the warehouse collapsed inward. The racks and interior footwalks had already collapsed and did not resist the fire more than one half hour.

The flames shot up to heights of approximately fifteen meters. They were beat to the ground. The meteorological conditions were characterised by a strong wind exceeding 100 km/h that probably fuelled the fire but also considerably dispersed the hot gases and very significantly reduced the lateral thermal radiation.

The wind changed direction, but during the worst of the fire and smoke, it was luckily oriented to the east toward an adjoining lot intended for extensions, and thus not occupied for approximately 200 m up to a departmental highway that passes through the industrial area.

After the cells collapsed, the wind blew burning paper over several hundred meters. The firemen set up a safety barrier around the service station located 200 m down wind.

Informed at 10.30 am, the Registered Installations Inspectorate arrived at the scene of the accident around **11.15 am**.

The warehouse continued to burn throughout the day. Fuelled by the wind, the fire was not totally extinguished until four days later.

Consequences:

The fire destroyed the two cells of the warehouse and all that they contained: the archives of several financial establishments and part of those of Paris hospitals. The structure of the largest cell was totally ruined. Only the siding of the smallest cell remained. This is essentially due to the efforts of the firemen who protected the administrative building. As the amount of damage is not available, this information does not figure in the scale below.

European scale of industrial accidents

By applying the rating rules of the 18 parameters of the scale made official in February 1994 by the Committee of Competent Authorities of the Member States which oversees the application of the 'SEVESO' directive, the accident can be characterised by the following 4 indices, based on the information available.

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

Quantities of dangerous substances	☐ ☐ ☐ ☐ ☐ ☐
Human and social consequences	☐ ☐ ☐ ☐ ☐ ☐
Environmental consequences	☐ ☐ ☐ ☐ ☐ ☐
Economic consequences	☐ ☐ ☐ ☐ ☐ ☐

ORIGIN, CAUSES AND CIRCUMSTANCES OF THE ACCIDENT

The circumstances in which the warehouse fire started are not known, although the flashover phenomenon observed enables a scenario to be considered.

Flashover is a result of a long process that probably started well before the fire alarm was triggered, in the form of smouldering fire without flame.

An ignition point appeared within the warehouse. Very limited in the beginning, the fire spread and began to heat up the surrounding materials. Due to the configuration of the pallet racks, chimney phenomena must have promoted the vertical propagation of the fire while accentuating the thermal radiation and the release of overheated smoke loaded with flammable gases.

The start of operations by company employees on the day of the accident (a Monday) may have contributed to creating a draft which fed the fire and promoted the sudden fire and its spread throughout the entire warehouse complex.

ACTION TAKEN

As the fire of January 28, 2002 put the operator's storage warehouse completely out of service, the Registered Installations Inspectorate, in compliance with article 39 of the order of September 21, 1977, proposed that restart take place only following explicit authorisation by the Prefect.

The Prefect rescinded the prefectoral order of January 14, 2002. The operator subsequently decided to stop operations at this site and submitted a discontinuance of business file.

LESSONS LEARNED

The fire highlighted the consequences that certain non-conformities, relative to regulations applicable to warehouses (technical instruction of February 4, 1987), could have had on fire's progression, as well as the special features of the internal layout specific to the warehousing and archive management activity operated by the company.

Firefighting measures:

The warehouse was equipped with fire extinguishers, a hose station network and an automatic fire extinguishing network. It appears that when the employees became aware of the fire, they attempted to bring it under control with water and power-type fire extinguishers, but for undetermined reasons the hose stations with their greater extinguishing power and range were not implemented.

During the intervention by the firemen, it appears that the water tanks and the public network were insufficient. The fire supply had a capacity of 120 m^3 and the site could only have a single hydrant with an output of 52 m^3 / h at 1 bar. In its danger study, the petionner indicated that two fire hydrants were located near the site. However, the hydrants were on the same line and the emergency services were only able to use one of them owing to the excessively low flow rates. The emergency services had to bring water with their vehicles in order to supply the site with water.

Smoke control:

For the large cell, the automatic smoke vents, with no heat-activated elements, ensured smoke control. For the small cell, no smoke vent was provided; there were no heat-activated elements (they were blocked when the roof was renovated).

When the emergency services arrived, white smoke was exiting both cells at the gutter level. More than the upper half of the warehouse was filled with smoke. The smoke gathered near the 3rd level. The "flashover" phenomenon observed bears witness to the excessive amount of heat present. The smoke vents should have operated. The vents opened under the blast effect caused by the gas explosions in the warehouse.

This type of phenomenon was not included in the scenarios described in the danger study. This is also true for the smoke and consequences that could have lead to the near total loss of visibility if the wind had not pushed it toward the north in the direction of the closest residences.

The smoke, gathered in the upper reaches of the warehouse owing to the smoke vents being closed, should have triggered the fire alarm and automatic extinguishing system.

Fire detection:

The alarm seems to have been triggered late. The detection systems were triggered at the same time the Roye response centre was informed. This element leads to serious consequences relative to the emergency response team's intervention. The firemen left to fight a fire in a paper storage warehouse equipped with sprinklers. When help arrived, the automatic sprinkler system was not in operation as it should have been, thus placing the firemen in a dangerous situation.

Emergency exits:

Access to the pallet racks was gained by means of grating distributed over 5 levels. The various levels are accessed via the spiral staircase. Four staircases provide access to the levels. The emergency exits to the outside were located on ground level that required the personnel to go back down via the centre stairs in order to use the emergency exits. The minimum distances to travel (i.e. 40 m from one emergency exit or 25 m in the case of "dead end" parts) were not respected. The operator intended to install facade emergency exits over the building's entire height to facilitate evacuation. These emergency exits were not created. During the intervention, the firemen encountered difficulties intervening on the various levels of the pallet rack owing to the insufficient width.

Fire resistance of the structure:

The warehouse had a metal structure. The cells were separated from each other by a wall of solid cement blocks built against the metal structure of the largest cell. The ″firewall" stopped at the height of the small cell.

The collapse of the large cell's structure caused the firewall to fall and destabilise the small cell's structure. The fire resistance of the internal structures were significantly less than ½ hour. The warehouse's metal structure resisted approximately 45 minutes.

Danger study:

The danger study submitted by the operator did not reveal the specific consequences of the very specific layout and operation of this paper archival storage and dynamic management warehouse in terms of the safety of individuals and firefighting measures:

✓ Lack of smoke control

✓ Consequences of the layout and alternating configuration of the grating on the development and propagation of the fire, notably the chimney phenomena accentuating the propagation of the fire.

✓ The narrowness of the aisles and access and the organisation of the storage space appear to have been extremely dangerous for the response personnel considering that the minimal distances to the emergency exits were not respected.

✓ Poor operation of the alarm and the automatic surveillance that reacted belatedly.

✓ Automatic extinction system that operated poorly or not at all and was not able to stop the outbreak of the fire and to prevent it from spreading.

✓ The lack of firefighting water in terms of both the network and the fixed tanks.

In addition, the danger study's modelling of the environmental consequences of a fire omitted several scenarios which may have lead to domino effects. The fire, fed by winds gusting from 80 to 100 km/h, caused embers to blow more than 200 m requiring the firemen to establish a safety perimeter around a service station.

It should be noted that part of these subjects (extent of the zones of effect, fire resistance of the structures, aggravation of a fire by the internal layout and evacuation distances) were dealt with in several requests for further information by the Registered Installations Inspectorate from the operator and from the agency called upon to intervene as third-party expert. The Inspectorate thus proposed that prefectoral authorisation be contingent on the backfitting of the warehouse.

Rupture of observation windows in a brewery

January 17 and 18, 2002

Champigneulles

(54 – Meurthe et Moselle) – France

Brewery
Observation window
Rupture disc
Valve

THE INSTALLATIONS IN QUESTION

The brewery was created January 1st, 1897.

This establishment is subject to the legislation of the Installations Classed for the Protection of the Environment. The orders governing the site date from April 18, 2000 (a unique operating permit order) and January 29, 2001 (supplementary order of the prefect establishing the measures required to prevent and fight Legionella).

Authorised annual production is 360 million litres of beer, 20 million litres of cider and 15 million litres of carbonated beverages. As of September 1st, 2003 there were 350 employees.

For the beer production activity, the site has 64 metal tanks fo that consists of a basement and three storeys, each level is designated as a "cellar". The building dates back to 1957. Each of the four cellars contains 16 tanks arranged in two rows of 8. The incidents took place in the cellar located on the second floor.

To manufacture beer, water, barley, hop and yeast are required.

Water contributes its mineral properties to the beer. Water hardness and pH play a decisive role in the quality of the beer produced.

Hop is a "source" of starch. However, the yeasts cannot assimilate starch in its "natural" state, so it must first be transformed into sugar by enzymes. In order to create enzymes, the barley must first be transformed into malt. To do this, the hop is subjected to four operations (soaking, germination, kiln drying, then malt screening) thus enabling the creation of enzymes, through cereals, enabling the transformation of the starch contained in the barley into a fermentable sugar.

The cereals are then dried to obtain the malt. The greater the drying temperature, the darker the grains, which thus defines the colour of the beer. The malts used influence the taste of the beer.

The hop provides the beer with taste and bitterness. The tannins in the hob flower (non fertilised) clarify the must and preserve the beer.

The yeast allows fermentation and thus the transformation of the sugar present in the malt into alcohol and carbon dioxide (CO_2). It is this part of the process that was involved in both accidents. The yeast also participates in the giving the beer its final taste.

The fermentation tanks used on the site are made of coated steel. They feature a Plexiglas observation window on the upper part to enable visual inspection of the beer during the fermentation phase. The tanks measure 3 meters in diameter and 17 meters in length, for a volume of 120 m^3, and are installed in a horizontal position.

These 120 m^3 are used in the following manner:

- 80 m^3 of beer in fermentation;
- 40 m^3 of free space required for fermentation.

The tanks are equipped with an outlet and a fitting to connect a hose onto a pipe that conveys the carbon dioxide to be released to the atmosphere (pipe 1) or to the gas recovery system (pipe 2). These two pipes are each equipped with a check valve and manual valve. The check valves are cleaned after each use of a tank. The connection between the tank outlet and one of the two drainpipes is made manually depending on the state of the beer's fermentation phase.

The tanks, during the fermentation phases, are subjected to gauge pressures from 500 to 700 millibar. The carbon dioxide is released by simple overpressure. The installation are thus not subject to regulations on the pressurised equipment, namely decree No. 99-1046 of December 13, 1999 relative to pressurised equipment, the order of March 15, 2000 relative to their operation and the ministerial order of January 5, 1962 governing plant piping.

THE ACCIDENT, ITS BEHAVIOUR, EFFECTS AND CONSEQUENCES

The accident of January 17, 2002:

The tanks concerned are tanks of beer in the fermentation phase which are located on the second level. This fermentation period can be broken down into two phases:

- ✓ **Start of fermentation**: the air-CO_2 mixture is released to the atmosphere
- ✓ **Fermentation**: the carbon dioxide is recovered in a gas recovery station to be used in other purposes in the installations (lasting approximately 8 days).

Tank 224 was in fermentation phase with the vent positioned to release the CO_2 to the atmosphere. The casking took place January 16 at 1.15 pm.

Suddenly, at 10.10 am on January 17, 2002, the window (a Plexiglas disk measuring 26 cm in diameter, screwed onto a metal support, and used to observe the level of the tank, at a height of 2.80 m) of tank 224 burst, resulting in the sudden release of carbon dioxide (approximately 40 m^3) and a small quantity of beer (approximately 250 litres) as well as the projection of Plexiglas which destroyed a light fixture.

The spilled beer was absorbed by the plant's water treatment facility.

The carbon dioxide spread throughout the workshop. The personnel present evacuated the cellars. A qualified member of the personnel put on a PBA and inspected the cellars to ensure that everyone had managed to evacuate the premises. The fire and emergency services were informed by the guardhouse.

The SDIS ("Service Départemental d'Incendie et de Secours", departmental fire and emergency service) arrived at the scene 20 minutes after the explosion and checked that no personnel were in the cellars, then provided forced ventilation to disperse the CO_2 present in the workshop to the atmosphere.

The personnel present in the workshop during the incident were examined by an occupational health physician who happened to be at the site at that time. The physician determined that no one was injured.

The accident of January 18, 2002:

On January 18, 2002, at 4 am, while all of the personnel were in the break room relaying instructions between two shifts, the observation window of tank 226, located just opposite of tank 224, ruptured.

In a manner identical to the accident of the previous day, this rupture resulted in the release of carbon dioxide (approximately 40 m^3) and a small quantity of beer (250 litres). Here again, the spilled beer was absorbed by the plant's water treatment facility.

Carbon dioxide spread through the workshop in which no one was present. The fire department and emergency services were called. No one entered the workshop as PBA was no longer available.

The SDIS ("Service Départemental d'Incendie et de Secours", departmental fire and emergency service) arrived at the scene 15 minutes after the explosion and provided forced ventilation to disperse the CO_2 present in the workshop to the atmosphere.

Overall consequences:

Loss of production due to the downtime following these incidents can be evaluated at 800,000 litres of beer.

The corrective actions implemented cost a total of approximately 800,000 Euros, including 350,000 for the tank equipment.

European scale of industrial accidents

By applying the rating rules of the 18 parameters of the scale made official in February 1994 by the Committee of Competent Authorities of the Member States which oversees the application of the 'SEVESO' directive, the accident can be characterised by the following 4 indices, based on the information available.

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

Quantities of dangerous substances	☐	☐	☐	☐	☐	☐
Human and social consequences	☐	☐	☐	☐	☐	☐
Environmental consequences	☐	☐	☐	☐	☐	☐
Economic consequences	☐	☐	☐	☐	☐	☐

ORIGIN, CAUSES AND CIRCUMSTANCES OF THE ACCIDENT

Origin and causes of the first accident:

The first reports allow the possible causes of the tank 224 window explosion to be identified.

The following was noted on the atmospheric release piping:

- ✓ The hose was correctly connected on the CO_2 atmosphere release outlet;
- ✓ The "atmosphere release" valve was open;
- ✓ The "atmosphere release" check valve **was installed backwards**.

This check valve, thus blocking any release of CO_2 to the atmosphere, contributed to the overpressure in the tank. This overpressure resulted in the window exploding which acted as a rupture disc.

The tanks are equipped with a rupture disc or valve in the case of overpressure and are not equipped with an automated pressure-measuring device.

Furthermore, the check valve is a screw-type device that is completely removed for cleaning during maintenance operations. This valve is symmetrical in appearance and has no distinctive marking showing the installation direction or feature preventing it from being installed backwards.

A leak on one of the window bolts was noted and repaired (screw changed) by the crew of the 4 am to 8 am shift in the morning of January 17, 2003. This event did not alert the personnel.

Origin and causes of the second accident:

In relation to the 1st incident, the only difference is that the check valve was correctly installed on the CO_2 atmosphere release pipe.

The window explosion could thus have the following causes:

- ✓ The weakening and the loss of its mechanical characteristics as the window as nearly opposite the window of tank 224 that exploded the day before;
- ✓ The ageing of the material (Plexiglass). There is no long-term guarantee of the windows' mechanical characteristics. The windows are supplied by a company that machines the Plexiglas to the required dimensions;
- ✓ An overpressure in the tank due to blockage of the atmosphere release pipe (impurities, build up of ice, …). This hypothesis is the most probable from the operator's point of view.

ACTION TAKEN

The operator responded to all of the administration's requests. The new casking operations were partially renewed beginning Wednesday, January 23, 2002. The internal pressures of each tank in the fermentation phase was monitored once per each shift (that is, every 8 hours) until August 29, 2002 noon, at which time all of the medium-term measurements were in place (sensors, rupture discs and discharge outlets). No other incident has occurred since January 18, 2002.

Measures taken following the first accident:

The following measures were taken in view of the inquiry's conclusions:

Short-term measures:

- ✓ Inspection of all check valves;
- ✓ Information provided to all operators concerning the incident and its probable causes. Their attention is drawn to the proper installation of the check valves.

Medium-term measures:

- ✓ "Foolproofing" devices are installed on the valves: initially, indelible paint on valves and piping, then installation of systems equipped with a "male" side and "female" side.

Measures taken following the second accident:

Following these two accidents, the operator was to implement more stringent and security measures:

- ✓ All of the fermentation tanks in the workshop in question were connected carbon dioxide recovery pipe's atmosphere by-pass;
- ✓ Manual verification of the internal pressure of all tanks is conducted as well as all of the valves and observation windows;
- ✓ The cellar is barred;

✓ Filling of new tanks (casking) is suspended as of 6.15 am.

The investigations conducted immediately after the accident lead to the following findings and decisions:

✓ No tank was in overpressure status;

✓ All of the valves and all the dampers were in the correct position;

✓ The atmosphere by-pass of the carbon dioxide recovery pipe was operating correctly; all of the tanks are thus configured to the by-passed recirculation pipe;

✓ 2 observation windows were bowed.

Not being able to exactly define the origin of the 2nd incident, the operator made the following decisions:

✓ Not conduct a new casking operation;

✓ Conduct manual internal temperature checks regularly over the entire weekend and on all tanks in fermentation phase (20 out of 32);

✓ Regularly purge the carbon dioxide recovery system to discharge the foam that it may contain;

✓ Decompress the tank and destroy the foam, resulting from the decompression, contained in the tank should any risk appear.

The operator requires that the following measures be undertaken prior to the restart of the installation:

✓ In the short term:

- Systematic changing of all observation windows;
- Inspection of the 2 pipe networks (release of gas to the atmosphere and recirculation systems);
- Installation of a pressure gauge on each tank and implementation of a procedure ensuring the regular inspection of said gauges;
- Implementation of a cellar "access authorization" procedure.

✓ In the medium term:

- Installation of a rupture disc on each tank with recovery of the gas and evacuation to the outside;
- Observation windows replaced by metal sheeting as visual inspection is not essential;
- Personnel supplied with a portal CO_2 detector and leak masks;
- Personnel are required to move about and work in teams of 2 in the cellars and to sign an in/out log;
- Ventilation of hallways, installation of CO_2 detection and alarm equipment;
- Emergency lighting;
- Increase the number of personal breathing apparatus at the plant.

The Inspectorate went to the site on the day of the accident and requested that the operator provide the following:

✓ For January 25, 2002, submittal of an incident report and the compensatory measures undertaken (locking out of the workshop, release of the CO_2 to the atmosphere via a by-pass on the recovery piping, etc);

✓ For February 1st, 2002, the submittal of the accident causal and failure analysis also including a description of the safety devices installed.

✓ For March 1st, 2002, the submittal of the corrective measures implemented to prevent such an incident from happening again.

LESSONS LEARNED

Since these incidents, the operator has implemented the following additional means:

- ✓ Installation of pressure sensors on the tanks with remote display of values in the control room and triggering of a threshold alarm in case of a problem;
- ✓ Installation of pressure control equipment on half of the tanks. This equipment features a bubbling sight glass (avoiding the possible fouling of upline pipes and equipment) and a lever valve enabling the desired tank pressure to be adjusted. It can be cleaned "on site" and no longer requires disassembly and reassembly which can be a source of errors.
- ✓ Installation of a spring-loaded valve ensuring that a fixed amount of backpressure is applied for the other half of the tanks (reserve tanks: temperature near 0°C, no more CO_2 release, no more foam).

Rupture of observation windows in a brewery

January 17 and 18, 2002

Champigneulles

(54 – Meurthe et Moselle) – France

Brewery
Observation window
Rupture disc
Valve

THE INSTALLATIONS IN QUESTION

The brewery was created January 1^{st}, 1897.

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To manufacture beer, water, barley, hop and yeast are required.

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Hop is a "source" of starch. However, the yeasts cannot assimilate starch in its "natural" state, so it must first be transformed into sugar by enzymes. In order to create enzymes, the barley must first be transformed into malt. To do this, the hop is subjected to four operations (soaking, germination, kiln drying, then malt screening) thus enabling the creation of enzymes, through cereals, enabling the transformation of the starch contained in the barley into a fermentable sugar.

The cereals are then dried to obtain the malt. The greater the drying temperature, the darker the grains, which thus defines the colour of the beer. The malts used influence the taste of the beer.

The hop provides the beer with taste and bitterness. The tannins in the hob flower (non fertilised) clarify the must and preserve the beer.

The yeast allows fermentation and thus the transformation of the sugar present in the malt into alcohol and carbon dioxide (CO_2). It is this part of the process that was involved in both accidents. The yeast also participates in the giving the beer its final taste.

The fermentation tanks used on the site are made of coated steel. They feature a Plexiglas observation window on the upper part to enable visual inspection of the beer during the fermentation phase. The tanks measure 3 meters in diameter and 17 meters in length, for a volume of $120\ m^3$, and are installed in a horizontal position.

These 120 m^3 are used in the following manner:

- 80 m^3 of beer in fermentation;
- 40 m^3 of free space required for fermentation.

The tanks are equipped with an outlet and a fitting to connect a hose onto a pipe that conveys the carbon dioxide to be released to the atmosphere (pipe 1) or to the gas recovery system (pipe 2). These two pipes are each equipped with a check valve and manual valve. The check valves are cleaned after each use of a tank. The connection between the tank outlet and one of the two drainpipes is made manually depending on the state of the beer's fermentation phase.

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THE ACCIDENT, ITS BEHAVIOUR, EFFECTS AND CONSEQUENCES

The accident of January 17, 2002:

The tanks concerned are tanks of beer in the fermentation phase which are located on the second level. This fermentation period can be broken down into two phases:

✓ **Start of fermentation**: the air-CO_2 mixture is released to the atmosphere

✓ **Fermentation**: the carbon dioxide is recovered in a gas recovery station to be used in other purposes in the installations (lasting approximately 8 days).

Tank 224 was in fermentation phase with the vent positioned to release the CO_2 to the atmosphere. The casking took place January 16 at 1.15 pm.

Suddenly, at 10.10 am on January 17, 2002, the window (a Plexiglas disk measuring 26 cm in diameter, screwed onto a metal support, and used to observe the level of the tank, at a height of 2.80 m) of tank 224 burst, resulting in the sudden release of carbon dioxide (approximately 40 m^3) and a small quantity of beer (approximately 250 litres) as well as the projection of Plexiglas which destroyed a light fixture.

The spilled beer was absorbed by the plant's water treatment facility.

The carbon dioxide spread throughout the workshop. The personnel present evacuated the cellars. A qualified member of the personnel put on a PBA and inspected the cellars to ensure that everyone had managed to evacuate the premises. The fire and emergency services were informed by the guardhouse.

The SDIS ("Service Départemental d'Incendie et de Secours", departmental fire and emergency service) arrived at the scene 20 minutes after the explosion and checked that no personnel were in the cellars, then provided forced ventilation to disperse the CO_2 present in the workshop to the atmosphere.

The personnel present in the workshop during the incident were examined by an occupational health physician who happened to be at the site at that time. The physician determined that no one was injured.

The accident of January 18, 2002:

On January 18, 2002, at 4 am, while all of the personnel were in the break room relaying instructions between two shifts, the observation window of tank 226, located just opposite of tank 224, ruptured.

In a manner identical to the accident of the previous day, this rupture resulted in the release of carbon dioxide (approximately 40 m^3) and a small quantity of beer (250 litres). Here again, the spilled beer was absorbed by the plant's water treatment facility.

Carbon dioxide spread through the workshop in which no one was present. The fire department and emergency services were called. No one entered the workshop as PBA was no longer available.

The SDIS ("Service Départemental d'Incendie et de Secours", departmental fire and emergency service) arrived at the scene 15 minutes after the explosion and provided forced ventilation to disperse the CO_2 present in the workshop to the atmosphere.

Overall consequences:

Loss of production due to the downtime following these incidents can be evaluated at 800,000 litres of beer.

The corrective actions implemented cost a total of approximately 800,000 Euros, including 350,000 for the tank equipment.

European scale of industrial accidents

By applying the rating rules of the 18 parameters of the scale made official in February 1994 by the Committee of Competent Authorities of the Member States which oversees the application of the 'SEVESO' directive, the accident can be characterised by the following 4 indices, based on the information available.

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Human and social consequences	☐ ☐ ☐ ☐ ☐ ☐
Environmental consequences	☐ ☐ ☐ ☐ ☐ ☐
Economic consequences	☐ ☐ ☐ ☐ ☐ ☐

ORIGIN, CAUSES AND CIRCUMSTANCES OF THE ACCIDENT

Origin and causes of the first accident:

The first reports allow the possible causes of the tank 224 window explosion to be identified.

The following was noted on the atmospheric release piping:

- ✓ The hose was correctly connected on the CO_2 atmosphere release outlet;
- ✓ The "atmosphere release" valve was open;
- ✓ The "atmosphere release" check valve **was installed backwards**.

This check valve, thus blocking any release of CO_2 to the atmosphere, contributed to the overpressure in the tank. This overpressure resulted in the window exploding which acted as a rupture disc.

The tanks are equipped with a rupture disc or valve in the case of overpressure and are not equipped with an automated pressure-measuring device.

Furthermore, the check valve is a screw-type device that is completely removed for cleaning during maintenance operations. This valve is symmetrical in appearance and has no distinctive marking showing the installation direction or feature preventing it from being installed backwards.

A leak on one of the window bolts was noted and repaired (screw changed) by the crew of the 4 am to 8 am shift in the morning of January 17, 2003. This event did not alert the personnel.

Origin and causes of the second accident:

In relation to the 1st incident, the only difference is that the check valve was correctly installed on the CO_2 atmosphere release pipe.

The window explosion could thus have the following causes:

- ✓ The weakening and the loss of its mechanical characteristics as the window as nearly opposite the window of tank 224 that exploded the day before;
- ✓ The ageing of the material (Plexiglass). There is no long-term guarantee of the windows' mechanical characteristics. The windows are supplied by a company that machines the Plexiglas to the required dimensions;
- ✓ An overpressure in the tank due to blockage of the atmosphere release pipe (impurities, build up of ice, …). This hypothesis is the most probable from the operator's point of view.

ACTION TAKEN

The operator responded to all of the administration's requests. The new casking operations were partially renewed beginning Wednesday, January 23, 2002. The internal pressures of each tank in the fermentation phase was monitored once per each shift (that is, every 8 hours) until August 29, 2002 noon, at which time all of the medium-term measurements were in place (sensors, rupture discs and discharge outlets). No other incident has occurred since January 18, 2002.

Measures taken following the first accident:

The following measures were taken in view of the inquiry's conclusions:

Short-term measures:

- ✓ Inspection of all check valves;
- ✓ Information provided to all operators concerning the incident and its probable causes. Their attention is drawn to the proper installation of the check valves.

Medium-term measures:

- ✓ "Foolproofing" devices are installed on the valves: initially, indelible paint on valves and piping, then installation of systems equipped with a "male" side and "female" side.

Measures taken following the second accident:

Following these two accidents, the operator was to implement more stringent and security measures:

- ✓ All of the fermentation tanks in the workshop in question were connected carbon dioxide recovery pipe's atmosphere by-pass;
- ✓ Manual verification of the internal pressure of all tanks is conducted as well as all of the valves and observation windows;
- ✓ The cellar is barred;

✓ Filling of new tanks (casking) is suspended as of 6.15 am.

The investigations conducted immediately after the accident lead to the following findings and decisions:

✓ No tank was in overpressure status;

✓ All of the valves and all the dampers were in the correct position;

✓ The atmosphere by-pass of the carbon dioxide recovery pipe was operating correctly; all of the tanks are thus configured to the by-passed recirculation pipe;

✓ 2 observation windows were bowed.

Not being able to exactly define the origin of the 2nd incident, the operator made the following decisions:

✓ Not conduct a new casking operation;

✓ Conduct manual internal temperature checks regularly over the entire weekend and on all tanks in fermentation phase (20 out of 32);

✓ Regularly purge the carbon dioxide recovery system to discharge the foam that it may contain;

✓ Decompress the tank and destroy the foam, resulting from the decompression, contained in the tank should any risk appear.

The operator requires that the following measures be undertaken prior to the restart of the installation:

✓ In the short term:

- × Systematic changing of all observation windows;
- × Inspection of the 2 pipe networks (release of gas to the atmosphere and recirculation systems);
- × Installation of a pressure gauge on each tank and implementation of a procedure ensuring the regular inspection of said gauges;
- × Implementation of a cellar "access authorization" procedure.

✓ In the medium term:

- × Installation of a rupture disc on each tank with recovery of the gas and evacuation to the outside;
- × Observation windows replaced by metal sheeting as visual inspection is not essential;
- × Personnel supplied with a portal CO_2 detector and leak masks;
- × Personnel are required to move about and work in teams of 2 in the cellars and to sign an in/out log;
- × Ventilation of hallways, installation of CO_2 detection and alarm equipment;
- × Emergency lighting;
- × Increase the number of personal breathing apparatus at the plant.

The Inspectorate went to the site on the day of the accident and requested that the operator provide the following:

✓ For January 25, 2002, submittal of an incident report and the compensatory measures undertaken (locking out of the workshop, release of the CO_2 to the atmosphere via a by-pass on the recovery piping, etc);

✓ For February 1st, 2002, the submittal of the accident causal and failure analysis also including a description of the safety devices installed.

✓ For March 1st, 2002, the submittal of the corrective measures implemented to prevent such an incident from happening again.

LESSONS LEARNED

Since these incidents, the operator has implemented the following additional means:

- ✓ Installation of pressure sensors on the tanks with remote display of values in the control room and triggering of a threshold alarm in case of a problem;
- ✓ Installation of pressure control equipment on half of the tanks. This equipment features a bubbling sight glass (avoiding the possible fouling of upline pipes and equipment) and a lever valve enabling the desired tank pressure to be adjusted. It can be cleaned "on site" and no longer requires disassembly and reassembly which can be a source of errors.
- ✓ Installation of a spring-loaded valve ensuring that a fixed amount of backpressure is applied for the other half of the tanks (reserve tanks: temperature near 0°C, no more CO_2 release, no more foam).

Explosion
Death
Property damage
Explosives- Dynamite
Start-up
Organisation / Inspections

Explosion in a dynamite loading workshop

March 27, 2003

Billy-Berclau

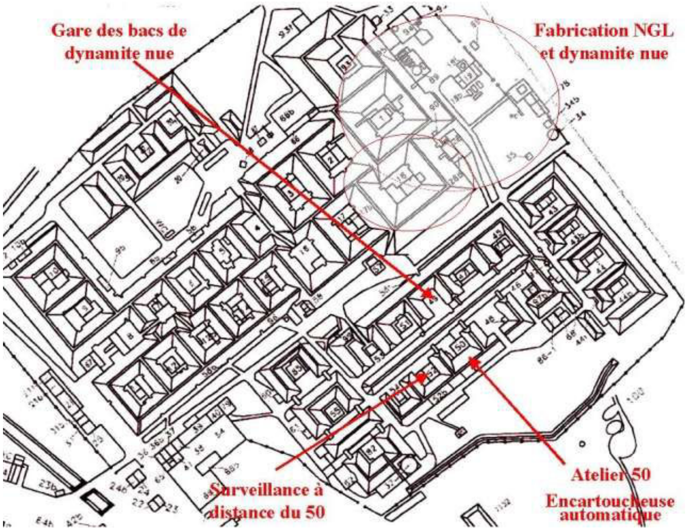
(62 – Pas de Calais) - France

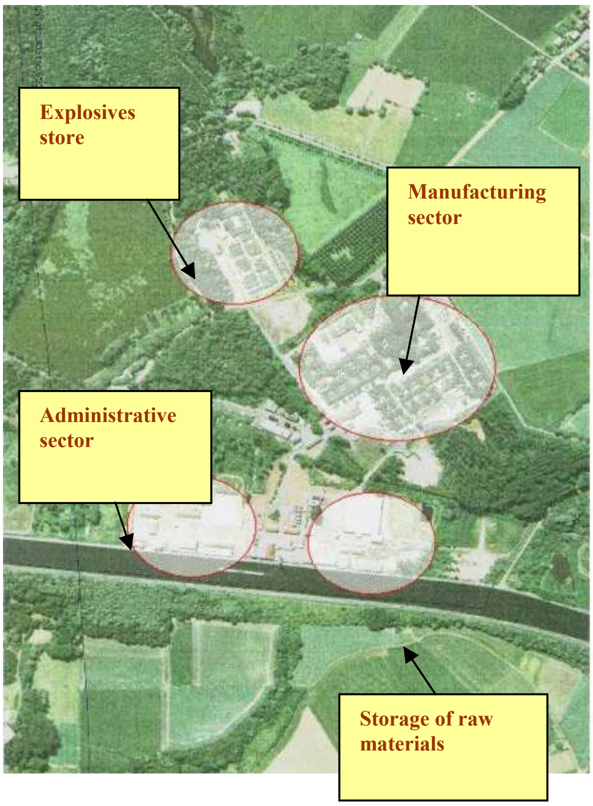
THE INSTALLATIONS IN QUESTION

The establishment, with roughly one hundred employees and spread over 75 ha, produces two types of explosives:

- ✓ Dynamite manufactured from nitro-glycerine, nitrocellulose and ammonium nitrate;
- ✓ Explosives made from ammonium nitrate and fuel oil (ANFO).

For 2002, the site produced 6,500 t of dynamite and 8,500 t of ANFO.





The plant is divided into four main sectors:

- ✓ An administrative sector,
- ✓ A raw material storage sector,
- ✓ A "dynamite" manufacturing sector, including the fabrication of nitro-glycerine, paste dynamite manufacturing shops, automated (shop 18 or Tellex) or non-automated (several shops where the paste is produced in low-volume mixer-dryers or "*guédus*"), dynamite loading shops and an ANFO manufacturing and packaging shop.
- ✓ An explosive storage sector.

Nitro-glycerine is synthesised from nitric and sulphuric acids to form a sulpho-nitric mixture to which glycerine and glycol are added to obtain a nitro-glycero-glycol mixture (called nitro-glycerine). Following the separation steps, this nitro-glycerine is mixed with ammonium nitrate, nitrocellulose (gun cotton), and barium sulphate,…. The "bare dynamite" is formed in this manner. This dynamite paste is then sent to the loading shops to be shaped into sticks of dynamite to be marketed.

The is governed by the SEVESO classification for the storage of explosive substances (350 t – Seveso / high level), the manufacture of explosives (25 t – "AS" level) and the storage of ammonium nitrate (2,200 t – Seveso / low level). It is also subject to pyrotechnic regulations.

The SEVESO danger zones extend 783 m, and the pyrotechnic danger zones up to 1,565 m (Scenario: explosion of explosive stores) and the radius of the PPI ("plan particulier d'intervention", special intervention plan) is 1,900 m (Scenario: explosion of ammonium nitrate). 4 *communes* are located within the pyrotechnic radii. A procedure to reduce the risk at the source was underway prior to the accident.

The workshop involved in the accident (workshop 50) is an automatic dynamite cartridge loading workshop (a "Rollex" type cartridging machine). The production capacity is 900 kg/h. The dynamite is brought in bins on rollers containing 80 to 150 kg. The bins are tipped into a feeder that includes a loading hopper and two screws that mix the paste and extrude it through a die. The strip of paste thus obtained is then driven by a belt conveyor and shaped to the desired thickness by a smoothing roller, then cutup by a knife into parallelograms that are pushed and packaged into waxed paper into a keg. The dynamite cartridges are then transferred to the neighbouring workshops to be packaged into shipping containers.

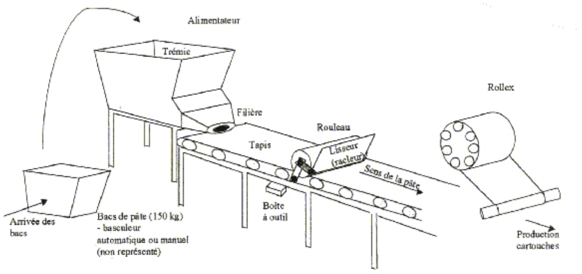


Figure 1 : Schéma représentant l'alimentateur et la Rollex de l'atelier 50

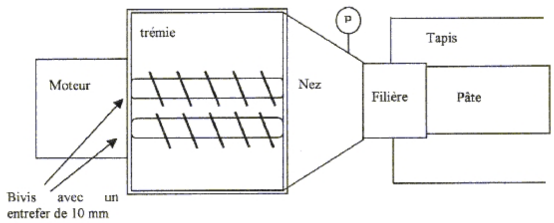


Figure 2 : Vue longitudinale de l'alimentateur de la Rollex 50

The workshop is fully automated once the production cycle has been initiated, with the operators monitoring from a protected control room located in an adjacent shop. For a complete production line, the crew during normal operation consists of a machine operator, who ensures correct operation and makes the necessary adjustments, and one or two operators, who take care of the counting, bagging and loading into cases. These operations are performed remotely or in the associated workshops. However, during start-up and shutdown phases, which require adjustments or emptying of the machine, one to three people may be located next to the machine.

THE ACCIDENT, ITS BEHAVIOUR, EFFECTS AND CONSEQUENCES

The accident:

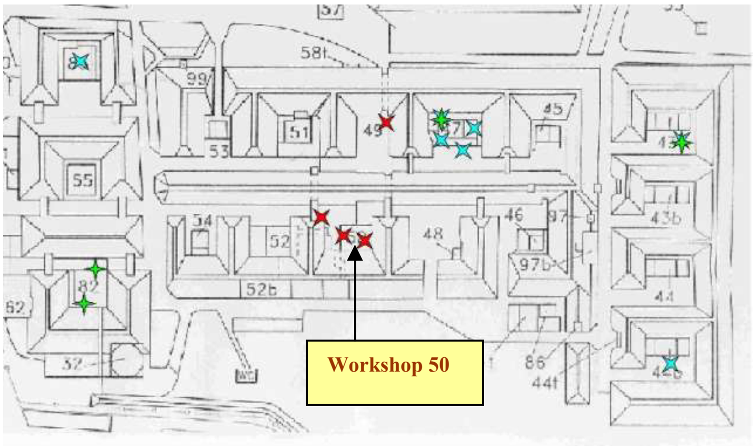
On March 27, 2003 at 6.16 am, there was an explosion in workshop 50. The sound of the explosion was heard more than 10 km away.

At the time of the accident, adjustment operations were underway as the shift had begun exceptionally early (5 am instead of 7 am). The adjustment phase was a little longer than normal. The workshop contained a total of 580 kg of dynamite.

A significant cloud of black smoke was released from the site but the fire that followed the explosion was quickly brought under control.

At the alleged time of the explosion, 4 employees were in the shop or in the immediate vicinity: the machine operator, an individual in charge of collecting waste and a mechanic who was passing in front of the shop near the tunnel. All 4 died in the accident.

In the diagram opposite, the individuals who died are indicated in red, and the injured in blue and green.



Consequences:

The cartridging shop was destroyed, leaving large craters:

✓ One near the passageway between workshops 50 and 48 (1m x 1.30 m and 0.60 m deep) in the location where 2 dynamite bins were positioned, according to witnesses,

✓ The other near the feeder itself (0.80 m in diameter x 0.20 m, the floor consisting of a 15 to 20 cm concrete slab then backfill).

✓ A hole was also observed in the concrete wall a distance of 2 meters from the feeder (1 m to 1.5 m in diameter.

Crater at the location of the machine – Photo DRIRE NPC

What's left of the machine – Photo DRIRE NPC

Parts of the cartridging machine were found in a radius of 600 m. According to the expert appointed by the Inspectorate, considering the resulting damage, it is difficult to accurately quantify the amount of charge involved: it could be in the neighbourhood of an equivalent of approximately one hundred kg of TNT, although less than an equivalent of 300 kg of TNT.

In the adjacent workshops, serious although more limited damage occurred: for example, the structures and the accessories such as cable trays were destroyed. The mounds of earth surrounding the shops definitely attenuated the effects of the blast. The damage observed was primarily broken windows, siding and structural damage and disturbed roofing tiles. No domino effect was observed in the other shops or pyrotechnic stores

On the outside of the site, broken windows and the displacement of roofing tiles were observed (up to approximately 1 km).

Workshop hallway- Photo DRIRE NPC

Machine impact in concrete wall – Photo DRIRE NPC

European scale of industrial accidents

By applying the rating rules of the 18 parameters of the scale made official in February 1994 by the Committee of Competent Authorities of the Member States which oversees the application of the 'SEVESO' directive, the accident can be characterised by the following 4 indices, based on the information available.

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

Quantities of dangerous substances	■ ■ □ □ □ □
Human and social consequences	■ ■ ■ □ □ □
Environmental consequences	□ □ □ □ □ □
Economic consequences	□ □ □ □ □ □

ORIGIN, CAUSES AND CIRCUMSTANCES OF THE ACCIDENT

Several inquiries were conducted following the accident:

- ✓ A judicial inquiry (the police department assisted by two experts from the Paris police explosives laboratory),
- ✓ An administrative inquiry (a commission of several general inspections assisted by the expert appointed by the Inspectorate),
- ✓ Internal inquiries conducted by the operator.

The expert submitted a preliminary report and the operator's final report is to be completed at the request of the Registered Installations Inspectorate. However, the inquiries are still in progress and responsibility for the accident has thus not yet been established.

The difficulty with **search for causes** on this type of accident results from the disappearance of the witnesses and the destruction of material elements. In this case, two elements slightly mitigated this difficulty: a witness entered the shop several time during the hour that preceded the accident (the operator of a "*guédu*" mixer-dryer type workshop who was bringing bins of paste to shop 50), on the one hand, and the area surrounding the Rollex machine are filmed in order to continuously monitor and record the operations from the control room, on the other hand..

An examination of the parts shows that the initial explosion took place in the Rollex feeder, then propagated to other explosives present in the workshop. The explosion could have been caused by the presence of a foreign object in the feeder that may have become caught between the extruder screw and the steel housing. According to the expert appointed by the Inspectorate, the special sensitivity of the dynamite cannot be excluded even if tests conducted on the explosives manufactured at the time of the accident show no signs of anomaly.

The accident resulted in a high number of victims in proportion to the number of people likely to be present under normal circumstances. The following individuals were present in the workshop concerned (50) at the time of the accident:

- the machine operator who made adjustments on the Rollex machine; the quality of the paste exiting had posed a few problems,
- an operator came from another shop to assist him,
- a custodial technician, who was passing by the workshop to collect the waste bins specifically designated for pyrotechnic wastes,
- a mechanic who had participated in a maintenance operation not far from workshop 50 and who, having forgotten a tool in that shop, was passing through a hallway in front of the tunnel connecting shop 50 to shop 49.

ACTION TAKEN

After the explosion, the operator began evacuating the personnel. Operations to secure the site were undertaken at the same time as the workshops were secured, particularly those of the nitro-glycerine manufacturing shop and the shutdown of power distribution, except those required for safety-related equipment.

The operator engaged the internal contingency plan. The fire that followed the explosion was quickly brought under control. Approximately sixty firefighters arrived at the site. The safety perimeter, first established by the emergency services, was removed at around 10.30 am. Traffic on the Deûle river canal, which runs alongside the site, was closed until 5 pm.

On the proposal of the Registered Installations Inspectorate, the *Prefect* established two orders calling for the following emergency measures:

- ✓ the determination and the implementation of a schedule for securing the installations,
- ✓ a study on the exact causes and circumstances of the accident,
- ✓ determination of the measures to be taken to prevent such an event from happening again,
- ✓ the verification of the security of the installations prior to continuing operations,

Beginning the next day, the intense phase of the crisis having passed, operations to secure the site were undertaken. A certain number of substances were found at the site: this particularly includes work-in-progress such as sludge acids, nitro-glycerine, dynamite paste or ANFO being manufactured, dynamite in the cartridging machine, and cartridges already manufactured.

Site securing operations continued until June with the recovery and the destruction or completion of work-in-progress, a priority was assigned to the various operations according to the stability of the products (nitration sludge acids, then nitro-glycerine then the dynamite paste, …).

The operator then compiled a plan to resume activities at reduced capacity.

The accident exceeds the European Union's notification levels as set Appendix VI of the Seveso directive. In this respect, it formed the subject of a notification report in the MARS database.

LESSONS LEARNED

In its accident report for which the Inspectorate requested additional information, the operator proposed avenues for improvement. The main points are listed below. They can be broken down as follows:

Preventive actions:

Transformation of the des cartridge machine feeders:

- ✓ Modify or remove the die of the feeders.
- ✓ Ensure that the protective housings on the ROLLEX machines are adequate.
- ✓ Limit feeder dimensions.
- ✓ Make the feeders out of a composite material.

Limitation of manufacturing operations to the least sensitive products:

- ✓ Specification of a "machinable" paste (bonding, hardness).
- ✓ Raise the impact sensitivity thresholds of the compounds, and study pastes that withstand the standby time better.
- ✓ Conduct a study on the pyrotechnic characteristics of a compressed paste.
- ✓ Determination of tests enabling the behaviour of the paste to be foreseen in the feeders in order to reduce the frequency of blockage.

Reducing the potential sources of foreign bodies

- ✓ Continue the prevention campaign against foreign bodies started prior to the accident.
- ✓ Limit the number of removable parts in the machines.
- ✓ Remove the tool boxes that are next to the ROLLEX machines and replace them with tool board featuring a silhouette of each tool.

Actions aimed at limiting accident consequences:

Monitoring of materials in the workshops:

- ✓ Removal of pyrotechnic trash bins by the workshop operators or during times when the workshops are not operation.
- ✓ Organise preventive inspections to check the condition of paste bins.
- ✓ Possibly modify the recovery bins that are located under the machines.

Limitation of personnel in the proximity:

- ✓ Organisation of a light indicator panel showing workshops in operation and locations.
- ✓ Use the documentation about corridor offsets and protected access routes to better foresee the effect of the corridors on the propagation of blast effects.

Other measures:

- ✓ Assign codes to the various steps of the test procedure.
- ✓ Install electronic torque measuring equipment.

Explosion
Explosive
Dynamite
Fatality
External materials

Explosion in a cartridges-filling workshop in a dynamite plant

July, the 30th, 2002

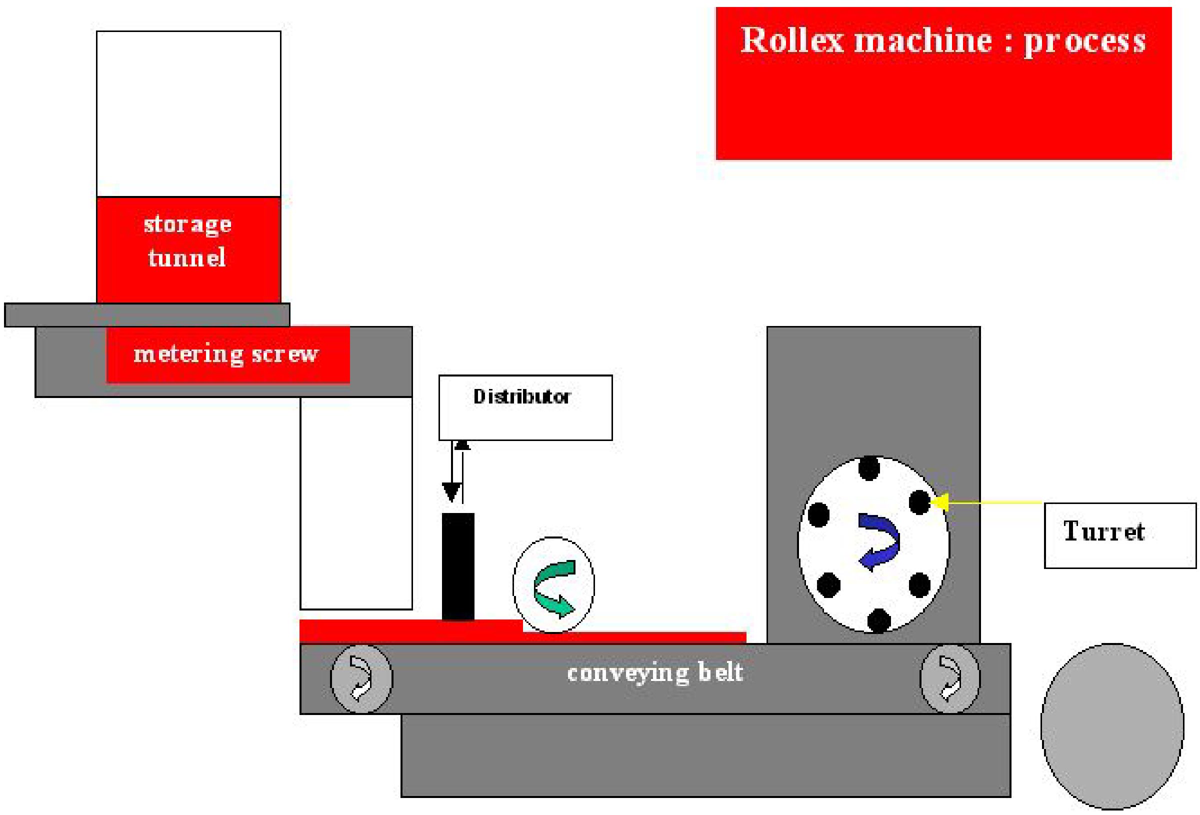
Burbach-Wurgendorf - Germany

THE INSTALLATIONS IN QUESTION

The accident took place in a plant where cartridges were filled with gelatinous explosives. The plant was subject to license according to the German Federal Immission Control Act and part of an upper tier Seveso-II-establishment. The operator had to fulfil the extended obligations of the German Regulation on Major Accidents (Störfall-Verordnung, the German implementation of the Seveso-II-Directive). A safety report had to be drawn up.

Due to the German Explosive Law which does not allow any endangered objects in the neighbourhood of such plants the establishment is located in a woody country far away from any residential districts.

The cartridges are produced by using a “Rollex-Machine”. The explosive (25 – 30 % ethylene glycol dinitrate, 60 – 70 % ammonium nitrate and < 2 % collodion wool) for a batch reaches the feeding hopper of the Rollex-Machine. Several explosion interruption devices are installed to prevent any propagation of explosions. From the hopper the explosive is metered to a conveying belt where it is distributed and drawn-out to a fleece. A portion of about 0,4 kg is pressed into a cell of the Rollex-Machine and rolled up with paraffined wrapping paper. After closing at both front sides the cartridge is thrown to a conveying belt. Rolling up and closing of the cartridges take place in the turrets of the Rollex-Machine.



Till the day the accident happened several process steps especially during starting procedure had been executed in a manual mode. The employee had to stay at the machine for doing necessary adjustments till it was working in a sufficient manner.

THE ACCIDENT, ITS BEHAVIOUR, ITS EFFECTS AND CONSEQUENCES

The accident :

On July, the 30th, 2002, at 12:35 h, the accident took place in the building where the Rollex-Machine was placed. About 90 kg explosives were involved. In the moment of explosion only one employee was working at the machine.

The consequences :

One employee surveying the process was killed: The body was found in a distance of 20 m from the place of explosion, his arms were ripped of and the body showed heavy injuries at his back as well as various fractures.

Additionally, the accident led to heavy damages by blasting debris and overpressure up to a distance of 120 m from the place of explosion.

The accident led to the following consequences:

- ✓ The ceiling of the building was completely demolished.
- ✓ The Rollex-Machine was encumbered by earth.
- ✓ Building fragments were being distributed within a radius of about 20 to 30 m.
- ✓ Some fragments were thrown to a distance of 150 m.
- ✓ Other fragments of the Rollex-Machine were found inside the destroyed building and in a distance of about 15 m from the place of explosion.
- ✓ The estimated cost of damages is about 0,5 Millions of euros.

European scale of industrial accidents

By applying the rating rules of the 18 parameters of the scale made official in February 1994 by the Committee of Competent Authorities of the Member States which oversees the application of the 'SEVESO' directive, the accident can be characterised by the following 4 indices, based on the information available.

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Human and social consequences	■ ■ □ □ □ □
Environmental consequences	□ □ □ □ □ □
Economic consequences	■ ■ □ □ □ □

ORIGIN, CAUSES AND CIRCUMSTANCES OF THE ACCIDENT

To find out the causes leading to the accident an international commission of experts and also the German Federal Institute for Material Research and Testing (BAM) carried out detailed investigations. Unfortunately the reason for the accident could not be identified free from doubt. Nevertheless a lot of circumstances and observations led to the identification of some possible reasons.

The circumstances :

Most likely immediately before the explosion took place the employee was carrying out the following actions:

- ✓ Putting explosives on the conveying belt.
- ✓ Cleaning of components with a wire brush
- ✓ Cleaning of the Rollex-Machine with compressed air
- ✓ Pulling out three "waste trays" that were placed under the "Rollex-Machine" and giving the explosives caught with a plastic shovel into a waste container or back to the conveying belt.

The injuries of the employee led to the conclusion that he had died immediately due to the shock wave. They also show that in the moment of the explosion there was no direct contact between employee and explosives. The distance between the source of the shock wave and the victim was most likely more than 1 m. The investigators gave their opinion that the explosion event did not result from negligent actions of the employee.

The hypotheses :

Finally the investigations led to two possible causes of the accident which were taken into account:

✓ Faulty explosive:

Special tests carried out with a sample of the explosive didn't lead to any indications concerning the cause of the accident. There were no deviations found from the values fixed for the composition of the explosive by the explosives permission. So a faulty explosive as accident cause came out of the question.

✓ Dangerous stressing

The explosive involved in the accident is very sensible to any mechanical stressing especially by impacts. Such stressing may occur due to :

× Impurities like slack parts of the machine, tools, etc,

× Parts of the machine failed due to fatigue or ageing processes

× Particles of ceiling dress or from the suction,

which could be able to ignite the explosive in the Rollex-Machine.

It was decided that more detailed investigations concerning the cause of the accident were speculative. So the whole production process had been evaluated by a fault analysis and appropriate measures had been taken.

ACTIONS TAKEN

Though it was impossible to find out the exact cause of the accident various measures were suggested by the expert group and implemented by the operator before restarting the production. These measures firstly have got the aim to prevent the input of impurities or foreign substances into explosives and raw material and secondly to guarantee the absence of any persons during the process of producing cartridges. In detail the following measures were taken into consideration:

✓ Preparing the raw material:

× -Now ammonium nitrate will be discharged from wagon or big bag to a closed pneumatic conveying system.

× There will be weekly inspections of screens for wood dust and wheat grit bran with regard to foreign substances.

× The conveying trays are covered with tightly closing tarpaulins.

✓ Mixing process:

× The ceiling construction in the belt tunnel has been cleaned and repaired. The free belt region was covered with domes and network. Additionally metal sensors have been installed at the end of the conveying belt before the raw material passes the closed vibration channel. Now there will be weekly inspections of ceilings, domes and networks.

× Tunnels and feeder regions are lined by fine-meshed network because in this region carriages are without covering.

✓ Explosive feeding to the building where the cartridges are produced:

The number of persons with permission of admittance is reduced.

✓ Producing cartridges in separate buildings:

× There is no more presence of any persons if the machine producing cartridges works also during starting and stopping. The entrance of persons is only for cleaning and repairing in the case the plant is out of action. This is guaranteed by key-operated switch and locked entrance regions.

× Critical combinations of materials like metal on metal will be prevented in the future to avoid ignition sparks.

✓ General measures for all process steps

All fixing elements in the installations which are able to contaminate the raw material or explosives in the case of detaching or falling down are secured.

There are safety rules created for employees concerning body decorative. Especially only clothing without pockets is allowed.

In the future an inventory of all tools and devices will be drawn up. All tools and objects which are brought into the buildings by craftsmen are registered. After finishing of an operation there will be a check whether all tools and objects have been taken from the plant or are installed (principle of surgeon).

LESSONS LEARNED

As a conclusion, the main principles resulting from the lessons learnt could be the following ones:

✓ Whatever the level involved, avoid the occurrence of creating a contamination of raw materials and explosive substance : use of covering devices (closed conveying systems, tarpaulins, fine-meshed network,…)

✓ Implementation of checking systems concerning polluting materials : regular and frequent inspections on installations and above all of fixing elements in sensitive areas, rules for employees,… For instance, the safety rules concerning the entrance of various materials in sensitive areas are very strict and harshly checked.

✓ If possible, use of materials involving no risk of critical contact such as metal / metal one.

✓ Implement devices on the machine able to avoid any human presence, even for adjustments, stopping or restarting steps.

✓ Reduce or even forbid the entrance to sensitive areas (even workshops in connection to the producing building or feeding tunnels)

✓ For this purpose, use locking devices (key-operated switch and locked entrance) in order to call the attention of surveying agents.

Fire in an ultimate waste underground storage facility

September 10, 2002

Wittelsheim (68 – Haut Rhin) – France

Underground storage
Ultimate wastes
Salt mine
Fire
Dioxines
Phytosanitary products
Asbestos wastes

THE INSTALLATIONS IN QUESTION

A retrievable underground storage facility for industrial wastes, located in the Alsace region of France, in the *commune* of Wittelsheim (Haut Rhin), near the city of Mulhouse, was authorised to operate for a 30-year period by a prefectoral order dated February 3, 1997.

The storage area is located at a depth of 600 m in *ad hoc* galleries (blocks) dug for this purpose by the site's mine operator in the geological salt formation.

With a maximum authorised capacity of 320,000 tons of waste for an annual capacity of 50,000 tons, this storage facility accepts ultimate wastes (incineration wastes, quenching salts, and arsenical, chrome and mercury wastes, laboratory wastes, and waste containing asbestos…) and wastes specifically intended for underground storage owing to their physical properties that do not allow them to be stored in buried waste disposal centres, even once they are stabilised. Approximately half of the waste stored at the site belongs to this category. All are packed in drums, big-bags or metal containers.

All of these wastes must be perfectly identified and come from recognized producers. Non-ultimate wastes, radioactive, toxic biological, volatiles, flammable, explosive, gaseous, liquid, thermal or volumetrically unstable products, that react with water or salt or indefinable products are not authorised to be stored in these installations.

This type of storage facility is the only one of its kind in France.

THE ACCIDENT, ITS BEHAVIOUR, EFFECTS AND CONSEQUENCES

The accident:

At 4.15 am, during the night of September 9 – 10, 2002, a fire was detected in the mine's galleries by miners on duty in the adjacent sites. As the walls between the mine digging site and the storage facility are not hermetic, the operators were alerted by an abnormal odour.

The fire was located in storage block No. 15 which held 1,800 tons of waste: drums of arsenic tainted soil, big-bags of household and industrial waste treatment residues (REFIOM/REFIDI), big-bags of asbestos removal wastes and big-bags of asbestos-containing residues collected after a fire in a phytosanitary product warehouse.

After an unsuccessful attempt at extinguishing the fire with water (given the depth of the storage facility, water supplies were low) and fire extinguishers, the emergency response teams set up barriers designed to smother the fire by reducing the amount of air circulating in the block.

Upon the request of the *Prefect*, a rescue team from the neighbouring mine, specialising in underground operations, also provided assistance but were still unsuccessful.

All of the firefighting operations conducted at the site of the accident had to be performed by operators wearing self-contained protection equipment knowing that the temperature at the bottom of the mine is normally in the order of 32°C (these factors limit the time of each intervention to 30 min. at the most and make it necessary to have a rescue team on the surface ready to intervene if required).

On September 20, reconnaissance was conducted and concluded that the fire had been extinguished, without disregarding the possibility of possible combustion points, conformed by continuous measurements conducted in the block using an automatic sampling apparatus. As these hot spots continued, nitrogen was injected **23 to 25 October** to "inert' the atmosphere inside the block and to thus extinguish the last hot spots.

During the following reconnaissance operations, a few hot spots were still noted. **On November 7**, a new extinguishing operation was undertaken by injecting nitrogen into the core of the few remaining hot spots.

On November 12, the fire was considered to be completely extinguished.

The consequences:

The consequences of the accident are directly linked to the generation of smoke caused by the fire.

Significant concentrations of sulphur dioxide were measured at the outlet to the atmosphere, at the level of the upcast. The installation of barriers rapidly deceased the amount of smoke released from these upcasts. The micro-pollutant analyses, conducted on samples taken at several locations and particularly in the environment (soils and vegetables), did not highlight any notable impact. The main values exceeding the authorised standards concerned two carcinogenic pollutants, benzene and benzopyrene. Subsequent analyses of these 2 pollutants, conducted on the smoke trapped in block 15, seem to imply emissions short duration. Significant amounts of dioxin and furan were recorded on the walls of the galleries near block 15, at a depth of 600 m, although no contamination was recorded at the surface.

The incident did not result in health hazard for the residents living near the installation. At the time of the accident, the population was not requested to remain at home although 3 schools were closed as a precautionary measure.

However, several miners exposed to the smoke during the firefighting operations complained of dermatosis and throat irritation.

These evaluations were confirmed by the committee of experts appointed by the local CLIS ("Commission Locale d'Information et de Surveillance", local commission for information and surveillance) which concluded that there was "no *specific risk for the residents, the population and the surface personnel*" and indicated that *"several rescue personnel showed clinical signs of slight carbon monoxide intoxication, skin irritations and digestive problems requiring medical attention"*.

Initially, the fire resulted in the suspension of the storage facility's activity: as a result, 27 employees of the storage facility and 350 miners applied for technical unemployment. The storage facility eventually closed down definitively. The future of the 40,000 tons of waste stored in the bottom of the mine has not yet been determined. Furthermore, the termination of the potash extraction activity, which should have occurred in April 2003, was brought forward 6 months.

European scale of industrial accidents

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Economic consequences	□ □ □ □ □ □

ORIGIN, CAUSES AND CIRCUMSTANCES OF THE ACCIDENT

The exact causes of the fire are not known. Several hypotheses were submitted, however:

✓ The presence of wastes that remain hot such as the REFIOM or REFIDI,

✓ The presence of prohibited wastes, flammable wastes in particular,

✓ The presence of incompatible products and/or products liable to change owing to the temperature in the mine.

As such, there is a presumption about "asbestos-containing" wastes coming from the fire of a phytosanitary product warehouse, with this waste being delivered in big-bags (these big-bags had not been opened when they arrived because of asbestos risk).

Various expert analyses are underway to determine the causes and circumstances of the fire:

✓ Judicial inquiry,

✓ Inquiry requested by the Administrative Court,

✓ Administrative inquiry,

✓ Inquiry conducted at the request of the CLIS which nominates a committee of experts,

✓ Inquiry conducted at the request of the CHSCT (the committee for hygiene, safety and working conditions).

The conclusions are not known for the moment. The CLIS experts have only retained the hypothesis of "self-ignition following biological downgrading, chemical decomposition or a chemical reaction between products, phytosanitary products in particular."

ACTION TAKEN

At the time of the accident, the *Prefect* set up a crisis centre directed by the Thann *Sub-Prefect* and which met often (2 times per day during the period following the start of the accident, then at more widely-spaced intervals).

On September 12, an emergency prefectoral order was drawn up requiring that the operator conduct the analyses required to evaluate the impact of the fire. These analyses formed the subject of numerous additional letters and their follow-up was ensured by the DRIRE, which was mobilised from the start of the fire and, subsequently, to provide its technical point of view to the *Prefect* in determining the operations to be conducted with regards to civil defence.

Furthermore, a formal prefectoral notice dated September 19 was issued requesting that all waste stored on the surface be removed (the prefectoral authorisation order only authorises wastes to be stored above ground for 2 days).

On December 17, a new prefectoral order required the operator to undertake additional mine surveillance measures as well as to conduct a study of the possible causes and the consequences of the fire on the environment.

Fire in a tire storage facility

February 4, 2002

Artaix (71 – Saone et Loire) - France

Tires
Fire
Pollution
Malicious intent
Environmental analyses

THE INSTALLATIONS IN QUESTION

Approximately 5 million tires had accumulated since the early 1990s at an old roofing tile manufacturing facility that stopped production in or around 1955. The storage facility is located in a rural area near a hamlet with a population of roughly forty, nearly 3 km from the village of Artaix.

Owing to the presence of third party residences less than 50 meters away, the facility was governed by authorisation under the terms of section No. 98A although no administrative procedure had been undertaken by the operator.

The DRIRE was informed of the existence of this facility in August 1999.

The operator initiated liquidation proceedings by order of the court in September 1999.

The judicial liquidator was served formal notification by an order dated November 2, 1999 to eliminate the tires. The formal notification was not respected, thus leading to consignment proceedings were undertaken as per the order of January 14, 2001. In a letter dated April 10, 2001, the General Paymaster stipulated that the consignment could not bound over By order of June 22, 2001, the owner was required to eliminate the tires within a period of six months, that is prior to December 26, 2001.

THE ACCIDENT, ITS BEHAVIOUR, ITS EFFECTS AND CONSEQUENCES

The accident:

Monday morning, February 4, 2002, a fire broke out in a storage facility holding 5 million tires extending to the base of a former 8-story roofing tile factory, also used as a storage facility. The firemen were informed at 9.53 am. The fire spread rapidly. The flames rose to heights of 10 meters and the plume of black smoke was visible 40 kilometres away.

The six houses closest to the fire were evacuated, and 35 people were relocated in the local community hall. A safety perimeter was set up and a departmental road blocked.

The fire was surrounded at 6 pm, although the firemen monitored the area for more than 2 weeks. The accident mobilised a large number of firemen: 70 on the 1st day, 35 the 2nd day and 12 on February 8. Owing to insufficient local water resources, the emergency services had to procure water from the Loire River side canal approximately 2 kilometres away.

Once the fire was brought under control, the plume of residual smoke progressively went away until it was reduced to just a few fumaroles. The fire smouldered in this manner for 9 months. Final extinction was achieved by removing the residues or tires that were still incandescent and soaking them in a bin containing water. This action took 24 hours.

The consequences:

Environmental consequences:

Owing to fire's high intensity, the pollutants emitted were widely diffused. Soot deposits in the surrounding area were never significant and were no longer visible after the first rainfall.

Measurements were conducted of the fallout in the environment:

✓ By the local air quality monitoring association, ATMOSF'air, from February 6 to 13:

- Only on February 6th, the SO_2 concentration exceeded the average European limit value for human health, set at 125 µg/Nm^3 in terms of daily average. This limit must not be exceeded more than 3 times per year.
- The CO concentrations remained below the average 8-hour European daily maximum rates.
- The concentrations in suspended particles significantly exceeded the European daily threshold for human health of 50 µg/Nm^3.
- The benzene concentrations distinctly exceeded the average European yearly value set at 5 µg/Nm^{3,} although owing to their short duration, the impact on health was not significant.
- The concentrations of polycyclic aromatic hydrocarbons (PAH), measured February 7 and 8 approximately 4 km from the site of the accident, were similar to those commonly measured in the ambient air of metropolitan municipalities or near highways.
- The results of the measurements conducted by ATMOSF'air show that the pollution peaked on February 6 around 6 am then fell off considerably around 1 pm.

✓ By the veterinary services:

× Analyses of the soil and vegetation showed no health risks (see the report by the *Direction Générale de l'Alimentation*); the following elements were sought: PAH, zinc, cadmium, dioxins and dioxin-like PCBs.

✓ By the SDIS ("Service Départemental d'Incendie et de Secours, departmental fire and emergency service):

× On February 6th, 3 water samples taken at the site, before emptying into the Arcon and in the river downstream from the release point, showed no pollution in the natural environment.

Next, during the smouldering phase, the ADEME had measurements taken to evaluate the effects on the environment: analyses in the ground water and underground water, in the soil and in the fumaroles.

The water analyses showed values very close to the values of the impact report for a few pollutants such as arsenic and benzopyrene.

Analyses conducted in the fumaroles and the evaluation of their toxicity potential showed that the latter presented a health risk (a risk indicator of 14.9 for the threshold effects, thus significantly greater than 1 and 7.6 10^{-2} for effects without threshold, thus distinctly greater than 10^{-5} .

Considering the direction of the wind during the 9 months while the fire was smouldering and the actual period over which the residents were exposed allows us to conclude that the risk index values were very close to the usual thresholds.

The INERIS conducted an expertise aimed at evaluating the toxic potential of the fumaroles.

During the extinguishing phase, the analyses conducted in the atmosphere around the site and near the closest homes, did not indicate concentrations liable to lead to significant health-related consequences. The measurements were most often lower than the detection threshold. Two pollutants considered to be representative of the two families of chemical compounds contributing to the toxic potential of the fumaroles were selected: benzene (a toxic pollutant with threshold effects) and naphthalene (a carcinogenic pollutant).

Property damage:

The buildings of the former tile kiln, measuring 35 meters tall, were very badly damaged by the fire and run the risk of collapsing.

The estimated amount for cleaning operations of the site is about 1 Million euros.

European scale of industrial accidents

By applying the rating rules of the 18 parameters of the scale made official in February 1994 by the Committee of Competent Authorities of the Member States which oversees the application of the 'SEVESO' directive, the accident can be characterised by the following 4 indices, based on the information available.

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ORIGIN, CAUSES AND CIRCUMSTANCES OF THE ACCIDENT

The tire storage facility was neglected. The fire appears to have been set intentionally by an individual who was stopped and questioned by the gendarmerie on May 28, 2002.

The tires' storage conditions, with no reasonable unitary distribution of the volume, promoted the fire's development.

ACTION TAKEN

An inventory of tire storage facilities in Bourgogne was conducted; 15 facilities were identified.

After having required the owner to undertaken emergency measures, which were not respected, the intervention by the ADEME was obtained, particularly for the following actions:

- ✓ Erection of a fence,
- ✓ Reestablishment of a trench damaged during the fire extinguishing operations,
- ✓ Evaluation of the impact on underground water,
- ✓ Characterisation of the toxicity potential of the fumaroles (during the 9 months that the fire was smouldering),
- ✓ Soil and combustion residue analysis,

- ✓ Extinguishing, in October – November 2002, of tires still incandescent by dumping them in a bin full of water,
- ✓ Demolition of the damaged building,
- ✓ Processing of combustion residues and rubble from the demolition of the building, while privileging their storage on site.

This accident and the 9 months during which the fire was smouldering created a significant emotion in the surrounding area; even an association was organised: the "Comité pour l'environnement d'Artaix et des communes voisines" (the committee for the environment of Artaix and surrounding communities). This association subjected a considerable amount of pressure on the *préfecture* to obtain information, particularly concerning the results of the environmental pollution analyses.

a follow-up committee, including the administrative departments, local elected officials, the ADEME and the president of the aforementioned committee, was created; it met 6 times (March 7, 2002, April 8, 2002, June 25, 2002, October 14, 2002, March 5, 2003 and June 11, 2003).

In order to respond to the population's concerns, a pneumologist was placed at its disposal; less than 10 individuals called upon the doctor.

LESSONS LEARNED

In the absence of a tire disposal sector, small companies collect them without appropriate means to manage the risks inherent with this type of storage facility. Large tire depots are thus created without control of the associated risks.

In the case of an accident, conducting measurements of pollution concentrations in the immediate environment of a site, particularly during the accident, is highly useful in providing elements to access the impact on health.

However, the evaluation of a smoke plume's toxicity inevitably leads to high risk indices. It is then difficult to access the true impact on the health of the local residents owing to difficulty encountered in determining their exposure to the plume's pollutants. Pollutant concentrations in the ambient air must be measured near the residences and not in the smoke plume.

Leak on effluent pipeline in a chemical plant

August 05 – 11, 2002

Le Havre (76 – Seine Maritime) – France

Pipeline
Acid wastewater
Commissioning
Stress corrosion
Organisation

THE INSTALLATIONS IN QUESTION

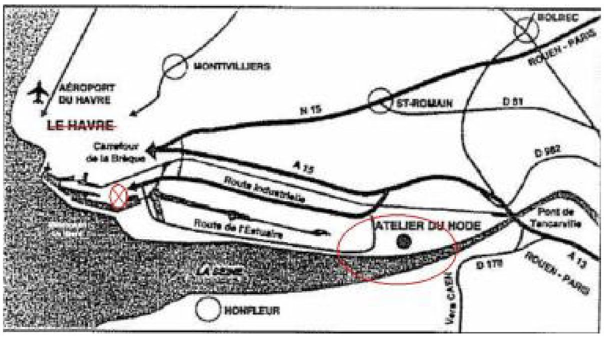
The chemical plant, located in Le Havre (76 – Seine Maritime) since 1957, is classed as a "Low Level" Seveso facility and employs 420 individuals at the site.

It essentially produces titanium dioxide, which is used as a pigment in numerous markets (paper, rubbers, ceramics, plastics, paints, and inks… as well as in the pharmaceutical and cosmetics industries). The Le Havre site has a maximum production capacity of the approximately 95,000 tons/year. Titanium dioxide can be produced industrially either by the chlorine process or by the sulphate process. The Le Havre manufacturing process uses the sulphate process.

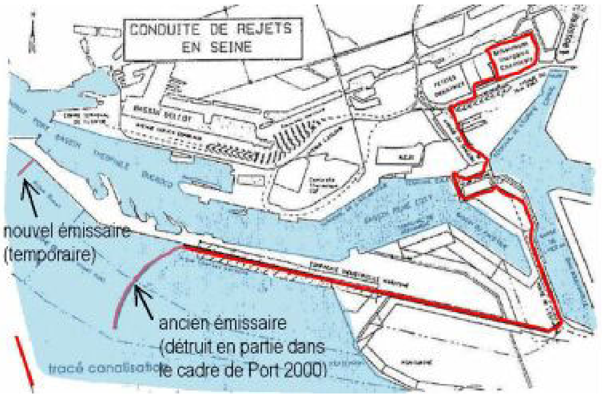
The titanium oxide fabrication operation employs a mixture of natural minerals (ilmenite) and steel industry slag containing a variable quantity of TiO_2. The process can be broken down into a series of operations that enables it to be extracted and subsequently purified.

The attack of these minerals by sulphuric acid (also manufactured at the site) generates acid effluents.

Part of this acid process water (the most acidic is referred to as "mother water") is conveyed, via a pipe measuring 18 km in length (ND 300 mm), to the Hode site for treatment before being released into the Seine River.



The other part of this acid water (referred to as "wastewater", with a flow rate of approximately 14,700 m^3/day) was released via a dispersal tube into the *Baie de Seine*, without any specific treatment whatsoever. As of July 31, 2002, the operator had planned to sent its water to the Hode neutralisation installation via a second 18 km long pipe made of SVR ("stratifié verre résine", laminated, fibreglass-reinforced) installed during 2001-2002 (SVR piping ND 400 mm).



July 31, 2002 was a cut-off date as the *Baie de Seine* drainage line had to be partly dismantled in order to allow the Le Havre port expansion works to continue. In the scope of the "Port 2000" project corresponding to the expansion of port capacities, the operator was required to move its drainage line located in the *Baie de Seine* in order to move further away from the port's new future access channel.

The two acid water pipes are installations that are related to the registered installations but are also governed by the ministerial decree of December 6, 1982 which outlines technical regulations for the pressurised transport of fluids in pipes other than hydrocarbons and combustible gases. In this respect, the prefectoral order of September 3, 2001 authorising the extension of the

Hode installations required the operator to observe specific instructions regarding the location and operation of the SVR ND 400 piping.

The SVR ND 400 piping was installed in compliance with the technical provisions stipulated by the order of December 6, 1982, namely, tubes adapted to the service conditions (nature of the fluid, temperature and pressure) and assemblies correctly installed and checked. The piping, having a design pressure of 10 bar (for a service pressure of approximately 4 bar) successfully completed the water resistance test at 15 bar on July 16, 2002.

On July 31, 2002, and in compliance with the prefectoral authorisation of September 3, 2001, the release of "low-acid" effluents into the *Baie de Seine* was stopped and the effluents were sent to the Hode facility via the new pipeline, beginning at the start of the week of August 5n 2002.

THE ACCIDENT, ITS BEHAVIOUR, EFFECTS AND CONSEQUENCES

The accident:

On **August 7, 2002 at 12.01 pm**, the pipe's monitoring system (line balance) detected a 100 m^3/h leak (with a nominal flow rate of 500 m^3/h) of wastewater (diluted sulphuric acid: concentration less than or equal to 15 g/l of sulphate), at 5 bar. An inspection performed by the operator in the field and in the set of galleries all along the line from Le Havre to Hode enabled the leak to be located. The leak, evaluated at approximately 20 m^3, was due to a 40 cm crack on a tube located on the grounds of the Le Havre plant. After replacing the faulty section, the entire pipe was again tested and the equipment placed back into service.

Four days later, on **Sunday, August 11, 2002 at 8.05 pm,** a new leak occurred and was immediately detected by the monitoring system. The rated output is 440 m^3/h (diluted sulphuric acid), at a pressure of 3.9 bar (these conditions are significantly below the maximum operating conditions and much below the test conditions). The leak was located on the outside of the Le Havre plant, on an underground part of the pipeline, near a section that passes underneath some railroad tracks behind a LPG storage and filling station. The leak was evaluated at between 100 and 200 m^3.

In all, **between August 5 and August 11, 2002**, eight problems were reported, six of which were on the first 2 kilometres of the pipeline. Two failures occurred while in service, in similar conditions, near elbows and changes in direction, while this pipeline had only been in operation roughly ten hours in service conditions where thepressure had never exceeded 5 bar in a diluted sulphuric acid environment (concentration less than 15 g/l) and at temperatures less than 35°C (temperature allowed for SVR tubes 50°C).

On **August 11, 2002**, the pipeline was shutdown due to a systematic defect. Experts were appointed by the contracting authority and the operator in order to determine the causes of the pipeline failures. In November 2002 and January 2003, leak detection tests using a nitrogen + helium mix enabled two additional leaks to be detected.

The consequences:

All of the soil polluted by the various leaks was treated with sodium carbonate and used as backfill to fill in the trenches. The soil analyses conducted after each of these incidents showed no significant impact on the soil or on the installations located in within the perimeter of the leaks' potential impact zone.

European scale of industrial accidents

By applying the rating rules of the 18 parameters of the scale made official in February 1994 by the Committee of Competent Authorities of the Member States which oversees the application of the 'SEVESO' directive, the accident can be characterised by the following 4 indices, based on the information available.

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

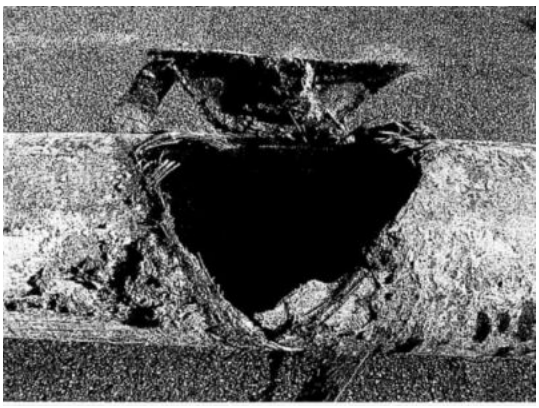
Quantities of dangerous substances	□ □ □ □ □ □
Human and social consequences	□ □ □ □ □ □
Environmental consequences	□ □ □ □ □ □
Economic consequences	■ ■ ■ □ □ □

ORIGIN, CAUSES AND CIRCUMSTANCES OF THE ACCIDENT

All of the faults observed on the pipes are similar in the following respects:

✓ the main direction of the cracking: longitudinal along the invert (lower generatrix),

✓ location: near a specific zone, namely a slope or angular change (45°, 30°, 22°, 11° elbows or high point).



It was clearly shown that the damage to the installation was due to a **stress corrosion mechanism in an acid environment**. Stress corrosion is a cracking mechanism that requires the participation of the following three elements:

- A stress (or a permanent deformation),
- A that is sensitive to this ,
- A corrosive environment.

All of the pipeline's basic dimensioning data were analysed when the damage was discovered. Several facts were established following this analysis:

✓ Soil / structure interaction

As far as the soil is concerned, the installation specification requires a minimum of compacting for the footing and the sides. Soil analysis conducted around the pipeline revealed compacting values lower than those specified. The ovalling of the pipe could have thus exceeded the maximum acceptable value locally.

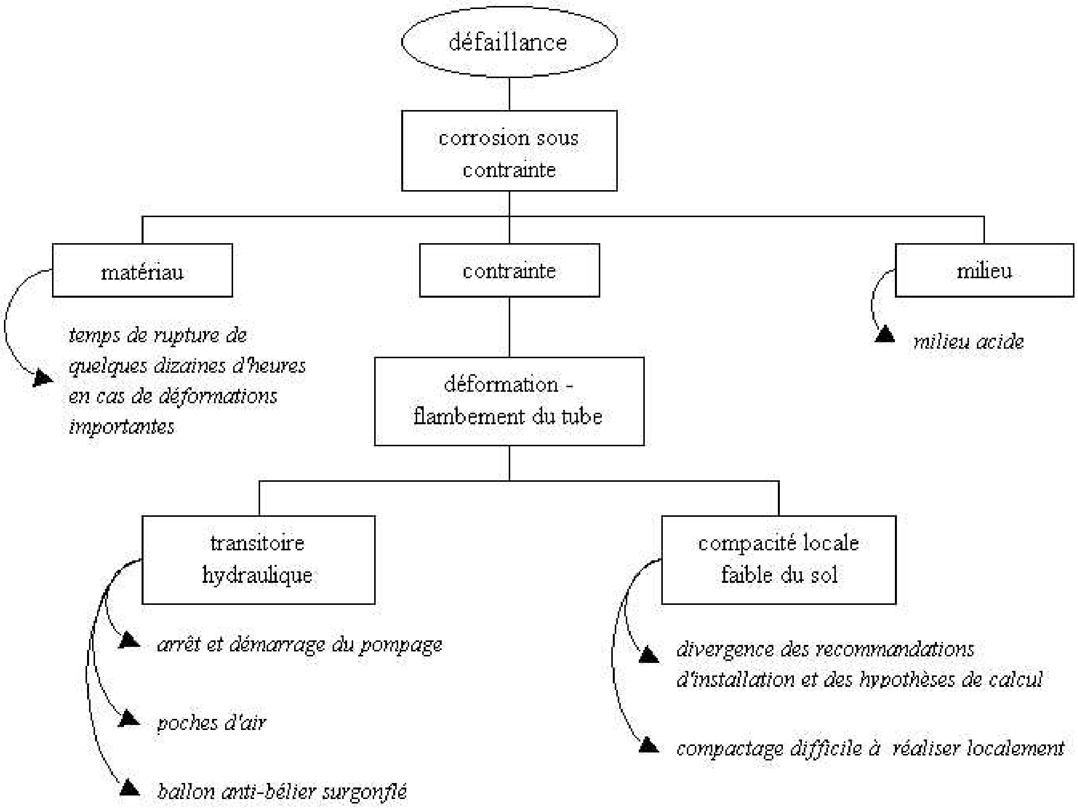
✓ Hydraulic dimensioning

In order to protect the pipeline from excess pressure (hammering at start-up) and vacuum (pumping shut-down/start-up step), a hammering tank of 20 m^3 was installed at the start of the line. In order to be efficient, it had been specified that the cylinder must be initially pressurised to 0.5 bar ; during the expert assessments conducted following the various incidents, it was noted that the cylinder hand been pre-pressurised to 1.7 bar. The entire pipeline had thus experienced a more violent fall of pressure when pumping had stopped (the greatest negative pressure having occurred in the first 2 kilometres). Furthermore, the potential existence of air at the high points, owing to the fact that there were no vents at the highest points, could have the same hydraulic consequences, in terms of both overpressure and negative pressure.

✓ Service life of pipelines made of composite materials

The pipeline's design curve relative to the stress corrosion, coupled with a few experimental values in the field of significant deformations, shows that the rupture time of composite pipelines is roughly ten hours for the major deformations.

In summary, the safe-T-tree of the incidents that occurred on the pipeline in August 2002 is as follows:



The failures occurred near or at high points and near a change in direction, which confirms the role played by hydraulic transitions. Certain failures occurred in a zone where it was difficult to correctly compact the soil (nearby pipeline and concrete well). Finally, the majority of the failures (6 out of 8) occurred in the first two kilometres, i.e. in the zone where hydraulic stresses are greatest.

ACTION TAKEN

Following the incidents of August 7 and 11, 2002, the pipeline connecting Le Havre and Hode was shut-down; the operator was no longer able to send its "low-acid" effluents to the Hode neutralisation facility. As the flow rate of the "low acid" effluents was approximately 15,000 m^3/day, the operator could not use the existing pipeline in service that was used to transport the "mother water" (the most acidic), as the pipeline was not designed accordingly.

The operator thus requested authorisation to release its "low acid" water into the Seine, as it did prior to commissioning the new pipeline, in order to do away with the time needed to replace the leaking pipes and conduct a thorough investigation of the pipeline. The plant cannot operate without creating these effluents and the available catchpit, despite its 30,000 m^3, could only accept the equivalent of roughly sixty hours of effluent. A draft order proposed by the DRIRE indicating emergency measures was signed by the Departmental *Préfet* on August 13, 2002, authorising the operator to release its effluents into the *Baie de Seine* for a maximum period of one month, provided that the requirements relative to the characteristics of the release be observed (pH at 50 m from the release point must be 5.5 and 9; the maximum average flow rate over 24 h is equal to 12,500 m^3/day…).

The problems encountered by the plant in operating its new pipeline were much more serious than foreseen and the operator did not plan to start using this new pipeline prior to September 2003.

As the emergency measures order of August 13, 2002 ran out on September 13, 2002, the operator requested an extension of the aforementioned order until December 2002. The Prefect signed a new emergency measures order proposed by the DRIRE on September 17, 2002:

✓ It took into consideration the true characteristics of the effluent, which thus lead to an increase in the amount of effluent released (with a maximum average flow rate over 24 hours equal to 14,760 m^3/day) and to extend the distance at which the pH is greater than 5.5 from 50 m to 80 m;

✓ It foresaw the implementation of a new temporary and back-up *Baie de Seine* drainage pipe in order to continue investigation operations on the pipeline connecting Le Havre to Hode and the progress of operations on the Port 2000 project.

Until December 31, 2002, the operator thus released its effluents into the Seine, via the old drainage pipe (used prior to the commissioning of the pipeline connecting the Le Havre site to Hode) which was partly amputated due to the Le Havre port expansion operations. At that time, the status of the Port 2000 operations required that this drainage pipe be dismantled as it was located in the zone that had to be backfilled in order to construct the terminals. As the commissioning of the new pipeline connecting the Le Havre plant to the Hode neutralisation facility was not foreseen before the end of the 3rd quarter of 2003, the operator decided to build the new drainage line as an intermediate solution. In compliance with the emergency measures order of September 17, 2002, the file relative to this new temporary and backup drainage line was submitted in mid-October 2002.

A prefectoral order was then signed on January 7, 2003, temporarily authorising (for 6 months, renewable):

✓ the release of effluents into the Seine estuary,

✓ the modification of the *Baie de Seine* discharge point.

As the regulations limited the possibility of temporary provisions, the operator may request that the temporary authorisation be renewed for 6 months, which was undertaken by mail on April 8, 2003. A new prefectoral order was thus signed July 2, 2003 thereby renewing the temporary authorisation for a maximum duration of 6 months.

The operator thus had until January 2, 2004 to discontinue the release of effluents into the *Baie de Seine* and put the pipeline connecting the Le Havre site to the Hode neutralisation facility back into service.

Furthermore, as the establishment had reported numerous accidents in just a few months time[1], an emergency measures order of October 21, 2002 prescribed an audit of its Hygiene, Safety and Environment management system in order to ensure that it was sufficient and that it operated correctly.

Finally, a prefectoral order was signed December 12, 2002 requesting that all of the danger studies relative to the Le Havre site be revised. The last danger studies conducted were specific to certain units and were more than five years old. In light of various incidents that occurred at the site, it seemed necessary to take stock of all of the site's dangers and not only on certain specific units.

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[1] June 8, 2002: overflow of the effluent storage tank
June 28, 2002: leak on the buffer tank filling pipe
August 7, 2002: leak on the Le Havre – Hode pipeline
August 8, 2002: leak on the Le Havre – Hode pipeline
August 14, 2002: leak on the catchpit
September 15, 2002: fire on an oven feed line
September 23, 2002: fire on a liquid sulphur storage tank

From the technical standpoint, the operator replaced several leaking pipes. On July 22, 2003, the pipeline successfully completed a new water test at 15 bar held for 2 hours. Acid water tests were undertaken since early August 2003, two other high point tubes that suffered damages were repaired. In November 2003, the plant was shut-down as the acid production unit was being overhauled. New tests were planned as soon as acid effluents would be available.

Finally, a prefectorial act had been signed on the 8th March, 2004. It requires the implementation of a new pipeline until the 30th of June, 2006. It will follow the same route as the previous one but will not be made of SVR but of PEHD (Polyethylene high density).

LESSONS LEARNED

The lessons to be learned from this series of incidents concern as much the technical aspect as the organisational component.

On the technical level

If the pipes and their assembly were in compliance with the regulatory provisions foreseen by the order, which was approved July 16, 2002 by a satisfactory resistance test, the installation of the pipeline and the pressure control equipment, however, was not completed in accordance with recognised trade practices (disregard for the installation specifications, incorrect dimensioning of the buffer tank and underestimation of the number of vents).

Obviously, this site's project management, involving several parties (internal and external engineering offices, the pipeline constructor, the public works contractors and their sub-contractors, and the operator…), was not optimal. In particular, the prior and systematic verification of calculations, the pipeline installation conditions and the respect of a certain number of rules relative to the pressurisation of the system.

On the financial level

This series of incidents generated significant costs for the operator (operating losses, leak repair, modifications of the *Baie de Seine* discharge point, investigations following the incidents, and the repair of the pipeline,…). For example, the shortening of the former drainage line and the reconstruction of a dispersal tube cost 329,300 € (exclusive of VAT) and the installation of a new discharge point was estimated at 5,500,000 €. This work had to be undertaken for conjunctural reasons (the Port 2000 project) by temporarily replacing the new pipeline connecting the Le Havre plant to Hode and would never have been initiated if the new pipeline had been operational as early as the 4th quarter of 2002.

On the organisational level

The operator must improve its HSE management system.

Chemical plant
Cyclohexane
Pipeline
Freezing temperatures
Soil pollution
Piezometres
Organisation

Cyclohexane leak in a chemical plant

December 16, 2002

Chalampé (68 – Haut Rhin), France

THE INSTALLATIONS IN QUESTION

Chalampé chemical platform

Installed at the site since 1957, the Chalampé chemical platform employs 1,200 salaried employees, extends over 93 hectares covering 3 communes and consists of 2 plants. The common general manager and the personnel of the first company operate the units of the second on its behalf.

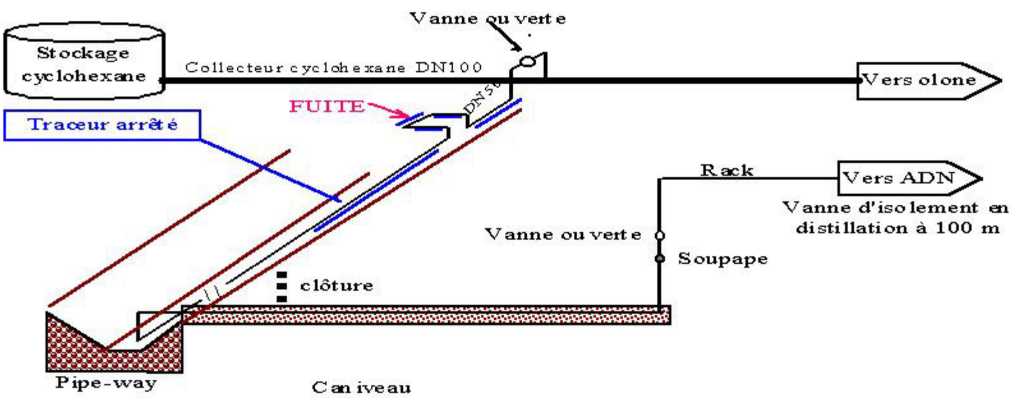
The Chalampé chemical platform specialises in the fabrication of "nylon" salt (a basic chemical intermediate product for threads, fibres and plastic materials).

The site stocks a significant amount of raw materials: two tanks of cyclohexane with a capacity of 5,000 and 10,000 m3, two 2,500 m3 tanks of butadiene, two 300 m3 ammonia tanks and numerous storage facilities for finished and intermediate products.

The Chalampé chemical platform is governed by the "AS" section of the nomenclature for installations classified for its industrial manufacturing activities requiring the implementation and storage of toxic products, flammable liquids and liquefied combustible gases. The last prefectoral order, which followed a public enquiry dates back to November 23rd, 1999.

Installation responsible for the leak

The 10,000-m^3 cyclohexane storage tank (B10000) is connected to the OLONE production shop (a mixture of cyclohexanol and cyclohexanone produced from cyclohexane) via a ND100 mm pipeline. A ND50 mm manifold connected to this pipe supplies the adiponitrile (ADN) production facility. This ND50 mm manifold is routed in a pipeway (a group pipes that are half-buried in a trench dug in the ground featuring intermediate mounds of earth) and features an expansion loop located above the other pipes in the pipeway, a manual valve at each end, a valve and heat lagging equipped with steam tracing to maintain the cyclohexane in liquid form (melting point of cyclohexane = 6.47° C).



The OLONE shop continuously draws 800 tons of cyclohexane per day. The ADN shop draws a few tons of cyclohexane only once every 6 weeks.

The OLONE shop and the 10,000 m^3 cyclohexane storage tank are used by 2 different departments of the first operator,, the ADN shop is operated by the second company.

THE ACCIDENT, ITS BEHAVIOUR AND CONSEQUENCES

The accident:

On December 16, 2002 at around 9.00 am, the OLONE shop's shift personnel noted an incorrect supply of cyclohexane. The filters were changed, the pumps checked and the ND100 mm pipe visually inspected and the ADN shop was queried. The next day, the disturbances continued and a visual inspection of the ND50 mm manifold was organised. The cyclohexane leak was located by its odour: the leak occurred on the expansion loop of the DN50 mm manifold that supplies the ADN shop.

The consequences:

Approximately 30 hours went by from the time the initial cyclohexane output disturbances were noticed and the leak being stopped. The leak was initially estimated to be in the order of a few tons. A material assessment conducted by the operator 10 days later re-evaluated the leak between 850 and 1,200 tons.

Cyclohexane is a "Category 1" flammable product, of relatively low toxicity, moderately miscible to water (solubility = 55 mg/l), less viscous and lighter than water.

After the leak, the cyclohexane infiltrated for the most part into the soil which was made up of gravel. Only a few small puddles of solidified cyclohexane were visible at the location of the leak; a fraction of gaseous cyclohexane also was released into the atmosphere.

At the upper level of the underground water table, located at depth of 15 metres, the cyclohexane tended to spread out rapidly (supernatant layer). After a few days, the spilled cyclohexane could be found in four different forms underground:

✓ A layer of superlatant cyclohexane above the underground water table represents 70 to 85% of the tonnage released by the leak;

✓ Cyclohexane trapped underground by a capillary phenomenon represents 15 to 30 % of the tonnage released;

✓ Cyclohexane dissolved in the underground water table (less than 1% of the tonnage released);

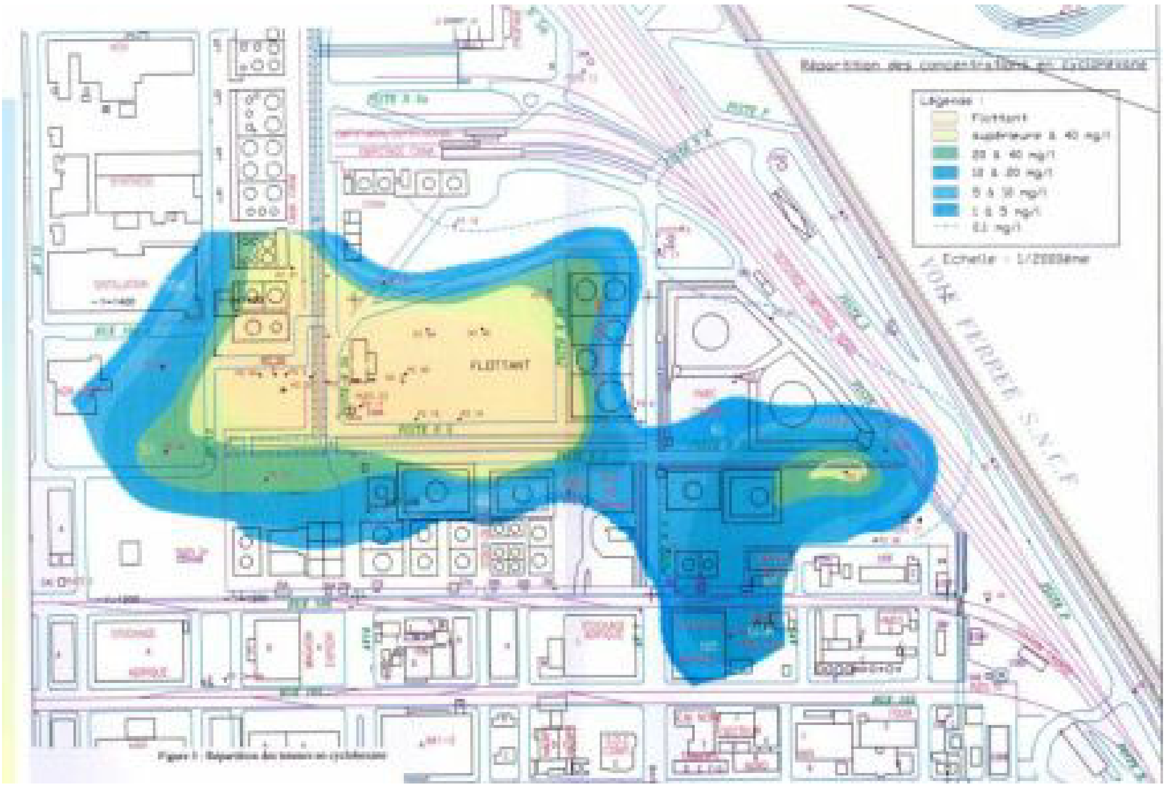
✓ Gaseous cyclohexane underground (less than 1% of the tonnage released).

The layer of supernatant cyclohexane formed the largest part of the cyclohexane released. It was also a supply source for the cyclohexane trapped underground by capillarity, for the cyclohexane dissolved in the underground water table and the gaseous cyclohexane.

The pollution of the water table, one of the largest in the region over the last 10 years, presented a risk of contamination of the community's drinking water reservoirs and agricultural pumping stations located downstream.

The cyclohexane released did not ignite or explode. The internal contingency plan was not put into action.

The overall cost of this leak and the resulting actions was estimated at 2 million Euros.



European scale of industrial accidents

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Quantities of dangerous substances	■ ■ ■ ■ □ □
Human and social consequences	□ □ □ □ □ □
Environmental consequences	□ □ □ □ □ □
Economic consequences	□ □ □ □ □ □

ORIGIN, CAUSES AND CIRCUMSTANCES OF THE ACCIDENT

The ND50 mm manifold's outlet valve is permanently open. Only the ADN shop's inlet valve is closed (the latter valve is opened only in case the ADN shop requires cyclohexane). The ND50 mm manifold is thus maintained under pressure on a permanent basis (2 to 3 bar).

The steam tracing, controlled by a valve, had been turned "off" for an unknown length of time and for an unknown reason. It not longer maintained the cyclohexane in liquid form.

In early December 2002, freezing temperatures caused the cyclohexane to solidify in the manifold. As the temperature varied greatly over the weekend of December 15-16, and owing to the play of the expansion and the retraction of the cyclohexane in the manifold, the manifold broke near the expansion loop (an oblong hole approximately the size of the palm of your hand), which was the part the most exposed to temperature variations due to its shape and raised position in relation to the pipeway.

ACTION TAKEN

The outlet valve of the ND50 mm manifold was closed as soon as the leak was detected, immediately stopping the leak. The supply of the OLONE shop returned to normal. An existing well, located 30 m from the leak (well No. 23), was used to create a cone of depression (output = 900 m3/h). The existing hydraulic barrier (a network of 25 wells distributed around the chemical platform creating a depression of approximately 2 m aiming to prevent all migration downstream of the water table pollution) was adapted to guarantee that the pollution was confined inside the industrial site.

In late August 2003, the following operations were undertaken:

✓ 55 piezometres (115 mm in diameter) were drilled at the site in order to determine the extent of the pollution, to pump the supernatant cyclohexane, to draw off the gases (venting), and to perform analyses. These operations required special precautions to prevent the risk of explosion during the drilling operations;

✓ 2 cyclohexane fixation wells with a water table barrier were drilled (300 mm in diameter);

✓ 1 sparging barrier measuring 300 m long was set up along the site's northern limit to reinforce the existing hydraulic barrier (injection of air into the water table and recovery of the gases using 18 well doublets);

✓ 4 control piezometres were drilled downstream from the site (in addition to the 3 existing ones);

✓ Several hundred cyclohexane analyses were conducted (on site and downstream) by an independent laboratory (detection limit at 5 µg/l for a potability limit at 10 µg/l).

These operations limited the expansion of the pollution that continued to extend under the industrial site in August 2003 over a surface area measuring 600 m long by 300 m wide. The thickness of the supernatant cyclohexane layer varies from several centimetres to roughly ten or so centimetres.

In late August 2003, 480 tons of cyclohexane were extracted from underground (more than 90% of which was in supernatant form), owing to 3 recovery systems in place: skimming of the supernatant, venting, sparging.

Studies are underway aimed at bio-remediation of the pollution using bacterial strains, specifically intended to denature the cyclohexane, detected along the periphery of the polluted zone.

The action by the administration lead to the following:

✓ Observe and report the facts,

✓ Conduct 5 inspections January 8, March 7, June 13, July 2 and 3, 2003;

✓ Propose 2 prefectoral emergency orders on January 9 (circumstances of the leak, cleanup operations, monitoring, feedback, information provided to the authorities) and March 12, 2003 (reinforcement of pumping operations, downstream monitoring, third-party expert assessment);

✓ Organise 7 meetings with the operator (including 3 relative to the information provided to the authorities);

✓ Draw up a large number of reports, communiqués and letters intended for the *prefect,* the operator and elected officials, environmental protection associations, judiciary department and the media.

A working group made up of the DRIRE, DDASS, DDAF, and DIREN, was specially compiled to follow-up and evaluate the consequences of the leak and to provide the *prefect* with a proposal to require possible safeguard actions relative to public heath and safety.

The working group's action was primarily based on:

✓ The operator's control of the efficiency of the hydraulic barrier in place in order to contain the pollution inside the industrial site and to avoid all contamination downstream;

✓ Recovery of the cyclohexane;

✓ Monitoring of the water table downstream from the chemical platform.

LESSONS LEARNED

Various actions were conducted aimed at preventing such a leak from reoccurring:

✓ On the leaking cyclohexane manifold:

× Installation of output measurements on all cyclohexane lines with remote reporting in the OLONE control room (material assessment display equipped with an alarm system),

× Preparation of a procedure in case the line is not used (closure of the inlet valve, drainage);

× Annual inspection of the steam tracing;

× Regular verification of the status of pipeway lines;

× Taking into account of the hypothesis of a leak whenever an anomaly is detected (information for the personnel + instruction).

✓ On the site's other transfer dangerous fluid transfer lines:

× A procedure for sharing responsibilities between the site's various units;

× 67 scheduled modifications on the dangerous fluid transfer lines;

× Definition of inspection and servicing of the tracings.

A procedure for providing the authorities with information in case of an incident was drawn up in cooperation with the internal departments of the *prefecture*. It was tested in early 2003. This procedure contains a rating scale for the incident established using a grid based on the characteristics of the chemical product (toxic, flammable, …), the extent of the leak, and the impact both on and off the site. A separate rating deals with the potential impact based on the volume of the system (potential leak), the controllable character of the event, the operability of the safety devices, the potential impact on and off the site, and the estimated cost of damages and operational losses. The information is submitted to the governmental departments (CODIS, Préfecture, Gendarmerie, DRIRE, labour inspectorate, CRAM, SAMU) and to the municipalities. The application of this procedure resulted in the company declaring 16 incidents from January to November 2003.

The Chalampé chemical platform has become a pilot site within the company's group in terms of the information made available to the authorities.

This leak highlighted the following elements:

✓ Technical malfunctions: failure of the steam tracing, lack of real-time information (material assessment) and an alarm enabling the leak to be detected;

✓ The lack of verification programs for the equipment involved (manifolds, steam tracings, …) and the actual designation of the individuals in charge of conducting these checks;

✓ The lack of appropriate instructions in case of a leak;

✓ Communication problems between the operators of the 3 departments involved;

✓ The presence of a large size dead branch without a catchpit due to the inlet valve of the ND50 mm manifold being maintained open;

✓ The inappropriate reactions of the operators associated with the above-mentioned technical and organisational deficiencies and the lack of diagnostic tools should an alarm be triggered;

✓ Incomplete information about the incident.

This leak lead to the following:

✓ Confirmation of hydraulic barrier efficiency (installed in the 1980s following pollution of the community drinking water reservoirs due to the chemical platform);

✓ Retrofitting and implementation of action programs to prevent an major leak from reoccurring;

✓ Re-engineering of the information sent to the authorities and the neighbouring communities;

✓ The manufacturer was reminded of its duty to remain vigilant and to control the processes and the risks presented by its installations;

✓ Quick assessment of the skills and experience of the various departments in charge of overseeing public health, the conservation of natural environments, the water police and the registered installations through the work group.

Other documents

European scale of industrial accidents

Graphic presentation used in France

European scale of industrial accidents

Graphic presentation used in France

1 – Reminder of the characteristics of the European scale for industrial accidents

This severity scale was made official in 1994 by the Committee of Competent Authorities of the member States which oversees the application of the 'Seveso' directive. It is based on 18 technical parameters designed to objectively characterise the effects or consequences of accidents: each of these 18 parameters include 6 levels. The highest lever determines the accident's severity index.

2 – Difficulties encountered with the single index derived from the European scale

The main difficulties encountered stem from the attribution of an overall index covering the consequences that are completely different according to the accidents, while these consequences can only be directly compared between themselves: death, length of waterway polluted, harm to the fauna, flora, property damage, operating losses… Dialog is often difficult with the media or victim associations which poorly understand the mixture of various categories of consequences formed within a single and obscure index. No one deduces that a valuation system between the various interests involved in the industrial accidents was knowingly established.

Examples*:

AZF Toulouse	ERIKA	Crédit Lyonnais fire
ARIA No. 21329	ARIA No. 16879	ARIA No. 9384
Level 6	Level 6	Level 6

The unique scale does not differentiate these three accidents in terms of its "Level 6" rating, although the Toulouse accident caused 30 deaths and more than 5,000 injured, 56 people were slightly intoxicated during the Crédit Lyonnais fire and the sinking of the Erika had no known human impact. The environmental consequences of the pollution caused by the Erika (300,000 birds and 150 ha of oyster beds polluted, the coastline of the Finistère, Morbihan, Loire Atlantique, Vendée and Charentes Maritimes *départements* were polluted) cannot be compared to the other two accidents. All three accidents had serious economic consequences (AZF: 15,000 MF, Erika: 1,200 MF, Crédit Lyonnais: 1,956 MF).

The lack of sufficient information about certain pertinent technical parameters can lead to an underclassification of the accident. This difficulty, however, must not be attributed to the scale, but to deficiencies in the acquisition and communication of information about the accident by the private or public entities concerned.

3 – Improvement proposal

Further to these difficulties, a new presentation of the European industrial accident severity scale with four indices was proposed (see the table in the appendix hereto). After having completed a large consultation of the various categories of the players concerned in 2003, this proposal was retained by the Higher Council for Registered Installations. It includes the 18 parameters of the European severity scale in four uniform groups of effects or consequences:

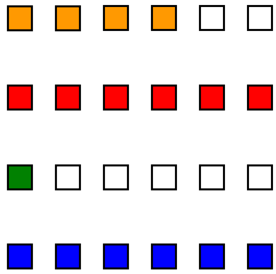
- 2 parameters concern the quantities of dangerous materials involved,
- 7 parameters bear on the human and social aspects,
- 5 concern the environmental consequences,
- 4 refer to the financial aspects.

This presentation modifies neither the parameters nor the rating rules of the European scale.

Examples*:

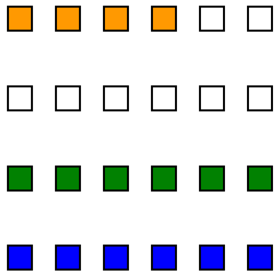
AZF Toulouse (ARIA No. 21329)

- Quantities of dangerous substances
- Human and social consequences
- Environmental consequences
- Economic consequences



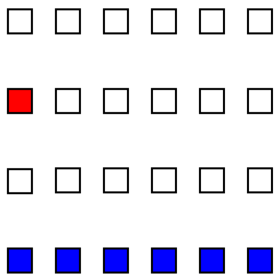
ERIKA (ARIA No. 16879)

- Quantities of dangerous substances
- Human and social consequences
- Environmental consequences
- Economic consequences



Crédit Lyonnais fire (ARIA No. 9384)

- Quantities of dangerous substances
- Human and social consequences
- Environmental consequences
- Economic consequences



* Visit the web site: http://www.aria.environnement.gouv.fr

Technical parameters of the european scale

Quantities of dangerous substances		1	2	3	4	5	6
Q1	Quantity Q of substance actually lost or released in relation to the "Seveso" threshold	Q < 0,1 %	0,1 % ≤ Q < 1 %	1 % ≤ Q < 10 %	10 % ≤ Q < 100 %	De 1 à 10 fois le seuil	≥ 10 fois le seuil
Q2	Quantity Q of explosive substance having actually participated in the explosion (equivalent in TNT)	Q < 0,1 t	0,1 t ≤ Q < 1 t	1 t ≤ Q < 5 t	5 t ≤ Q < 50 t	50 t ≤ Q < 500 t	Q ≥ 500 t

Human and social consequences		1	2	3	4	5	6
H3	Total number of deaths: including - employees - external rescue personnel - persons of the public	- - - -	1 1 - -	2 – 5 2 – 5 1 -	6 – 19 6 – 19 2 – 5 1	20 – 49 20 – 49 6 – 19 2 – 5	≥ 50 ≥ 50 ≥ 20 ≥ 6
H4	Total number of injured with hospitalisation ≥ 24 hours: including - employees - external rescue personnel - persons of the public	1 1 1 -	2 – 5 2 – 5 2 – 5 -	6 – 19 6 – 19 6 – 19 1 – 5	20 – 49 20 – 49 20 – 49 6 – 19	50 – 199 50 – 199 50 – 199 20 – 49	≥ 200 ≥ 200 ≥ 200 ≥ 50
H5	Total number of slightly injured cared for on site or with hospitalisation < 24 hours: including - employees - external rescue personnel - persons of the public	1 – 5 1 – 5 1 – 5 -	6 – 19 6 – 19 6 – 19 1 – 5	20 – 49 20 – 49 20 – 49 6 – 19	50 – 199 50 – 199 50 – 199 20 – 49	200 – 999 200 – 999 200 – 999 50 – 199	≥ 1000 ≥ 1000 ≥ 1000 ≥ 200
H6	Total number or homeless or unable to work (outbuildings and work tool damaged…)	-	1 – 5	6 – 19	20 – 99	100 – 499	≥ 500
H7	Number N of residents evacuated or confined in their home > 2 hours x nbr of hours(persons x nbr of hours)	-	N < 500	500 ≤ N < 5 000	5 000 ≤ N < 50 000	50 000 ≤ N < 500 000	N ≥ 500 000
H8	Nbr N of persons without drinking water, electricity, gas, telephone, public transport for more than 2 hours x nbr of hours (persons x hour)	-	N < 1 000	1 000 ≤ N < 10 000	10 000 ≤ N < 100 000	100 000 ≤ N < 1 million	N ≥ 1 million
H9	Number N of persons having undergone extended medical supervision (≥ 3 months after the accident)	-	N < 10	10 ≤ N < 50	50 ≤ N < 200	200 ≤ N < 1 000	N ≥ 1 000

Environmental consequences		1	2	3	4	5	6
Env10	Quantity of wild animals killed, injured or rendered unfit for human consumption t)	Q < 0,1	0,1 ≤ Q < 1	1 ≤ Q < 10	10 ≤ Q < 50	50 ≤ Q < 200	Q ≥ 200
Env11	Proportion P of rare or protected animal or vegetal species destroyed (or eliminated by biotope damage) in the zone of the accident	P < 0,1 %	0,1% ≤ P < 0,5%	0,5 % ≤ P < 2 %	2 % ≤ P < 10 %	10 % ≤ P < 50 %	P ≥ 50 %
Env12	Volume V of water polluted (in m^3)	V < 1000	1000 ≤ V < 10 000	10 000 ≤ V < 0.1	0.1 Million ≤ V< 1 Million	1 Million ≤ V< 10 Million	V ≥ 10 Million
Env13	Surface area S of soil or underground water surface requiring cleaning or specific decontamination (in ha)	0,1 ≤ S < 0,5	0,5 ≤ S < 2	2 ≤ S < 10	10 ≤ S < 50	50 ≤ S < 200	S ≥ 200
Env14	Length L of water front or water channel requiring cleaning or specific decontamination (in km)	0,1≤ L < 0,5	0,5 ≤ L< 2	2 ≤ L< 10	10 ≤ L < 50	50 ≤ L< 200	L ≥ 200

€ Economic consequences		1 ■□□□□□	2 ■■□□□□	3 ■■■□□□	4 ■■■■□□	5 ■■■■■□	6 ■■■■■■
€15	Property damage in the establishment (C expressed in millions of € - Reference 93)	0,1 ≤ C < 0,5	0,5 ≤ C < 2	2 ≤ C< 10	10 ≤ C< 50	50 ≤ C < 200	C ≥ 200
€16	The establishment's production losses (C expressed in millions of € - Reference 93)	0,1 ≤ C < 0,5	0,5 ≤ C < 2	2 ≤ C< 10	10 ≤ C< 50	50 ≤ C < 200	C ≥ 200
€17	Property damage or production losses outside the establishment (C expressed in millions of € - Reference 93)	-	0,05 < C < 0,1	0,1 ≤ C < 0,5	0,5 ≤ C < 2	2 ≤ C < 10	C ≥ 10
€18	Cost of cleaning, decontamination or rehabilitation of the environment (expressed in millions of €)	0,01 ≤ C < 0,05	0,05 ≤ C < 0,2	0,2 ≤ C < 1	1 ≤ C < 5	5 ≤ C < 20	C ≥ 20

Conclusions

Closing speech

IMPEL seminar November, 04th and 05th, 2003

Seminar closing speech

Bruno Cahen
Head of the office of technological risks and chemical and petroleum industries.

I would first like to thank you all for coming to this ninth seminar on industrial accidentology. All of you, both French and foreign inspectors, have contributed to making this event a success through the operations that you have conducted.

This year again, a great deal of participation from inspectors from the European Union enabled us to confront our working methods: 5 accidents were presented that occurred outside our borders.

I would especially like to thank the participants who, through clear and well-argued presentations, were able to share what they experienced in the often-dramatic situations that they were confronted with.

I would also like to thank the DRIRE Bourgogne as well as the BARPI for designing and organising this seminar.

This "*cuvée* 2003" had been placed under the dual presidency of the DPPR and the labour inspectorate. It should be reminded that we often share the same areas of concern: Danger studies in accordance with the transposed Seveso directive, for one, and risk assessment as foreseen by the labour code, for the others. Our inspectorates sometimes investigate the same accidents: during the seminar, an illustration of our respective roles was presented through the Calais explosion. I see these mutual exchanges as only being advantageous, enabling the expansion of our habitual framework in terms of different points of view and additional elements.

Without going into the details of the accidents presented or the assessment of the past year, a few key points come to mind:

- ✓ Dramatic accidents recently occurred in installations where explosives are handled: two similar accidents occurred less than a year apart in a dynamite manufacturing facility in Germany and another one in France, in Billy-Berclau. This again validates the need for exchanges between the various member states in terms of feedback and common themes.

- ✓ 2002 was marked by an increase in events involving silos. The Vailly sur Aisne and Jussy accidents, both of which caused serious damage to the installations, were presented during the seminar. These accidents, as well as all the others (the case of Annoisin-Chatelans, Chavannes-Sur-L'etang, Beligneux and Breuil resulted in the death of operators) must incite the utmost vigilance of these installations and to continue the backfitting operations already initiated.

- ✓ Among the cases presented, one of them (the first: Château Arnoux) dealt with the release of chlorine: for this problem, I would like to remind you of the existence of a technical working group, set up last year, whose objective it was to propose means to improve in terms of major risk prevention in chlorine storage and unloading installations. Furthermore, as announced last year, a chlorine training seminar was organised last December by the INERIS and the BARPI. A study was also drawn up and a CD-Rom featuring all of the work conducted will be distributed in early 2004.

- ✓ I won't reiterate all of the themes for which nation-wide reflective thinking were engaged: I noted that yesterday afternoon was dedicated to accidents involving flammable substances, including one in particular in Italy where LPG was involved. A working group formulated proposals on this theme as well, which lead to a circular being drawn up. Furthermore, I would like to remind you that the ministerial order of November 9; 1989 has been modified in terms of the distances relative to the thermal effects of butane and propane.

- ✓ The case of Artaix, which took place in an abandoned installation not far from here, reminds us of the need to anticipate the end of industrial sites' service lives. On this topic, the new law concerning risks, voted upon last summer, features provisions aiming to protect against this type of situation, throughout the installation's "service life".

Last year, many important points were brought up following the Toulouse catastrophe. The Act of last July 30 relative to the prevention of technological risks was passed. It is a challenging text that is divided into several main topics, some of which offer new approaches:

✓ The need to estimate the reliability of preventive measures in the analysis of reducing risks at the source,

✓ The active participation of employees and sub-contractors now associated with the risk prevention procedure (the CHSCT (the committee for hygiene, safety and working conditions) are now associated with these procedures),

✓ Control in terms of community planning with the implementation of compensable easements for new sites or extensions and the PRRT ("plans de prévention des risques technologiques", technological risk prevention plans) in order to curtain difficult situations around existing cites,

✓ Information made available to the public by the installation of CLIC ("comités locaux d'information et de concertation", location information and joint action committees) around Seveso sites.

Certain points of this text have been anticipated: as such, in terms of the CLIC, it is predicted that no less than 127 CLICs will be in place by late December 2003. Their procedures will be varied although they come within the scope of the objective set by the law, providing a great degree of openness and better information for the public. The goal is to provide elements enabling an opinion to be made on these files and, beyond this, to acquire a technological risk culture that shared better. Other tools will be added to this system: the use of DRIRE internet sites to publicise authorisation orders and, in the long run, the results of inspections conducted in the field.

The European severity scale for industrial accidents is also part of these tools that contribute to enhancing the information made available to the public. A new presentation was proposed this morning. A large consultation effort was undertaken: by the Registered Installations Inspectorate during the second quarter of 2002 and by a larger group of organisations and entities during the first quarter of 2003. The CSIC requested that it be progressively introduced in the exchanges between the installations and the inspectorate. It use has begun with the publication of a certain number of accidents and their associated severity on the BARPI public web site.

In order to facilitate the use of the severity scale, you were also introduced to an electronic accident reporting project was established by a working group made up of inspectors, SEI ("Service de l'environnement industriel", Industrial Environment Department) representatives. Beyond determining the severity indices of an accident, enhanced information formatting would rationalise, enrich and facilitate exchanges between local inspectors, the BARPI, in charge of collecting and diffusing information, but also all of the Inspectorate's other players.

As you know, these exchanges are essential in acquiring pertinent feedback elements. While it is the operators' responsibility to initiate the process, the Inspectorate's role is to ensure that it is properly organised in terms of incident detection and analysis as well as the implementation of corrective measures. In this respect, feedback is an important factor in the constant improvement of installations and their operation. Sharing this experience enables everyone to access the lessons learned from the analysis of the errors made and possible good practices (positive feedback).

Thank you for your attention and I hope more than ever, considering the important changes and evolutions of our missions, that our work can be used and help you in accomplishing your daily tasks.

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