Evolution in industrial risk management in France. The agenda concerning LUP, risks and stakeholder perspective on a national level

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EVOLUTION IN industrial risk MANAGEMENT in France

The Agenda Concerning LUP, Risks And Stakeholder Perspective on A National Level

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Introduction

Industrial risk management in France has recently evolved for several reasons, both technical and societal. First of all, the consequences based approach for risk assessment appeared to be inappropriate to fulfil the requirements of the Seveso II directive, in particular in terms of demonstration that major risks are **controlled**, and especially when the demonstration is based on the reduction of the probability of occurrence of the possible accident scenarios. Second, the analysis of the situation regarding land-use planning in France has shown a lot of discrepancies **difficult** to justify, in front of the public. The discrepancies seem to be generated by the uncertainties related to the selection of the scenarios, the models to quantify the consequences of the accident and the assumptions for the calculations. Third, the changes in our «information society» have led to increase the public interest and participation in decision making process related to environmental and risks issues.

This diagnosis was made in the framework of a project funded by the French Ministry in charge of **Environment**, which started in 1999. Then the Toulouse disaster occurred on the 21st September **2001**. This major event has played the role of a catalyst for changes in the risk management process and has led the authorities to prepare a new law that covers both natural and technological hazards and the compensation of the damages. For the technological **part**, the law took advantage of the recommendations made by the project and it was adopted on **the 30th** July 2003.

In 2004, the **competent** authorities, with the help of INERIS and other technical supports have developed methods and tools to accompany the implementation of the technological part of this law which introduced 4 new aspects :

- ✓ the involvement of stakeholders with the creation of Local Committees for Information and Dialogue,
- ✓ the preparation of Technological Risk Prevention Plans (long term view),
- ✓ the participation of the workers, and subcontractors in risk management,
- ✓ measures to speed up the compensation related to the damages.

The methods and tools were under development and tested in several real situations in 2004 and they were made public at the end of 2004.

This paper will first describe the evolutions of the concepts related to risk management for hazardous installations in France, in particular in the aspects related to the link between risk

assessment and land-use planning. Then, the paper will present in details the main novelties introduced by the law of 30th July 2003, and the methods and tools that have been developed to enable its implementation. The results related to the cases studies carried in 2004 on several industrial sites will be presented and analyzed.

1. Review of the current situation

1.1 The policy of industrial Risk management in France is well structured

If we consider the traditional model of the accident made up of the source of hazard (the industrial plant), the flow of hazard (propagation of the dangerous phenomena - pollutant gas dispersions, fires, explosions, liquid pollution) and the risk receptor (human, environmental and material), the industrial risk management policy in France takes shape according to 3 complementary general principles' which are :

1. The risk reduction (action on the potential of hazard).
2. The limitation of the effects of an accident (action on the vector of propagation).
3. The limitation of the consequences (action on the exposure of the receptor)

Thus, these principles are declined by the competent authorities according to the step in four points :

1. The risk reduction,
2. The land use planning,
3. The public information,
4. Emergency plans,

This four points have defined the bases of the policy of industrial risk management in France during the 15 last years. The recent evolutions of the concepts related to the industrial risk management in France did not call into question its principles. However, they considerably contributed to modify the way of applying them while insisting on the first three points previously quoted.

1.2 The risk reduction is not enough applied and thus the authorities must enforce it.

Risks reduction refers to the reduction of the potentials of hazard (quantity of substances, pressure and temperature of reactions...) and the application of the best available techniques in term of process and safety measures. It is accompanied by the control of the reduction of the occurrence probability of the accidental events and on the attenuation of their severity.

This principle, which is however the first principle of the French policy, was not always applied in the past. Indeed, for a long time, it seemed in opposition with the idea of industrial growth whereas the idea of sustainable development haven't developed in the mind of the risk managers.

1.3 Lessons learnt from the implementation of LUP in France

After more than 15 years of application of the legislative and lawful texts relative to land use planning, it has appeared necessary to draw up an assessment on its implementation.

It comes out from this assessment that the overall application of the principles of the previous laws made it possible to limit the urbanisation around the seveso sites and that the tools used were relatively well adapted for new installations. However, it appeared that the legislative framework was complex and not very readable. This aspect was amplified by the variety of the decision authorities the weak readability of the responsibility for the various actors. Moreover, the concept of acceptance of risk for the public had never been explicitly defined

In addition, it appears that the legacy of the past (old plants) was difficult to manage with the existing tools, more adapted for the new installations. The implementing rules of the tools were insufficient for a homogeneous dimensioning of the safety zones. Moreover, there was a difficulty in carrying out a true dialogue between the local actors, without counting the delicate legal context.

1.4 Evolutions in risk assessment practices

Quality improvement of the safety reports for seveso plants

In France, the Safety report was, until a few years, elaborated with a very deterministic approach. It presented only in a very pessimistic way a list of scenarios (worst case scenarios) which were used only:

- For Land use Planning,
- For emergency plans.

This kind of approach did not pose problems for the preparation of the emergency plans but it was proven not very effective for the urbanisation management (cf. point 1). Indeed, in the cases where the deterministic scenarios were used for the land use planning that often resulted in the introduction of large unusable zones.

With the wish to be more pragmatic and for choosing the appropriate scenarios for land use planning, the safety report is improved by making more and more place to the risk assessment. The concept of probability was progressively introduced by taking into account the safety measures and the application of grid of criticity. With this, the safety report became the official key document in the management of the hazardous establishments and the communication on the major risks. The guiding principles governing its development became double:

- The industrial operator must demonstrate that all the risks on the site are identified and are actually controlled. This first condition makes it possible to deliver the permit to operate.
- The industrial operator must provide in the safety report, all necessary information to land use planning and emergency plans

New assessment methods proposed at the European Level

With the evolution of the contents of the safety reports (INERIS is one of the driver of this change in France), at the European Level was also bom a will to improve risk assessment methods for seveso plants.

The European project **ARAMIS**[1] precisely aimed to develop a new risk assessment method for major risks that integrates the forces of the various existing approaches at the European Level (deterministic or probabilistic culture). This project lays within the scope of the European directive Seveso ÏÏ.

For a more explicit demonstration of the risk control, ARAMIS had chosen to be directed towards a safety barrier approach. It was a question of identifying all the scenarios leading to major accidents, then to count the safety measures (barriers) being opposed to the development of the accident. The acceptability of the risk lays then in the choice of the number and the performance of the barriers in order to consider that the risk is controlled. The human organisation ensured the maintenance in the time of the quality of the barriers.

Concerning land use planning, except the political or social stakes, one noted that the current representation of the risks did not make it possible to the decision-makers to have an overall vision of the problems. ARAMIS sought to develop on this point the current tools for cartography and in particular the GIS (Geographical Information System). The strong idea was to dissociate the danger potential of the seveso site of the sensitivity of its impacted environment, in the representation of the consequences of a major accident. Thus, research proposed the development of a vulnerability map independent but **superposable** to a severity map of the scenarios selected.

The work within this program contributed to the writing of guide related to the elaboration of the safety report in France and which was published in June 2003.

2. The main novelties introduced by the law of 30th July 2003

2.1 The law of 30th July 2003

The law related to the prevention of the technological and natural risks, and to the compensation for the damages envisages to bring answers to certain deficiencies of the existing laws as regards to technological risk.

In particular, the accident of Toulouse, at the origin of the great reflection in France, which led to the proposals contained in the technological part of the **law**, revealed:

1. Insufficient information of the public and a need for a stronger involvement of the public in risk related decisions,
2. A need to involve employees of the seveso sites, as well as the personnel subcontractor intervening on the hazardous installations, in the risk management leaded in the companies,
3. A need for engaging a reflection on the compensation to the victims so that it is faster and more effective,
4. Situations where the proximity of very urbanised zones is likely to strongly worsen the consequences of major accidents on seveso sites.

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[1] Accidental Risk Assessment Methodology for Industries in the framework of Seveso II Directive

Concerning the later point; this law introduced two new tools to facilitate the land use planning around the high-risk sites:

- Utility easements compensated by the owner who generates the Risk. This utility easements are instituted for any "new" Risk generated by the extension or the creation of an industrial facility witch would require an additional restriction of the land use.. These tools, which existed already in the L. 515-8 article of the French environment laws, was extended by the law of July 30, 2003

- The creation of Technological Risk Prevention Plans (TRPP). These plans are foreseen to limit the exposure of the population to the consequences of the accidents. They will make it possible to reabsorb a difficult existing situation as regards town planning and to prevent that such a situation is renewed in the future.

The TRPP delimits, around the seveso sites, zones inside where regulations can be imposed on existing and future constructions.

TRPPs also define the sectors inside where expropriation is possible due to very serious hazard threatening the human life. They define the sectors inside where the local authorities can give to the owners a right of renunciation due to serious hazard threatening the human life, and those inside where the local authorities can preempt the goods at the time of transfers of properties.

The figures 1 and 2 below present how starting from zone of risk qualified by the State (on the basis of information provided by the industry) the authority determines sectors of expropriation or renunciation).

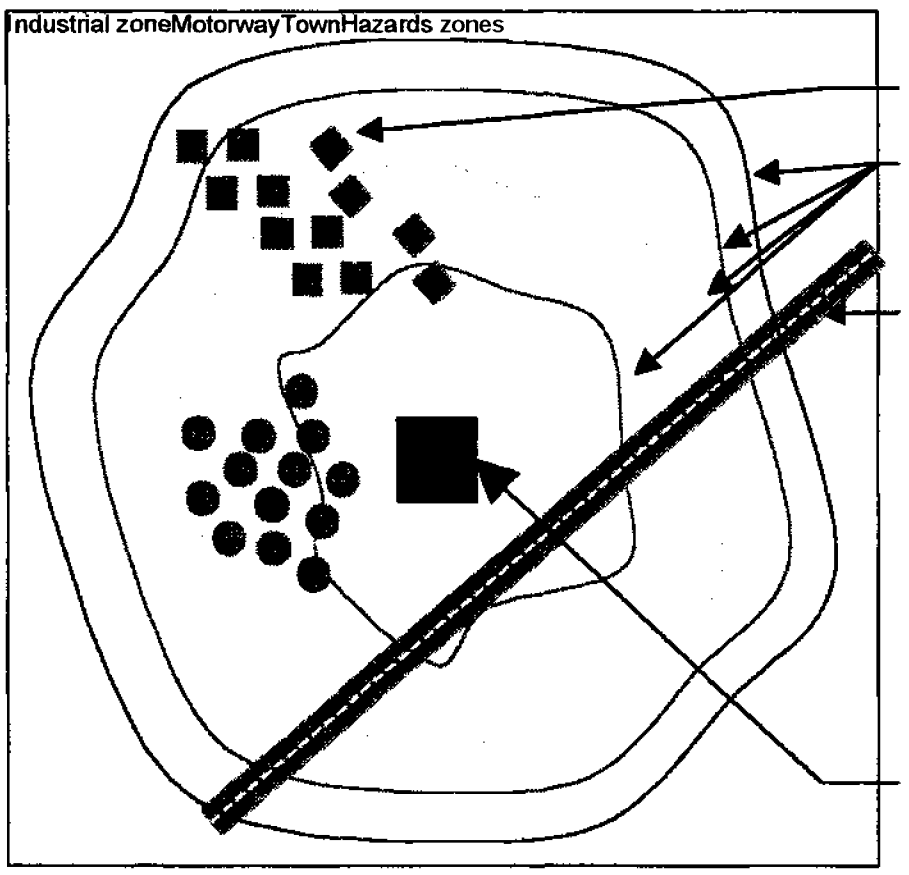

Figure 1 : hazards map with the localisation of the risk receptor

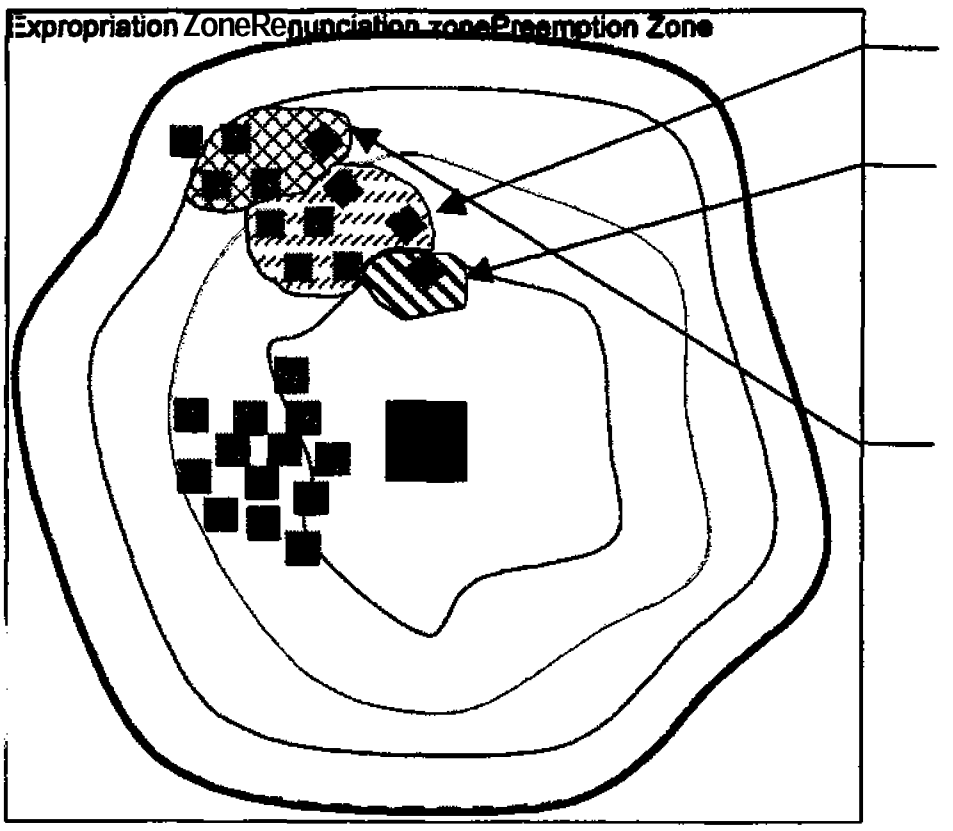

Figure 2 : regulatory map

The financing of the measures associated with the **TRPP** is defined by conventions between the State, industry, and local authorities.

The representative of State at the local level (the Préfet) leads the development of a **TRPP**. .

The TRPP approved after public investigation is considered as a Utility easements. It is annexed in the Local Plans of Town development.

The number of TRPP to be elaborated from now to July **31,** 2008 on the French territory is estimated at approximately 400. About 700 industrial plants and 500 towns are concerned with the TRPP process. Time necessary to the application of the whole process associated with the TRPP is estimated at approximately a generation (20 years).

2.2 New **Technical and legal tools to apply the Land use planning**

Three phases are to be distinguished for the realisation of the TRPP: the technical phase, the dialogue phase and the lawful phase.

The technical phase is the definition of the hazards. Upstream of this definition, it is advisable to check that the reduction of Risk was indeed applied by the owner in accordance with the Seveso regulation. This characterisation of the risks must come before the characterisation of the sensitivity of the receptor in the environment (surrounding the plant).

The dialogue phase is intended to carry out an analysis of the costs of an additional reduction of risks. It is necessary to set up the local committee of dialogue.

After that is the phase of drafting and consultation (with public consultation), which ends in the drafting of the lawful text and the signature of tripartite convention for the payment of measure related to the TRPP and rules applying on the land.

Concerning the Technical phase, this one is held in **five** stages:

- Hazard assessment and identification of risk receptors.
- superposition of these data;
- costing associated with land measurements;
- strategy of risks definitions ;
- preliminary draft of zoning

A national framework is necessary in order to determine the scenarios of accidents and the vulnerability of risk receptor.

Tools to evaluate the hazards

The objective is to have solid technical tools for the phases of characterisation of the hazards and the vulnerability of the risk receptors. The publication of a Technical guide is planned for the second six-month period 2005.

The guide will provide a methodology to evaluate the hazards and the vulnerability of the risk receptors. It will define simple rules to work out the **TRPP**. It will present an illustration starting from the experiments carried out.

Because of the 3 dimension of the hazards, - intensity, probability, kinetic -, adapted tools are thus necessary.

Firstly, a definition was necessary to the glance of the law of 2003: It was brought by the decree of 22 October 2004 relating to the reference values of the thresholds of effects of the accidental phenomena.

The threshold of very serious hazards corresponds, at the national level, to the threshold of the significant lethal effects. The thresholds of the serious hazards correspond of the first lethal effects. The thresholds of the significant hazards correspond to the threshold of the irreversible effects the ministerial decree indicates three types of effects: toxic, overpressure, and thermies effects.

With regard to the toxic effects, the ministerial decree distinguishes four reference thresholds. Reference thresholds exist for twenty-six substances, defining thresholds for the significant dangers and dangers serious. For the other substances, the industry will have the responsibility to propose values. Overpressure (explosion) and the heating effects are also evoked. For the three levels of hazards (very serious, serious, significant) are indicated the corresponding thresholds.

The French threshold levels are synthesised in table 1.

For the kinetic, scenario will be described as slow if it is possible to set up measurements putting at the shelter the population. Principles were to be highlighted : response time of the safety barriers, prevention and protection measures inside or outside the site in coherence with the kinetic of the accident scenario.

Table 1

	thresholds of the significant Lethal effects	thresholds of the first Lethal effects	thresholds of the irreversible effects	thresholds of the irreversible effects by breaking of panes
Toxic	LC 5%	LC 1%	SEI	-
Thermies	8 kW/m2 or 1800 [(kW/m2) 4/3]. s	5 kW/m2 or 1000 [(kW/m2) 4/3]. s	3 kW/m2 or 600 [(kW/m2) 4/3]. s	-
Overpressure	200 mbar	140 mbar	50 mbar	20 mbar

About the probability, it is necessary to have: data on accident causes, on the safety barriers in place. We need also a framework for their use. Various stages result in working out an accident scenario: causes, loss of containment, sequence of events leading to a major event. Barriers make it possible to avoid this one. The method suggested consisted in identifying the various accidents scenarios being able to lead to the major accident and the various safety barriers installed. The initial events have several orders: intrinsic with the process, external with the process (domino effect), and external and natural causes. The method gives indications on the frequency of these initial events. The barriers must be qualified according to several criteria: effectiveness, response time, Safety Integrity Level. An index of probability of the major accident must also be defined according to the scarcity.

This method allows an easier visualisation of the devices acting on the control of the risks and preventing thus major accidents. It authorises also a better transparency in the presentation of the control of the Risk. Lastly, it helps to understand the concept of probability.

Tools to estimate the vulnerability of the risk receptors

Three great stages must be distinguished:

- to carry out a total analysis of the risk receptors on the whole of the study perimeter
- to engage the studies of vulnerability on more restricted sectors
- to define a strategy of Risk control financially and technically acceptable by the stakeholders (operating, local authorities, State, private individuals)

The analysis of the risk receptors is an essential phase. Competent authorities must elaborate several studies on the populations and the territory giving place to a cartography. From a synthesis of these studies, it will be possible to concentrate on the particularly vulnerable zones.

On the base of these elements a total strategy of risks control will be developed with an aim of controlling the evolution of the population exposed to the Risk. This phase will make it possible:

- to evoke the possibility of reducing the risk at the source,
- to examine the possible effects of a reduction of vulnerability on the buildings,
- and to consider to remove buildings from given sectors.

The strategy of risk reduction will be declined through measurements taken within the framework of the TRPP, but also within the territory project of transfer of public equipment.

Tools for land control :

In very serious hazards zone it is possible to delimit sectors of expropriation. In serious danger zone , sectors of renunciation can be given. On the whole of the TRPP, the local authorities have the possibility of exerting an urban right of pre-emption.

Expropriation:

Expropriation must be used in an exceptional way. The law states indeed that expropriation is not possible only if the measures for protection of the populations proved to be impossible or more expensive than acquisition. It is thus an ultimate recourse.

Expropriation requires in addition, after the approval of the TRPP, the signature of a convention between the plant operator, the local authorities and the State, as well as a declaration of utility easement for the benefit local community (municipality).

It should be noted that this expropriation will apply to the built properties, not with the public domain (inalienable). It is carried out in accordance with the French Code of expropriation.

The renunciation:

The renunciation is the possibility given to the owner of a building to put in residence the local authorities to acquire its good. It will be exerted in sectors delimited for this purpose within the framework of the TRPP.

The right of renunciation applies to the only built properties.

The right of pre-emption is exerted in the perimeter of exposure to the risk for a reason of risk reduction.

Constructive measures:

Constructive measures are another specific tool related to the TRPP. They are intended to defend oneself of dangerous effects (panes, adaptation of materials). These measurements will apply to the existing buildings and the new buildings. In addition, the reflections on this subject are in hand to identify the tools and the needs for future work.

3. Case studies to improve applicability

3.1 Justification of the experiments

The French approach was regarded as deterministic, maximalist, being based on the consequences of reference scenarios, which one considered only according to their intensity. The control of the risks was not sufficiently taken into account. The innovation of the law of 2003 is the introduction of the possibility of an action on what exists.

Since this law, the adopted step is intermediate, between determinism and probabilism. Several possible scenarios must be drawn up, that will be only analysed in terms of intensity but also in capacity of appearance (probability) and kinetics of development. The concept of danger zones is abandoned. The concept of Risk indeed implies the presence of a technological Risk but also of vulnerable stakes. The reasoning thus does not relate any more on danger zones, but to risks zones and levels of hazards, with various vulnerabilities of stakes.

The experiments were launched in 2004 to help the ministry for national and regional development and the environment in the drafting of texts on the subject like the decree for the TRPP. They were necessary because the law introduced new and/or complex concepts. The experiments were intended to help to write operational texts sticking to real situations. For this reason, the experimental TRPP do not profit from a single method.

The State has also wished to encourage a broad discussion, very upstream, with the various stakeholders of the real TRPP: industry, elected officials, associations of environmental protection. The objective was to facilitate making of the regulatory texts and a Technical guide bound for local competent authorities.

Eight experiments took place in 2004, in different industrial sectors, in two phases. The first phase covered the experiments having begun in the first half of 2004, with a strong assistance of the national steering committee. The objective was to test the method and the tools. The second phase started later, by taking account of the first results of the experiments of phase 1.

The eight experiments are to synthesise in following the table.

Table 2

Kind of site	Town	Firm	Characteristic of the experimentation
Petrochemical platform	*Notre Dame de Gravanchon (76)*	*Exxon Mobil*	*Relate to only one part of the installations*
Oil terminal	*Toulouse (31)*	*Esso*	*Real size*
Oil terminal	*Lorient (56)*	*Total*	*Real size*
LGP terminal	*Vire (14)*	*Butagaz*	*Real size*
LGP terminal	*Bollène (84)*	*Butagaz*	*Real size*
Chemical Site	*Mazingarbe (62)*	*Total et SAV*	*Real size*
Chemical Site	*Roussillon (38)*	*Rhodia*	*Real size*
Raffinage	*Fezin (69)*	*Total*	*Relate to only one part of the installations*

In the development of the **TRPP,** two phases were considered at the beginning: one is technical, the other commits of dialogue. During the Technical phase, it was envisaged to carry out in parallel the characterisation of the hazards and to analyse the risk receptor and their vulnerability. The superposition of these two characterisations was to give an idea of the zones of Risk and lawful zoning. The lawful project of zoning was then subjected to discussion with the associated parts to lead to a final draft.

3.2 Example of Mazingarbe.

The industrial complex of Mazingarbe is made up of two establishments. The first contains vinyl monochlorure, flammable **gas,** with an explosion risk. The second (the Grande Paroisse Firm) contains **ammonia,** whose risk is toxic. Both have storage zone and a discharge area. In addition we **find** other products which are toxic or explosive.

September 21, 2001, the company Grande Paroisse underwent the catastrophe of Toulouse following the explosion of a hangar containing off spec ammonium nitrates stored in bulk. As in Toulouse, the factory of Mazingarbe produces pure ammonium nitrate, for industry purpose. Following this catastrophe and in preamble with experimentation TRPP, it was set up an important plan of risk reduction. The first measure consisted in removing the storage in bulk of industrial ammonium nitrate. Since the end of 2001, these products are bagged with the wire of the production. 500 tons per day are conditioned. A new storage area of these products is in construction; it will be entirely concreted and completely enclosed. Storage will be split in small batches. The size of the batches and the distance are made to contain the possible **effects** of one explosion inside the site and to avoid a domino effect between batches.

This experimentation began in April 2004 and ended up in December 2004. The objective was to characterise the hazards goshawks of this site according to the new methodology and to characterise the associated stakes.

The classification of the risks was carried out by a semi-quantitative **approach,** called "Safety barriers approach". It was necessary to determine for each accident scenario the initial events (frequency of initial events classified from 1 to 6, 6 being the lowest sequence) and their barriers, with dimensions according to their Safety Integrity Level). By integrating the frequencies of initial events and the Safety Integrity Level by the means of a matrix, the authority has led to a characterisation of the hazards in the form of probability indices of major incident with dimensions from 1 to 7. It was considered various types of risks: thermies, toxic and overpressure. For each scenario, the various types of **effects** were evaluated and all initial events were studied. Vis-a-vis with these events, barriers are interposed, classified according to their reliability and their response time. That made it possible to reach indices of probability of accidents and to analyse coherence. It was then proposed to draw aside the scenarios characterised by an index 7 and presenting moreover one additional and independent barrier, not taken into account in the index.

The following figures show the hazards map of the case study :

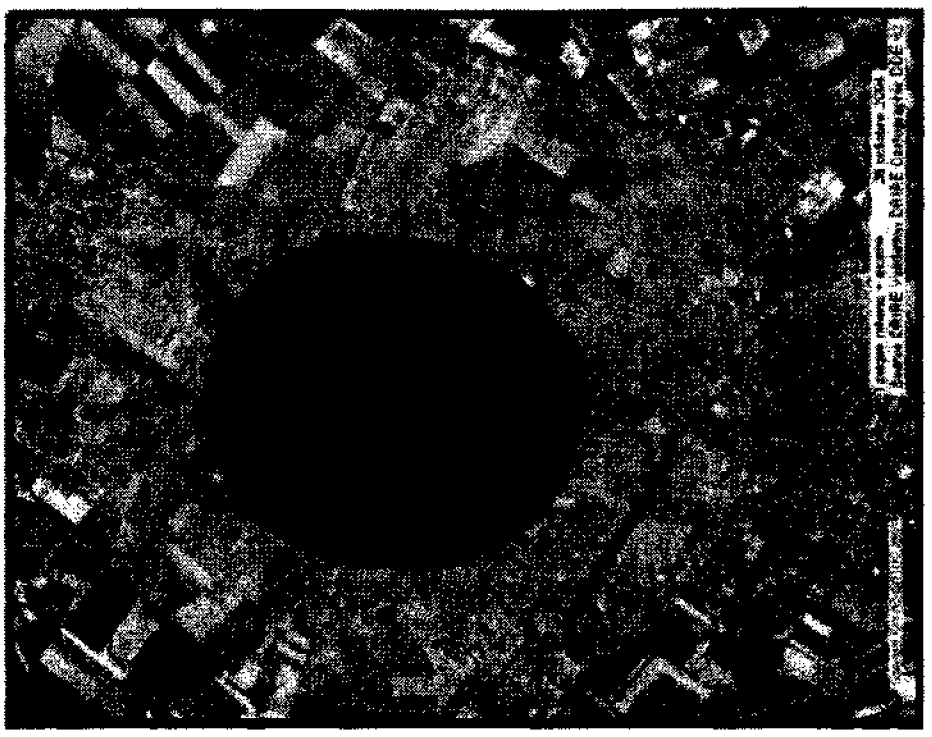

figure 3 : toxic **effect**generated in case of accidents (from the safety report)

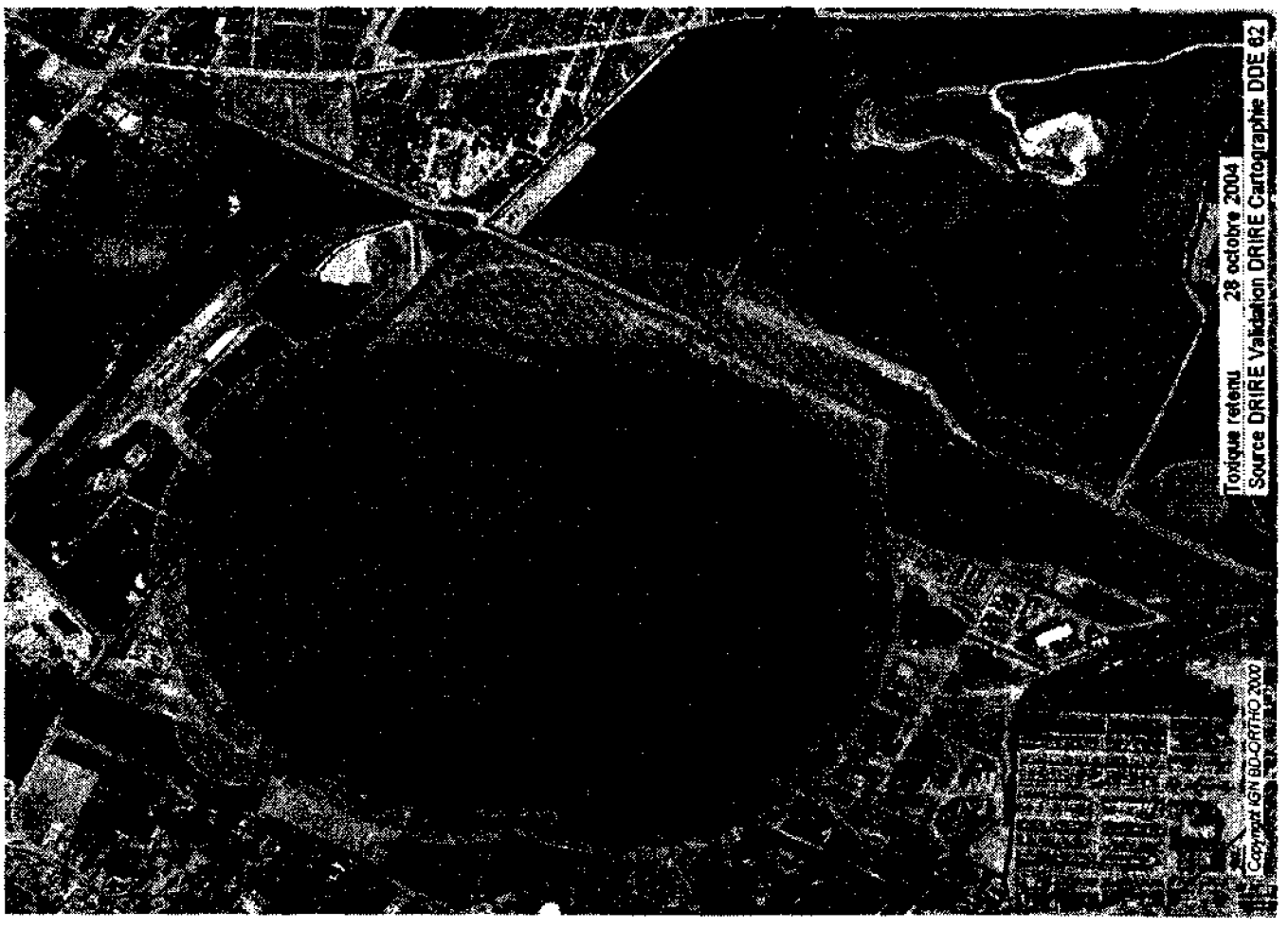

Figure 4 : toxic hazards considered for the experiments of the **TRPP**

Concerning risk receptors, the principal results of the experimental method were charted, by presenting the human stakes and the use operation of the territory. This method enabled the implication of each actor and a shared appropriation of the stakes of the territory.

The two following stages were the study of the vulnerability and the estimation of the costs of land and buildings.

About buildings, the vulnerability study was carried out considering a homogeneous type of residences. The principal results consist in determining built sectors having vocation to give place to expropriation and to renunciation. The study of vulnerability also continues on the infrastructures of general interest.

With regard to the estimation of the costs, the first provisional result is as follows: on the perimeter of risk retained at October 28 2004, 61 residences that need to be expropriated or renunciated represent a cost of about 5 to 7 millions Euros.

3.3 Major lessons learnt from case studies

The **TRPP** were created from the report of an insufficiency of the Land Use planning around the existing sites; they aimed at solving this coexistence between the risk sites and urban network. These plans act on three components:

- to examine the possibilities of the risk reduction,
- to set up constraints of public utility proportioned at the risk
- to reinforce constructions if the hazards or the vulnerability requires it
- **and,** in the most exposed sectors, to set up the rules for of renunciation and expropriation.

It seems essential to reduce the risks before considering the creation of the TRPP. That simplifies very much the discussions during of the TRPP.

To work out the TRPP, the administration must have the elements necessary in order to determine the relevant risk in terms of town planning.

It is thus essential to obtain a safety report, which provide the necessary **information,** in particular regarding the probability.

The experimentation also shown that it is in addition necessary to progress on the decision-making relates to the probability **criteria,** kinetics and intensity. The definition of acceptability becomes essential. The competent authority in France has prepared for several months a decree on the control of the risks. These rules will make enable the administration to give an opinion, whether the probabilities of accident are quantified or taken into account in a qualitative way.

Lastly, It is necessary to have industrial databases on safety barriers, frequency of occurrence of the initial events.

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