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Application of the Seveso Directive in France

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Abstract

First, the paper presents a brief summary of the French actual regulation on installations registered for the protection of the environment and covered by the Seveso I Directive. Then the paper discusses research and development needs for a sound implementation of the Directive, and for the new requirements on safety reports established by the Seveso II Directive. Further, it discusses issues connected with coverage of hazardous activities, learning from accidents, technical and organisational measures (safety management systems and emergency response) and human factors. The conclusions stress the need for networking and dissemination of accident investigations, development of safety management systems, and research on cognitive ergonomics and psychology related to the decision making and interventions of the operator.

Keywords: Seveso II Directive; Major accidents; Human factors; Emergency planning; Safety management systems

1. Introduction

In its mission of advice and support for the French Ministry for Environment (ME), Institut National de l'Environnement Industriel et des Risques (INERIS) has a long experience of the requirements and safety issues covered by the Seveso Directive, and more generally, in risk assessment related to dangerous substances. Even the earlier institutes, which merged in 1990 to create INERIS, were previously deeply involved in similar issues.

The following review concerns both technical problems not yet resolved and new technical and organisational ones arising with the Seveso II Directive, published in December 1996. First, it briefly describes the relevant French regulation, and then it

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analyses issues related to the requirements for safety reports as laid down in the Directive, namely:

- accident hazards and their coverage by the safety studies;
- research and development needs related to the safety studies;
  - scope of the safety report;
  - learning from accidents and incidents;
  - improvement of knowledge on physical/chemical phenomena and their effects;
  - technical preventive measures and mitigation of accident consequences;
  - safety management systems;
  - emergency planning and response;
  - human factors.

2. French regulatory frame

One can say that the Seveso I Directive (82/501/EEC) on major accident hazards of certain industrial activities was implemented in France without major modifications of the existing law. This was mainly due to the fact that the regulation related to the installations registered for the protection of the environment (July 19, 1976) encompassed already in its objectives the prevention of pollution and accidents, and included most of the Directive requirements in this matter.

This regulation, according to named substances (and qualifying quantities) and installations, required a number of 'études' (studies) being prepared by the operator to obtain an operating license. The number of installations submitted to the licensing procedure substantially exceeds the number of establishments covered by the Seveso II Directive. In addition to various data for the identification of the establishment (such as site maps, drawings, description of the facilities, etc.), an application for licensing must include:

- a safety study addressing accident hazards (*étude des dangers*);
- an impact study addressing chronic pollution aspects;
- a report on health and safety at the work place.

After a public inquiry, the studies are examined at local level with the assistance of the Direction Régionale de l'Industrie, de la Recherche et de l'Environnement (DRIRE); and, after completion of the whole procedure, an authorisation may be given to the operator of the establishment.

It should be pointed out that the Ministry Act 77-1133 of September 21, 1977 allowed an execution of a critical analysis of the safety study or a part thereof by an independent third party. The conclusions of such an analysis may imply modifications of the safety report if requested by DRIRE. A limited number of French and foreign organisations are accepted by the ME as experts in this area. INERIS and Institut de Protection et de Sûreté Nucléaire (IPSN) are two of them.

In the following, most of the discussions of technical issues are based on the lessons learnt from these analyses, but they are also based on results of experimental and modelling R&D projects, concerning physical phenomena (emission, fire and explosions), and of accident investigations. At INERIS, this work is mainly funded by the ME, or by contracts with industries and associations.

3. Accident hazards coverage by the safety studies

Does the Seveso II Directive have a scope large enough to cover all major industrial accidents? This is a question of prime importance. Major accidents may originate in industrial activities involving dangerous substances: then, the question can be transposed as 'Are all possibly dangerous substances covered? Is there a method for their characterisation?'

Investigations of French accidents record that only a small number of accidents occurred at 'Seveso' sites. This can be seen as the result of an efficient prevention policy of these accidents in France. The last major accident occurred at La Mède refinery in 1994, and resulted in four fatalities. Further analysis emphasises the fact that three very severe accidents (with about 10 fatalities and extensive damage) since 1982 did not involve substances covered by the Seveso I or II Directives. In fact, in two cases, grain dusts were involved (grain explosions in silos at Metz on 1982, and at Blaye on 1997); the third accident occurred in a zinc distillation plant. [1] Such figures may question the extension of the Seveso I list of dangerous substances, and warn against possible major accidents involving other substances and activities. This problem seems to exist also for the Seveso II approach, even if a larger variety of substances are taken into consideration by using generic criteria (i.e. classes of dangerous substances).

Thus, the French Law and this EC Directive are considering two different coverage policies. The application of the Seveso II Directive is restricted to a relatively low number of substance categories, essentially chemicals, which from experience were at the origin of accidents. The field of application of the Directive could also be further limited when harmonised criteria are agreed on the absence of major accident hazards in certain activities.

The French regulation includes naturally the full implementation of the Directive, but requires also safety reports for a larger number of substances (for instance, flammable solids) and makes reference to a larger number of installations. Its field of application is more extensive, and therefore, control is extended over a larger number of accident hazards, but it implies a more onerous task for industry and authorities.

There are two further considerations to be made.

(a) The EC Directive has its juridical basis in the articles of Maastricht treaty for the European Union which refer to the protection of environment (articles 130 R, S and T), and allow member states to apply 'more rigorous' environment protection criteria, than those stated by the Directive, and therefore a more wide-scoping legislation is not in conflict with the EU rules. Experience in member states can be valuable to improve commonality of regulation over time.

(b) The Seveso Directive is not the only EU legislation in safety matters. One should also consider Directives such as those on safety at work, and machinery safety, to provide a more complete picture.

[1] Information on major accidents is recorded in MARS (Major Accident Reporting System) of the European Commission, which is now a distributed database in each EU country (see the paper by Kirchsteiger in this issue, pp. 211–231) and/or other databases [1]. Analysis of accidents is an important tool both for improving prevention and mitigation, but also for improving regulation.

4. Research and development needs for the application of the Seveso II Directive

As mentioned previously, INERIS is running R&D projects funded by ME or private industrial companies. But also it has been involved in five projects funded by the EU shared cost action programmes (major technological hazards, STEP, Industrial Hazards in Framework Programmes 2 to 4) which allowed French organisations to cooperate with other European partners in a total of 17 projects. In eight cases, a French organisation acted as the main contractor. The distribution in the various sub-areas was as follows:

1. sociological and information issues (seven projects);
2. modelling and experimentation on phenomena and systems, including protective systems and dependability of computer control (nine);
3. uncertainties in risk assessment (one).

In these projects, only one was dealing with lessons learnt from accidents.

Based on the experience gained via such R&D programmes, and, with reference to the contents of the safety report as requested by the Seveso II Directive, a critical review will focus on learning from accidents and incidents, improvement of knowledge on phenomena and their consequences, technical preventive measures and mitigation of accident consequences, safety management systems, emergency planning and response, and major role of human factors.

4.1. Contents of the safety report

The experience gained with independent expertise on safety reports and accident investigations stresses the need for a detailed explanation of operating conditions, including outside supplies and utilities.

Indeed, many accidents emphasised that the operating procedures were not satisfactorily developed, a detailed analysis of the range of safe operating conditions for the system was absent, suitable instrumentation was lacking, redundancy of safety systems and dimensioning of safety measures were not given adequate consideration. By comparison, hazard sources and accidental scenarios usually received more attention.

In addition, the Seveso II Directive requires that a major accident prevention policy and safety management systems be adopted by the operator and described in the safety report. With respect to the French current practice, this aspect was not explicitly required by law, but the inspections were in practice often dealing with such aspects. Further development and improvement of present organisational measures will be necessary in France to put into operation safety management specially developed for the control of major accident hazards.

All these aspects, included now within the requirements of the Seveso II Directive, should be more extensively investigated in the safety report.

4.2. Learning from accidents and incidents

Article 14 of the Seveso II Directive is dealing with information to be supplied by the operator following a major accident, but does not insist on the importance of analysing

any significant incident (although some mention is made when discussing the safety management systems). Availability of a tool for collecting data and carrying out analyses at establishment level and drawing conclusions can increase the safety level of the plant. At the competent authority level, information on any significant accident must be made available to the commission and later included in an accident database. One such database (ARIA) is run in France under the supervision of the Bureau d'Analyse des Risques et Pollutions Industrielles (BARPI), a ME service. Reviews on accidents in a particular industrial field or involving particular substances are regularly published. BARPI exchanges also information collected within the OECD programme on accidents involving hazardous substances, and has a cooperation with the secretariat of the UN/ECE convention on transboundary effects of major accidents for defining an outline of accident notification report for further analyses.

Also other organisations have been active abroad for a long time in the area of accident data collection and analysis, and have organised the collected information in databases such as MHIDAS (UK) and FACTS (NL) available to the public. The ultimate objective should be the networking of these databases (and other existing ones) as a unique collection of data and the establishment of a sound framework for inputting and analysis of data. Under this respect, the working group 'Accident Analysis' [1] of the European Safety, Reliability and Data Association (ESReDA) has developed a directory of accident databases [2] and is currently working on a framework for design and operation of accident–incident databases which will address different aspects of data collecting and recording, and will insure quality of the data. It is also of primary importance to take into account the lessons learnt from the collection and analysis of data on major accidents in the database MARS, which should be a strong incentive to develop more proactive policies in this area.

All in all, these data are valuable for improving both technical safety measures and safety management systems.

4.3. Improvement of knowledge on physical phenomena, consequences and modelling

Although an important number of studies, either experimental or by modelling, have been carried out, uncertainties still remain in hazard analysis, source term, physical phenomena and especially their effects.

This is mainly related to the large number of possible hazard sources linked to operation, external events, security, and other causes related to design, construction and safety management. For example, all the possible interactions from lightning should be considered. The establishment and use of operational procedures is a well-known problem which is not necessary to discuss further, but the need to focus on the role of the operators, especially in emergency situations, should be pointed out.

As far as developments on the consequences of physical phenomena are concerned, in many instances, the overestimation of the consequences when using extrapolated experimental results or non-validated modelling can induce unnecessary economical constraints. This can both refer to equipment to be used, and to unnecessary extensions of endangered areas to be considered in land use planning decisions.

In this respect, phenomena implying two phase-flows and the possible formation of aerosols, fire development in confined areas, the nature and amount of fire fumes, the acute toxicity values after an accidental toxic release, the conditions for—and products released after—runaway reactions, need further research work.

The adoption of machines and equipment specially designed for use in conditions where phenomena such as fire, explosion, or emissions can occur is a means to limit major accident escalations and to mitigate their consequences. Under this respect, adequate standards must be applied at design stage for addressing essential safety requirements put by directives such as those on machines, equipment and protective systems intended for use in potentially explosive atmospheres, pressure equipment.... Such requirements for the main equipment should be extended to all relevant connected equipment in the plant, in line with the results of a risk assessment. In addition, harmonisation of these various requirements may imply a detailed comparison of existing standards, rules and codes of practice.

4.4. Technical prevention and mitigation measures

Article 9 of the Seveso II Directive requires that, after identification of major accident hazards, the necessary measures to prevent such accidents and to limit their consequences for man and environment must be taken.

A very large range of preventive and protective measures exist and include process monitoring and anomalies detection systems, which generally are parts of control systems such as Programmable Logic Controllers. These control systems should be designed to prevent failures and faults, which can trigger adverse effects on the overall safety of the plant. In particular, these are generally related to the surveillance of the safety functionality of the system when using ‘fault detection’. In general, more emphasis should be paid on the dependability of such systems, and to the development of harmonised validation procedures for safety relevant complex components, which are becoming of common use in machinery safety. The final objective is to make a complete plant as failure and fault resistant as possible, and thus incapable of triggering major accidents. Work on related standards is in progress.

Special attention [3] should also be paid to sensors, which must remain reliable and not negatively affected by rapidly changing environmental conditions when an accident occurs. Development of technical specifications for such sensors is a prerequisite, especially for those to be used in emergency situations.

4.5. Safety management systems

The Seveso II Directive insists on a Major Accident Prevention Policy and a safety management system (SMS) for implementation. SMS must be site-specific. This implementation implies the availability of a general system of reference, with a particular chapter devoted to the identification and evaluation of major accident hazards.

The French competent authorities (Inspectorate for Registered Installations) will face the need to control these systems, which has not until now been a current practice. A methodology is under development.

The development of a reference system [4], the structure of which being commensurate with similar existing systems such as quality management (ISO 9000-type) or environmental management (ISO 14001), is currently a controversial issue. Some operators argued in favour of such standards, while the position of stakeholders after discussion at ISO level was clearly against such a development. Our analysis of annex III of the Seveso II Directive emphasised the fact that the issues to be addressed are very similar to those of existing abovementioned management systems, but a precise approach and a methodological development is not given. Seveso II SMSs should be put into operation on the basis of pilot experiences to be undertaken in various establishments, with a further comparison of results. A similar testing seems likely also to be adopted by the Technical Working Group set up by the European Commission on this issue.

4.6. Emergency planning and response

The on-site planning is referred to when dealing with safety management systems, and the off-site planning is given an increased importance in the relevant articles of the Seveso II Directive.

In fact, whatever the efficacy of the prevention measures identified via the risk assessment and of the SMS adopted could be, the possibility of a major accident remains and imposes the need for an emergency plan providing adequate procedures and logistics [5]. Lessons from training carried out in various establishments for simulated emergencies or responses in real emergency situations showed the need to get a better understanding of early diagnosis, procedures to be followed, protective means for population to be chosen, post-accident measures for population and environment (especially water and soil).

Thus, in France, accidents resulting in emission in air after a toxic liquid release (e.g. ammonia), release of fire fumes (fertilizer fire at Nantes in 1987), releases of water polluted by fire by-products (accident in 1985 near Tours, and at Sandoz, Bale, on 1987) emphasized the importance of a strategy to be applied for confinement to mitigate accidental releases, for decisions on evacuation or sheltering of population, and for logistics for emergency rescuers.

4.7. Human factors

In the previous paragraphs, procedures, safety management systems and emergency responses were discussed. In each case, the central role of any person concerned, either a staff operator or a member of an emergency body, or a person responsible for decision-making and actions, is paramount.

Any safety policy requires the application of pre-established rules at design, operation and emergency response stages, but often, limited attention is paid to the need of training operators to diagnose a sequence of events which could be unusual and out of the scope of normal operation. Another aspect is important: the selection of operators whose cognitive abilities can allow them to intervene in the right way under circumstances not sufficiently covered by the procedures.

Such problems were largely debated in a recent OECD workshop [6], where recommendations were given on the need for further research on operator perception connected to normal, abnormal and emergency situations.

As an example, in a research project under progress [7] using cognitive ergonomics methods, operators were interviewed about their perception of an emergency situation. From their answers, even when very detailed procedures did exist, important insights were gained on factors such as the moment for triggering an emergency, phenomena and hazardous situations to be taken into account, etc. Finally, an emergency situation was characterised by three main concepts:

- having a perception of the limited time span useful for action;
- identifying the necessity for decision making or action;
- avoidance of unwanted consequences of lack of a decision or an action.

The consideration of these notions emphasises again the need for better training programmes, including the use of simulators and re-examination of procedures to be used. All these aspects should be introduced at an early stage in the curricula of graduates, especially in chemical engineering.

5. Conclusions

The Seveso II Directive represents an important step forward for a minimisation of the risk of major accidents and will induce in France significant development work on safety management systems.

Learning from detailed investigations of accidents can improve plant safety level if information is widely disseminated. In this respect, the MARS tool, in which accidents are collected and analysed, should be extended to allow more in-depth investigation of a larger number of accidents and incidents, especially when direct or indirect effects on man are feared. A networking of existing public databases should be promoted so that relevant information be available to improve safety.

Research and development are still needed on accident phenomena, technical preventive and mitigation measures, safety management systems, and, especially, on human factors in their cognitive ergonomics and psychology aspects.

References

[1] J.P. Pineau, Development and use of a directory of accident databases involving chemicals. Proceedings of the ESREL'97, International Conference on Safety and Reliability, Vol. 3, Lisbon, Portugal (June 17–20, 1997) pp. 1841–1846.

[2] J.P. Pineau (Ed.), Directory of Accident Databases, ESREDA Safety Series, ISBN 92-9/74-000-4, European Safety, Reliability and Data Association (1997).

[3] A. Accorsi, D. Gaston, J.P. Pineau, P. Villeneuve de Janti, Reliability of data and dependability of atmospheric sensors in accident situations on a petrochemicals site, Oslo, Conference on International Aspects of Emergency Management and Environmental Technology, Norway (June 18–21, 1995).

[4] W.K. Thomas, W. Stimson, Using ISO 14001 to comply with the management system: requirements of the US EPA's RMP rule and the EU's Seveso II Directive, European Environmental Law Review (December 1997) pp. 337–343.
[5] Control of urban development around high risk industrial sites: a guide, Secretary of State to the Prime Minister for the Environment and the Prevention of Major Technological and Natural Risks—DEPPR—Industrial Environment Department (October 1990).
[6] B. Cadet, J.P. Pineau, L. Pioche, Perception par les opérateurs des situations d'urgence en raffinerie, OECD Workshop on Human Performance in Chemical Process Safety, Munich (24–27 June 1997).
[7] L. Pioche, J.P. Pineau, B. Cadet, Perception of an emergency situation by operators at an oil refinery, ESREL 98', European Safety and Reliability Conference (16–19 June 1998) Trondheim, Norway.