Preface

Safety and risk analysis is a topic of growing interest in the European process industry and in most of the issues of the Journal of Hazardous Materials it has been discussed in single articles. However, because of this growing interest and the importance of the subject, the Journal has decided to dedicate a special issue to safety and risk analysis

The aim of this special issue is to give an overview of the state of the art in both the practice of safety and risk analysis in the process industries, and in current research and development in this field. This issue also includes experiences, both positive results as well as limitations aimed in promoting the proper use of safety and risk analysis in the European process industries. Positive results illustrate the advantages that can be obtained by the timely and qualified use of safety and risk analysis. The limitations presented are those which should be considered when defining the objectives of an analysis and when interpreting its results. The limitations also represent challenges for the future and form the basis for further research.

Safety and risk analysis was first used in rail transport, aviation, space technology, and nuclear engineering. Subsequently, its use widened to other areas, primarily in the process industries. The main part of this special issue is devoted to the analysis, assessment, management, and communication of major hazards in the process industries; one article is included presenting experience gained in the nuclear industry.

This issue includes both reviews of certain topics in safety and risk analysis and results from recently completed studies. While European experiences and results are emphasized, three papers also describe experience gained in the U.S.A.

Most safety and risk analyses carried out in the process industries to date have been of a qualitative nature. Usually, such qualitative results form the basis for planning preventative and mitigating measures. Sometimes, however, some of the preventative measures become so expensive that there is a need for a quantitative assessment of their effectiveness before making final decisions. In some countries, quantitative reference values have been defined, either mandatory or as guidelines, for the tolerability of chemical risks.

Many of the articles in this special issue deal with quantification of chemical risks. In the nuclear industry, quantitative risk assessment, usually called Probabilistic Risk Assessment (PRA) or Probabilistic Safety Assessment (PSA), has been used extensively. These experiences are presented in one paper. Despite the differences between quantitative risk assessment in the nu-

clear and in the chemical industries, there are always some experiences that are applicable to both.

Safety and risk analysis includes many sources of uncertainty. These have been studied in a European benchmark exercise in which eleven teams carried out a quantitative risk assessment of the same ammonia storage installation. The use of a common installation allowed comparison of the different methods and models, as well as the assumptions used by the different teams. By analysing a common installation, the teams were able to avoid mutual confidentiality problems and could engage in detailed discussions of practical risk assessment. The results of this exercise and the lessons learned are presented in an article of this issue. A second European benchmark exercise on major hazard analysis is currently in preparation.

The quality of component failure data is often a serious problem in the estimation of accident frequencies, and in the reliability and availability of the protective systems for chemical installations. The large number of different components and chemical substances, the variations in operating conditions, and the need for resources has resulted in a situation where only small amounts of component data are publicly available. This is an area where international cooperation and jointly coordinated projects are needed.

A few techniques exist, however, which have been developed to improve the usefulness of existing data, and knowledge of component failures and their failure mechanisms. Structured expert judgement is a technique which has recently been studied both in chemical and in space technology. One article illustrates this technique and shows examples of results obtained.

Toxicity of chemical substances is another major problem in quantitative risk assessment. Much information exists on the toxicity of low concentrations over a long period (usually a working day). This information, however, cannot be used in the assessment of acute toxicity of high concentrations of chemical releases. Two papers in this special issue are devoted to this area: the first describes and evaluates the different sources of toxicity information based on past chemical accidents; the second proposes a new method for simplified assessment of the consequences of toxic releases. The method is based on a "fatality index" approach.

Assessment of the consequences of chemical releases can give valuable support to process design during the feasibility study of a plant. Options for plant location, layout, and major process units can be compared before preliminary selection. Two examples of the use of consequence assessment during feasibility studies are presented in one paper.

Safety and risk analysis requires considerable resources and expertise. Such studies often have to be performed rapidly in order to give timely support to the design and construction of new process installations. Several types of computer aids have been developed to speed up the analyses and to reduce the need for human resources. The first applications have concerned the mathematical

calculations needed in gas release and dispersion modelling, and in the assessment of reliability and availability. More recently, computer aids have been developed to support the documentation of analyses. Such aids have been developed, for example, to support the documentation of HAZOP-studies and FMEAs, as well as the drawing of fault trees. The development of knowledge engineering and expert systems has also produced new challenges to safety and risk analyses. One of the articles gives an overview of computer aids developed for hazard identification and accident modelling, with particular reference to an ongoing international project, where an advanced support for the interactive safety analysis of process systems is being developed.

Safety and risk analyses have frequently been performed for a company's own needs, to support the design of a new installation or for the safety management of an existing facility. However, as the Seveso directive is adopted throughout Europe, an increasing number of studies are being performed for the public authorities. Public interest in process and environmental safety is increasing worldwide. This is setting new requirements for chemical companies to communicate the risks involved and the measures taken to control these risks. In the U.S.A. the "Emergency Planning and Community Right to Know Act" is an example of this development. In the nuclear industry many efforts have been used to communicate the safety of the technology to the public, often with little success. We should investigate the lessons learned in the nuclear industry and try to develop better methods of communication to the public. The last article of this special issue is devoted to the communication of major hazards to the public.

In the field of safety and risk analysis there are many ongoing research projects and programmes, only some of these activities can be presented in a single special issue. In this context, I would also like to refer to two areas not covered in this issue, although they have been reported earlier. Recently, a review was published in the *Journal of Loss Prevention* (Vol. 4, No. 1, 1991) on the modelling of source terms, which is a most important topic in the assessment of the consequences of chemical releases. Two reviews of the computer aids developed for the modelling of gas dispersion and consequence assessment were also published in the *Journal of Hazardous Materials* (Vol. 26, 1991) and in the *Journal of Loss Prevention* (Vol. 4, No. 3, 1991).

This editorial is limited to a discussion of the topics covered in this issue and to presenting some of the reasons behind the inclusion of these topics. A more comprehensive review of the problems and future trends of safety and risk analysis has been presented in a previous issue of the *Journal of Hazardous Materials* (Vol. 21, 1989) by myself and Mrs. Kakko.

There are, of course, many other excellent articles and these here are offered to the readers simply as examples of supplementary information sources.

Finally, I want to express my thanks to the *Journal of Hazardous Materials* for giving me the opportunity to plan this special issue, and to the authors of

the issue for preparing such high quality papers which, I hope, will contribute to the worldwide progress of process and environment safety.

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