

PROMOTING PROCESS SAFETY IN THE FINNISH PROCESS INDUSTRY

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A research programme to promote process safety is being prepared in Finland. The goal is to improve process safety by combining the expertise and resources of major companies, authorities and research institutes. One concern is with small and medium-sized enterprises. The aim is to reduce the number of accidents, and the losses caused by them, and to improve the working environment in the process industry. The programme will also generate material suitable for training employees. For the programme, a survey looking into the safety-related needs within the process industry was carried out. During the winter of 1998/99, 52 representatives from the process industry, various authorities and research institutes were interviewed. The identified needs dealt with, for instance, knowledge management, human and organisational performance, safety in process plant design and construction, and ensuring safety in multi-company sites and production networks. The results and conclusions of the survey are presented in this paper.

Keywords: safety-related needs, risk management, survey results, research programme

INTRODUCTION

In global markets the process industry needs to be efficient, flexible and reliable. Market shares and the prices of raw materials, as well as products, vary a lot in time, which means continuing changes in the process industry. To follow up the markets and to stay profitable, companies need to develop their operations and find new products and processes for the future. This means, for instance, outsourcing the operations that are out of the companies' areas of expertise, extending the utilisation of expert-nets, and increasing the use of new technologies, e.g. information technology. All of this also affects the operations of the company and its safety.

The Finnish process industry is quite heterogeneous in the sense of safety management. Some companies have done safety work for a long time while others are just starting to realise its importance. But the best Finnish companies are still behind the best ones in Europe when comparing the accident frequencies and the numbers of the lost working days. Some of the differences can be explained by the different ways used to collect the statistics, but it can not be the only reason. The situation demands closer co-operation between companies, researchers and authorities, and this was the goal of the work presented in this paper.

THE STRUCTURE OF THE SURVEY

In order to improve process safety in the Finnish process industry, the safety-related needs and problems first needed to be surveyed and analysed¹. During the winter of 1998/99, VTT Automation interviewed 52 representatives from the process industry, various authorities and research institutes. The selected companies covered a broad section of the process industry and related services including, for instance, the chemical industry, the pulp and paper industry, the metal industry, the food industry, and also automation, and machinery and maintenance services. The interviews were mainly completed in groups, while some were done by interviewing one person at a time. The groups contained professionals from the areas of safety, production, maintenance, design, research, etc. In this way, the interview also

promoted discussion within the company. The interviewees were asked about their company's goals and their identified needs, especially with regards to the following questions:

- How do you manage risks?
- Which risk management tools do you use?
- How does risk management affect your decision-making?
- How do you manage technical and organisational changes?
- How do you manage knowledge?
- How do you manage risks in multi-company sites and in production networks?
- How do you manage safety responsibilities in your production environment?
- What challenges do you see in the future with regard to process safety?
- Is safety a critical asset in the competition for market shares?

Based on the results of the interviews a workshop was held in October 1999. During the workshop, the 74 participants were divided into six groups, where they further discussed those problems and targets for development identified from the survey. These discussions formed the basis for the project ideas that were prepared in four groups during the spring of 2000². The project ideas were presented in another workshop held in September 2000.

ANALYSES OF THE INTERVIEWS

The safety-related research and development needs in the Finnish process industry were determined on the basis of the interviews. Figure 1 outlines the demands created by the changes in the production environment and the continuous technical development. Similar demands were noted by several companies, and by the authorities. Solutions are most effectively found by combining the expertise and resources of major companies, authorities and research institutes in joint projects.

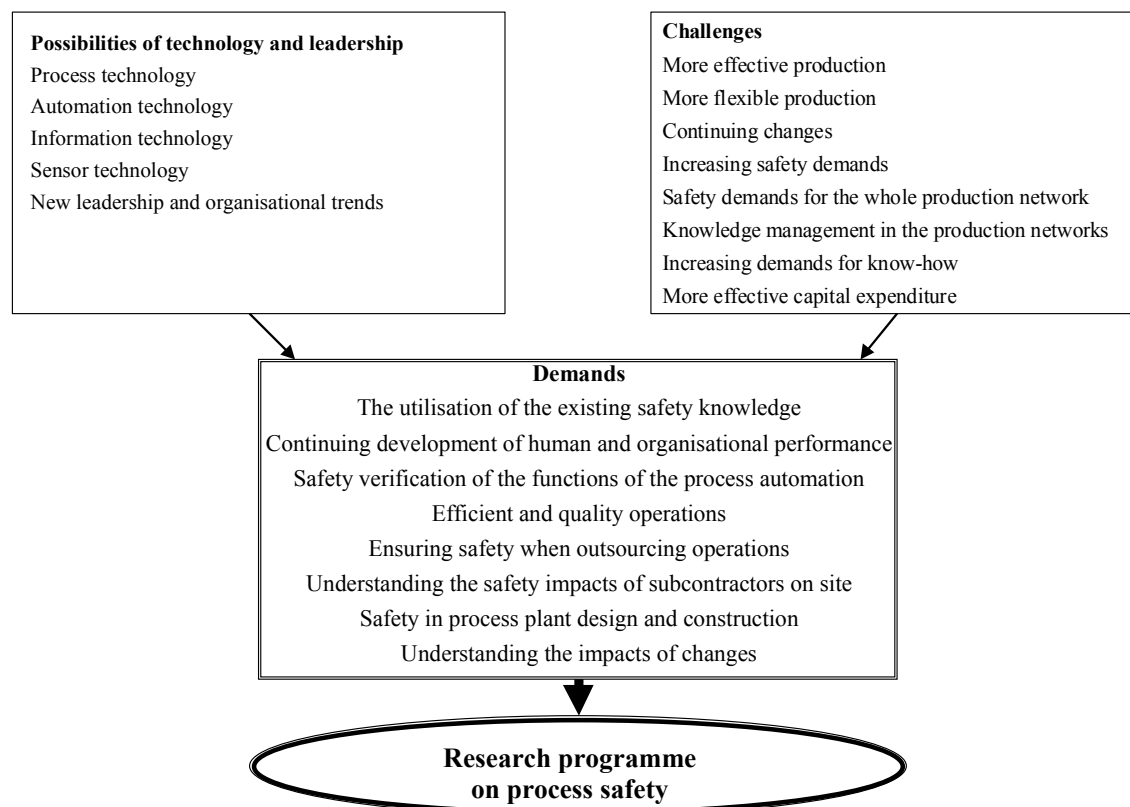


Figure 1. The safety-related research and development needs in Finnish process industry.

For some companies, safety is mentioned as a critical asset in the competition of market shares. Accidents or unsafe products are not good publicity in global markets. On the other hand, customers won't pay more for safety, which is perceived as a natural qualification of a product. But safety is also an economically critical asset. Accidents and breakdowns cause production breaks or may even shut down the factory. Also, the rebuilding of the good company image and new customer relations takes time and money.

SAFETY-RELATED NEEDS IN THE FINNISH PROCESS INDUSTRY

Analysis of the interviews revealed that most of the uncertainty and the identified needs fall into six groups (Figure 2). It was also noticed that some companies are much further advanced with regard to their perception of safety, and thus, the identified needs deal with every level from basic safety analysis to high-performance safety systems.

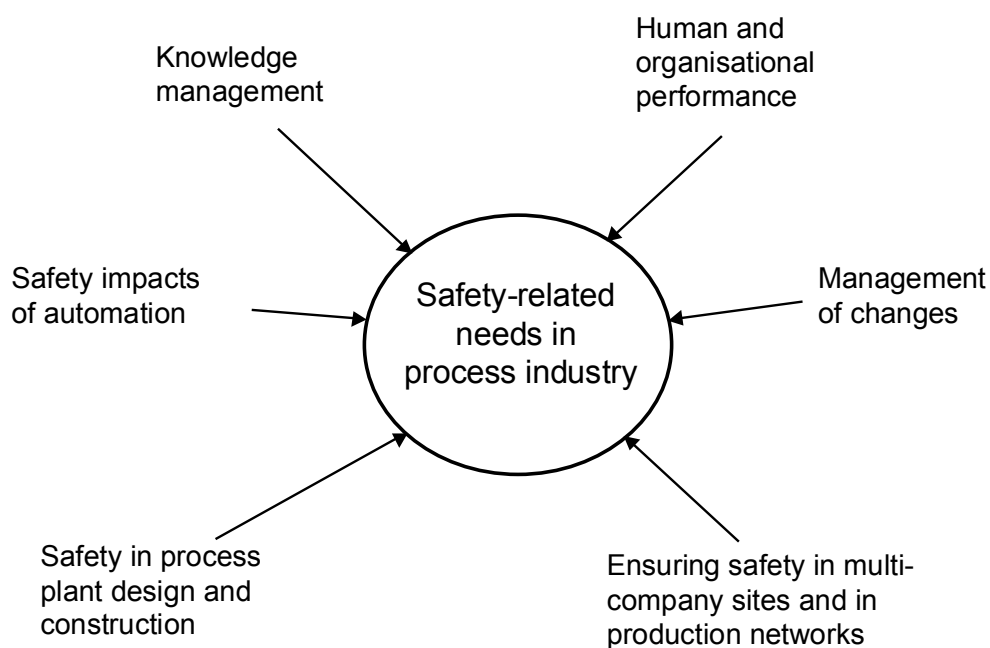


Figure 2. The grouping of the safety-related needs in the Finnish process industry.

KNOWLEDGE MANAGEMENT

There is lot of safety-related information available both within, and from outside the companies. The information contains, for instance, detailed knowledge about process solutions, chemical properties and malfunctions. The main problem concerns the efficient utilisation of that knowledge. It was generally felt that safety information is hard to find, but in reality people don't even know that the information exists and so they don't ask for it.

Inside companies, information about malfunctions, near-misses and even accidents almost certainly exists. Safety reports and the results of safety analyses also contain important data. But the problem is how to ensure the information flow between, for instance, shifts. Methods for collecting and arranging the information, in an easy to use form, are needed and better documentation procedures and guidance for the utilisation of the data would be good starting points.

Learning from errors is an effective way to promote safety. Databanks on accidents and other hazardous situations, for example, already exist^{3,4,5,6}. Valuable safety-related information may also be found in the inspection reports made by authorities, e.g. according to

the Seveso II Directive⁷, and auditing reports made inside the company or by an outsider. But the utilisation of the data and the follow-up of the suggested actions require specific company procedures.

Communication problems and misunderstandings can lead to hazardous situations arising within companies. Terminological differences especially, for example, arise between employees and management, between shifts, and between process workers and safety professionals. A common routine for handling safety issues could even improve the communication within a company and therefore promote safety.

At the moment, many companies have similar systems in place for safety, environmental and quality management. This not only means extra work, but also increases the chance for misunderstandings. A way to combine safety, environmental and quality evaluations may prove to be beneficial. One solution might be the integration of these management systems – perhaps even also including economical aspects in the same system.

HUMAN AND ORGANISATIONAL PERFORMANCE

Human and organisational performance is an important part of many companies' policies, and safety management is needed on an everyday basis. A procedure for handling safety issues should exist within the steering committee and weekly meetings, and guidelines for these routines are required.

Safety targets should be determined together with the employees as part of safety management, and the evaluation and the follow-up of the results needs to be improved. While already quite good, positive evaluation methods are especially being sought, and the evaluation of any actions made to promote safety also still needs to be further developed. Currently, also the terminology used in the existing evaluation methods is not familiar to all the employees.

Many companies lack the means to ensure that the safety rules and instructions are obeyed. The employees often have their old ways of doing things, and these habits are not always the safest, but changing those old routines may be difficult. Obeying rules means that one understands their meaning, and it has been observed that an obvious risk to one's own life or health will encourage the obeying of rules – nobody would light a cigarette in a solvent store, but sawdust fires often start from burning cigarettes. It is also a matter of communication between the management and the employees. A positive attitude towards safety and safer routines is needed at all levels in the organisation. As a result of these needs, a project to model the safety performance in the companies – in order to find the most suitable practices for the Finnish process industry – has been started.

One concern is in the small and medium-sized enterprises, which often lack the knowledge, resources and money to create their own safety culture. Tools for them have been developed, such as the PK-RH Toolkit⁸, but the implementation, acceptance, education in, and use of those tools requires time. Several SMEs may even be able to use, for example, a collective safety manager as a consultant. If so, more suitable tools for that collective safety manager need to be developed.

SAFETY IMPACTS OF AUTOMATION

In the production process, automation is used for both operational and safety purposes. Some experts in the process industry, however, have concerns about the reliability of automation systems during abnormal conditions. One reason might be that the structure of the automation systems is not familiar to those working at that production level. On the other hand, process automation has distanced the operators from the process itself, and so the operators do not

necessarily recognise serious malfunctions in time or they do not know the correct actions to take when something goes wrong.

The reliability of automation systems in all situations demands good co-operation between the process and automation designers. Correct and detailed definitions are the basis of a reliable automation system, and the client is required to demonstrate an understanding of the process itself. The operators also need to understand how both the process and the automation systems function, and this creates even more demands on the system designers.

The safety and reliability of automation systems also depend on the components and the equipment used. For so-called economical reasons, the automation projects are often divided into smaller units which are then delivered by several different suppliers. This creates barriers between different system units which, without the proper supervision, can then also cause safety problems. For short-term economic reasons the system components are often bought where they are cheapest without guaranteeing that they work together as expected. This increases the uncertainty of the automation systems.

Projects dealing with, for example, too many alarms at the same time, more informative and functional screens for operators, and methods to evaluate the reliability and safety effects of automation systems are under preparation.

SAFETY IN PROCESS PLANT DESIGN AND CONSTRUCTION

The basis of process safety is created in the process development and design stages. Mistakes and safety defaults carried over from the process development and design often show up as problems in the production. To identify the risks in advance, safety evaluation methods such as reaction and compatibility matrices⁹, the Dow Index¹⁰, and Hazop studies¹¹ are used. Methods that show the client that the safety aspects have been integrated into the design could also be useful.

Safety aspects should be considered as early in the design process as possible. Modifications made in the early stages of process design are more effective and less costly than those required later in the process design, or even during construction or operation. The development of inherently safer processes and their evaluation methods were also considered to be important, and the process industry is especially interested in inherently safer process solutions for today's processes.

The current research and development needs in the process industry often concern batch processes and their safety issues. More details of fire and explosion risks are also needed, and some companies are especially interested in ensuring safety on pilot plants.

Experience is very important when designing and building process plants. Unfortunately, in many cases the desired information is not available during the design phase of the project. Systematic methods to collect and find the information needed in the different stages of process development and design projects, and recording the information in databases might be the solution, and some databases and methods are already under development.

MANAGEMENT OF CHANGES

Both technical and organisational changes occur rapidly in today's process industry. The changes put pressure on the safety management, and guidelines to manage those changes are needed.

Technical changes are mostly done on operating plants, and as minor changes are not always documented, dangerous situations may arise later during operation and maintenance. Systematic documentation practises could help prevent these types of incidents. Major technical changes need proper planning and safety considerations in advance. The need for technical changes obviously increases in ageing plants, and therefore it is especially important

to recognise the critical pieces of equipment. Simple evaluation methods need to be developed.

Organisational changes need to be managed well in order to ensure that employees can adjust themselves to the new situation. Uncertainty amongst the employees may result in a hazardous situation arising due to a lapse in concentration. Especially the ways to implement these changes, however, need development. A step-by-step plan on how to carry out the changes, and document and inform about them, is needed. A lack of knowledge only causes uncertainty and rumours among the employees. Also, too often, there is no follow-up of changes and their results.

Changes often occur rather fast in the process industry and this creates demands on the education of the personnel. Many new technical issues need to be included in the training programmes at all levels and, unfortunately, this often means that fewer hours remain for safety, health and environmental issues. The lack of safety education also decreases the level of process safety in the industry. One goal of the forthcoming research programme, therefore, will be to affect the training programmes and to generate material suitable for the training of employees and graduates.

SAFETY IN MULTI-COMPANY SITES AND IN PRODUCTION NETWORKS

In the light of international competition, the process industry is concentrating on its main expertise areas. Many companies are now outsourcing, for example, the maintenance and the production of oxygen, steam and other goods. The workers coming from outside the factory, however, do not necessarily know the process at hand, and thus do not know the associated risks and how to behave in potentially dangerous situations. Also, several subcontractors with different safety protocols may be working on the site at the same time, making it an even more demanding task to manage safety.

In the process industry, it has become a recent trend to merge companies or sell parts of them. As a result there are often several independent units working on the same site. The workers from different companies may even use the same equipment, while the units themselves may have different ways to handle, for instance, the associated safety issues. It may even be that safety managers are not even located on the site. This raises questions about who is responsible and in charge of the safety issues. Several projects dealing with safety issues in production networks have been ongoing in Finland. While bigger companies have their own ways to ensure safety when using subcontractors, both the process industry and contractors would appreciate a uniform way of handling safety issues. There have even been discussions about safety passes or such an equivalent, while national tests for graduates of all educational levels have also been mentioned.

RESEARCH PROGRAMME ON PROCESS SAFETY

The results of the survey¹ during the winter of 1998/99, and the project planning² in the spring of 2000, clearly showed that a national research programme on process safety could be beneficial for all parties involved. This will be the first in-depth research programme covering the entire field of process safety. By combining the expertise and resources of the process industry, authorities and research institutes, the goal of the research programme will be effectively achieved. Small and medium-sized enterprises, which do not have sufficient knowledge and resources to manage safety issues by themselves, will also benefit.

The goal of the 3-year research programme is to reduce the number of accidents, and the losses caused by them, and to improve the working environment in the process industry. The concrete aims of the programme are to:

- achieve zero fatalities,
 - halve the number of accidents,
 - halve the number of accidental releases to the environment, and
 - eliminate the added expenses due to accidents,
- in the Finnish process industry.

The aims are meant to be achieved both in the individual companies participating in the programme, and in the process industry as a whole. The research programme also ensures that safety information and new inventions will reach the entire process industry.

At this point the safety-related needs have been surveyed from the process industry's point of view. To achieve the goal of this research programme the entire process safety field must be covered, and therefore the research field needs to be examined more scientifically. New themes in the programme could be, for instance, the bench-marking of Finnish companies, the management of acute environmental risks in the process industry, the risk evaluation of bio- and gene technology, and the wider use of information technology for ensuring safety.

CONCLUSIONS

During this work it was observed that the safety-related problems in many different fields of the process industry are quite the same, but the level of safety management differs between individual companies. Some have done safety work for decades while others are just beginning to realise the importance of safety management. At the same time, the safety-related problems are from the whole range of process safety – from human behaviour to technical solutions – and the solutions come from different fields of science.

To improve process safety in the Finnish process industry, the best way is to combine the expertise of the companies, researchers and authorities, like in a research programme. The best solutions can be found and tested for use in the entire process industry, and in the other fields of industry too. When problems are solved together all parties make savings with regards to the resources – and especially financially. To avoid repeating work, existing safety research must be investigated. For many of the safety issues that arose in this survey, solutions may also be found from outside Finland, but most of those would then probably need to be modified for the Finnish working environment. In any case, the main target is to improve process safety at all levels of the Finnish process industry.

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REFERENCES

1. Heikkilä, A-M., 1999, *The safety-related needs within the Finnish process industry* (in Finnish), VTT Automation, Tampere, 46p.
2. Heikkilä, A-M., 2000, *The safety-related needs within the Finnish process industry – the project preparation in workshops* (in Finnish), VTT Automation, Tampere, 38p.
3. Institution of Chemical Engineers, *The Accident Database*, <http://www.icheme.org/shop/> (April 3, 2001).
4. American Institute of Chemical Engineers, *The CCPS Process Safety Incident Database*, <http://www.aiche.org/ccps/ldb.htm> (April 3, 2001).
5. Safety Technology Authority, *The VARO accident database* (in Finnish), <http://www.tukes.fi/> (April 3, 2001).

6. Major Accident Hazards Bureau, *Major Accident Reporting System (MARS)*, <http://mahbsrv.jrc.it/mars/> (April 3, 2001).
7. *Seveso II Directive*, 96/082/EEC.
8. *Risk Management for SME*, <http://www.vtt.fi/rm/projects/pk-rh/eng/> (April 3, 2001).
9. Lees, F.P., 1996, *Loss Prevention in the Process Industries*, 2nd Ed., Butterworth-Heinemann, Oxford.
10. Dow Chemical Company, 1994, *DOW's Fire & Explosion Index Hazard Classification Guide*, 7th Ed., American Institute of Chemical Engineers, New York.
11. Kletz, T.A., 1999, *HAZOP and HAZAN - Identifying and Assessing Process Industry Hazards*, 4th Ed., IChemE, Rugby.