Safety, health and environment in small process plants – results from a European survey

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ABSTRACT

The handling of safety, health and environmental (SHE) issues in small process plants has been addressed in the European project SPASE. In this paper, results from a questionnaire to small process plants in five countries are presented. The response rate was low, and the greatest difference between countries was not found in the information obtained, but in the frequency of responses. Therefore the results have to be interpreted with caution. The companies' attitude to SHE issues was positive, and most companies declared that they had adequate resources for the work with SHE related matters. The findings do not support the common view that problems with SHE issues are related to the size of the companies. The "average" small company in this study does not seem to have much problems with their SHE work. However, the small percentage of the companies, which do have some problems, represents a large number and may constitute an unacceptable risk. It is suggested that the societal strategies for improving SHE performance in small plants should not be so focused on the "average" companies, but more on the companies with problems.

Keywords: Chemical plant, performance, questionnaire, safety, small companies

INTRODUCTION

From a political and financial point of view, the importance of small companies is becoming more and more noticeable. They constitute the majority of companies and they provide employment for a large part of the working population. Therefore the importance of health and safety in small companies is also large (e.g. Mikheev, 1998).

Various definitions exist for what a "small company" really is. One term often used is "small and medium-sized enterprise" (SME). Most often a "small company" only refers to the size in terms of employees, and 250, 100 and 50 are common numbers used. One formal definition of SMEs is: companies with less than 500 employees, a turnover of less than 38 million ECU, and not more than 1/3 owned by an organisation larger than an SME, if not a financial investor, e.g. a bank (European Commission, 1995).

Problems with small plants

In an OECD report (1995), it was concluded that *"there is very limited statistical information on the extent to which small and medium-sized enterprises (SMEs) manufacture, use, handle or store quantities of hazardous substances sufficient to create a risk of significant accidents, and on whether such SMEs have experienced a disproportionate number of accidents".* There was recognition, however, that *"SMEs are less likely to have the same access to information, expertise, and other resources related to chemical safety available to larger companies".*

This is a serious problem, as SMEs are a major component of the European chemical industry. In areas such as paints, cosmetics, and fine chemicals, they dominate (CEFIC, 1995). The number of plants with less than 100 employees was about 30 000 in 1990 and of these, about 25 000 had fewer than 20 employees. These plants accounted for around 20% of industry turnover – about 58 thousand million ECU per year (European Commission, 1994).

As small process plants represent a very large number of units, there may be a problem for authorities and other actors to reach them with, for example, information. Also, outside the chemical industry, there are many workplaces that handle hazardous chemicals in considerable amounts. The issues in this study are thus concerned with an even larger part of industry; however, no estimates have been made of its size.

The SPASE project

The great importance of the small process plants and their possible problems was the motive behind the European SPASE project *"Small Plants – Assistance with Safety and Environment",* which was co-sponsored by the Commission of the European Community. The project was carried out by a consortium of partners from Finland, Germany, Italy, Sweden and the United Kingdom.

The major aim of SPASE was to develop a tool to facilitate the handling of SHE issues in small plants. The tool should take into consideration and focus on the actual needs of the small plants, especially concerning chemical accidents. To obtain a better background knowledge for developing the tool, information about small process plants was collected from various sources.

This work has been reported by Whetton and Schabel (1997). The report includes data from:

- a questionnaire distributed to small plants handling, processing or storing hazardous chemicals in the participating countries,

- interviews with regulatory authorities and insurance companies within the same states,

- a review of relevant literature, and

- a review of SHE legislation within the EU.

Also other reports based on the SPASE project have been published (Harms-Ringdahl & Jansson, 1997; Harms-Ringdahl et al., 1998). An important part of the SPASE project was the questionnaire sent out to small process plants with the purpose to obtain up-to-date information on the needs of small plants concerning resources, management, methods used etc.

The target group for the SPASE project and the questionnaire was small process plants, defined as: *"An industrial entity with less than 100 employees that is handling, processing or storing hazardous chemicals. It may be an independent enterprise or a part of a larger company."* The term "industrial entity" can refer to an independent company or part of a larger company that is geographically or administratively separate from the parent company. A restriction was that the plant must handle, process or store chemicals on an industrial scale.

The present paper is focused on the data from the SPASE questionnaire and gives further analysis and discussion of this information. For results from the performed literature review we refer to the report by Whetton and Schabel (1997).

A study of large companies

A European investigation focusing on large companies in the chemical industry and authorities was performed in 1993 (Kok & van Steen, 1994a,b). The project was known as ACRONYM and was initiated by the European Commission. The investigation was carried out in connection with the revision of the Seveso Directive. Questionnaires were sent out by different organisations and directly to members in the European Chemical Industry Council. Over 130 responses from various establishments, which belonged to 40 companies in 18 countries, were received. A similar questionnaire was sent to authorities in all EU countries and of the 27 questionnaires distributed, only 9 were returned. This investigation was taken into consideration in the present study, both in the design of questionnaire and analysis of the results.

METHOD

A written questionnaire was chosen as a mean for obtaining up-to-date information on the needs of small process plants. The ACRONYM study (Kok & van Steen, 1994a) was considered in the design of the questionnaire. In order to be able to make a comparison, some questions were phrased in the same way, or similarly.

A number of important areas were decided to be included in the questionnaire. The questionnaire was structured into 7 main sections:

- operational profile of the plant/company,
- safety, health and environmental management profile,
- external relationships,
- what could help?
- knowledge,
- additional comments, suggestions?
- plant/company information.

The questionnaire contained both questions with check-boxes and open questions from which the answers were categorised. The full questionnaire has been published (Whetton & Schabel, 1997), and it can also be obtained from the authors. It was translated into the national languages.

The questionnaires were sent out to a variety of small process plants in Finland, Germany, Italy, Sweden and the United Kingdom with similar cover letters. The procedure in the distribution varied between countries. They were, for example, sent out via industry organisations or using contact lists.

Italy obtained no answers, and the obtained information was collected by interviews that posed the same questions as in the questionnaire.

In Sweden, the questionnaires were sent out to randomly selected companies from statistical records, and for those who did not answer, reminders were sent out. The types of company from which the Swedish selection was made were chosen according to industrial classifications. In Sweden, the reason for some companies not to answer the questionnaire was analysed (Harms-Ringdahl & Jansson, 1997), which is commented below.

RESULTS

Responses obtained

The number of questionnaires sent out to small process plants and the number of replies can be seen in Table 1. It can be noted that the material has a strong Nordic bias, i.e. 91 of the 136 companies that responded are from Finland and Sweden. The response rate is low in all countries, except in Sweden where 42% of the companies answered.

An analysis of reasons for missing responses was made on the Swedish material (Harms-Ringdahl & Jansson, 1997). It was found that of the 100 companies receiving the questionnaire in Sweden, 25 companies sent it back without answers. Their reason was that they did not fit into the definition of a small process plant, as defined in the questionnaire. If the Swedish response rate was corrected for this, it was 56%.
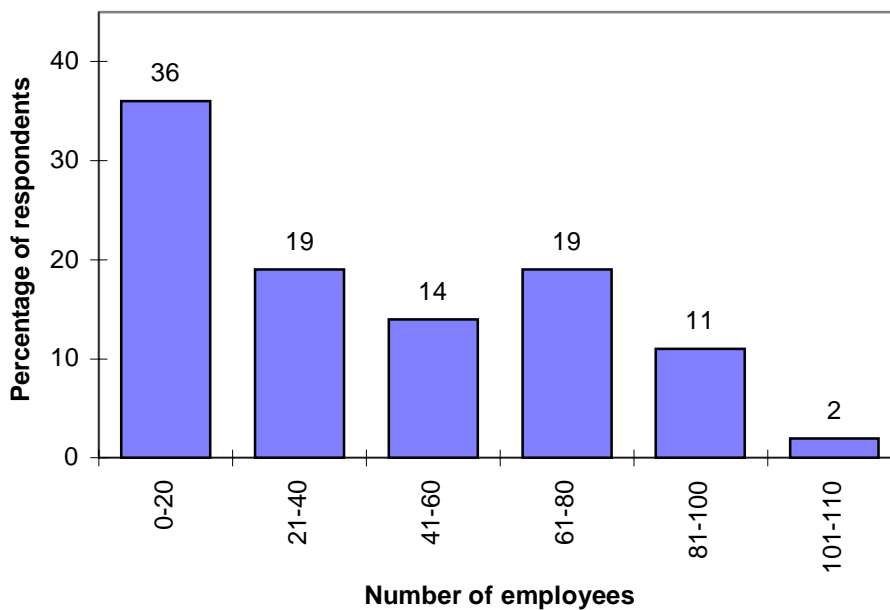
Table 1. Number of SPASE Questionnaires.

Country	No. sent	No. received	% responded
Finland	319	49	15
Germany	300	7	2
Italy	60	23	–*
Sweden	100	42	42
The UK	300	15	5
Total	1079	136	13

* All the answers were obtained by interviews

The size distribution of the respondent plants is shown in Figure 1. It shows that most companies were quite small and 36% could be found in the group with up to 20 employees.

FIGURE 1. Distribution of respondents (%) by company size (number of employees).

Safety, health and environmental management

The question *"How important is SHE management to your business?"* was contained in the questionnaire. There were 5 alternative answers. Of the responding companies, 75% gave the answers that the management of SHE issues are important or very important today, and the importance was considered to become even higher in the future.

One theme in the SPASE questionnaire concerned the resources for SHE management. The question was formulated as: *"Do you agree with the following statements concerning resources for safety, health and environmental matters in your*

plant?". The alternatives were, *completely disagree*, *somewhat disagree*, *no opinion*, *somewhat agree*, and *completely agree*. In Table 2, the nuances in the answers have been removed. It could be seen that most of the companies thought that they had enough resources for the work with SHE issues, and a majority of them also planned to use more resources in the future.

Table 2. Resources for handling SHE issues.

Do you agree?	Disagree	Agree
We do <u>not</u> have enough time to adequately deal with ...		
• Safety issues	63	24
• Health issues	66	21
• Environmental issues	65	24
It costs too much, to implement measures for ...		
• Safety control	71	14
• Health control	73	15
• Environmental control	65	19
In the future we plan to use more resources for ...		
• Safety (e.g. safety technology)	18	55
• Occupational health (e.g. personal protection and education)	20	51
• Environmental aspects (e.g. environmental technology)	18	61

Answers given as a percentage (n=136).

One question addressed the control of risks at the companies, where the respondents should judge the following statements:
"We have sufficiently good control of the....
- safety risks at our plant
- health hazards at our plant
- environmental risks at our plant"
The same type of alternatives was used as described above, that is from 1 (completely disagree) to 5 (completely agree). The average ratings obtained were 4.05 for safety risks, 4.03 for health hazards, and 3.94 for environmental risks. Most companies think that they have fairly good control of their risks.

Reasons for SHE management

A summary of the most important reasons for the companies to work with SHE issues can be found in Table 3, which also shows data obtained in the ACRONYM study of larger companies (Kok & van Steen, 1994a). The most important reason for working with SHE matters according to the SPASE study was *"to comply with regulations"*, followed by *"publicity/image"*, *"pressure from authorities"* and *"pressure from employees"*. *"Pressure from insurance companies"* was the least important of the options given.

Table 3. What are the key reasons for your company to be active in the field of safety, health and environment?

Key reasons for SHE	SPASE	ACRONYM
To comply with regulations	4.4	3.7
Publicity/image	3.8	2.4
Recent accidents	2.2	2.5
Because of pressure from:		
• Authorities	3.6	3.3
• Employees	3.5	3.1
• Customers	3.1	not included
• Press, society	2.8	2.6
• Competitors	2.4	1.8
• Industry organisations	2.3	2.5
• Labour unions	2.2	2.4
• Interest groups	2.1	not included
• Insurance companies	1.7	3.0

Results from SPASE and ACRONYM are shown as mean values of the judgements. The alternatives were from 1 (= not at all) to 5 (= to a large extent).

Views on legislation

A set of questions addressed the view on legislation, formulated as: *"Do you agree with the following statements?"*. The possible responses included: *completely disagree*, *somewhat disagree*, *no opinion*, *somewhat agree*, and *completely agree*. The results are shown in Table 4, where the nuances in the answers have been removed.

The data shows that about half of the companies (49%) think that it is not possible to follow all regulations. At the same time, 74% answered that they follow all regulations. A large number of companies do not understand the regulations, and the majority is convinced that following the regulations is not enough to obtain satisfactory SHE protection.

Table 4. View on legislation.

Do you agree?	Disagree	Agree
For a small company/plant it is not possible to know and follow all regulations	44	49
The regulations are so difficult to understand that we do not know if we follow them	54	35
If a company follow all regulations, this is sufficient to obtain satisfactory safety, health and environmental protection	53	33
We follow all obligatory regulations on safety, health and environment	14	74

Answers given as a percentage (n=136).

Sources of information

Where do the small plants find their information about safety, health and the environment? This was addressed in one question and the responses are shown in Table 5. The sources could be ranked from 1-5 according to the importance. The replies were classified as important (4 or 5) or not important (1 or 2), and are given as a percentage.

The most important sources were different types of publications and contacts with the authorities. Consultants, and the TV and newspapers were considered the two least important sources of information.

Table 5. Sources of information.

Sources of information	Important	Not important
Publications, journals, handbooks and books	74	5
Visit to / contact with the relevant authorities	71	4
Visiting workshops/seminars, meetings	45	26
Information received from ...		
• Industry group	56	19
• Parent company	31	38
• Consultants	26	50
• TV, newspapers	9	50

Answers given as percentage (n=136).

Methods and systems used

A set of questions addressed the methods and systems used by the small process plants. Some of the information obtained is given below.

A certified quality management system existed in 48% of the responding companies, and a further 30% of them planned to introduce such a system. This effectively means that about 80% of the companies are concerned with a quality management system, while 20% are not. Almost all were using or planned to use a standard related to ISO 9000 (ISO, 1987).

A certified environmental management system existed in only 5% of the responding companies. However, a further 35% of the companies planned to introduce such systems.

Risk analysis is applied by 44% of the companies and a further 7% indicated that they have plans to use it in the future. These data must be interpreted with caution as various differing definitions exist. For example, 83% of the Italian companies have answered that they use risk analysis. In Italy, however, the phrase "risk analysis" is often used when referring to a simple risk identification procedure.

About one third of the companies responded that they have a programme for safety and environment – the most common being the Chemical Industries' Responsible Care-programme (CEFIC, 1996).

What could help?

In Table 6, some results are shown from questions about the effectiveness of a number of approaches. The possible responses from which to choose included: *1 (= most ineffective)*, *2 (= rather ineffective)*, *3 (= neutral)*, *4 (= effective)*, and *5 (= very effective)*. For comparison, data from the ACRONYM study of large chemical companies (Kok & van Steen, 1994a) have also been included in Table 6.

Table 6. Effectiveness of different measures and/or policies.

Measures and/or policies	SPASE	ACRONYM
Harmonisation of rules and guidelines for safety management	4.2	3.7
Positive incentives	3.9	3.6
Less legislation	3.8	2.6
Increased self regulation by industry	3.5	3.9
Establishing international standards for safety management	3.4	3.3
Legislation that only sets goals	3.2	3.5
Negative incentives	2.5	2.4

The figures are the mean values of judgements on a scale from 1 *(= most ineffective)* to 5 *(= very effective)* *(n=136 in SPASE, n=123 in ACRONYM)*.

The most important issue according to the SPASE study, pointed out both by the companies and the Swedish inspectors, was *harmonisation of rules and guidelines*.

An open question requested suggestions for improving SHE activities in small process plants. From the 64 respondents, a few major themes could be identified (Whetton & Schabel, 1997). The three most common ones were:

- simpler and more clear legislation,
- provision of further education and training,
- greater appreciation by authorities of SMEs' problems,

DISCUSSION

Limitations of the study

The most essential limitation of the study is that the mean response rate was only 13%. It has not been possible to analyse the reasons for missing responses, except for the Swedish material. Similar problems with low response rate have been seen in other similar studies. For example in the ACRONYM, only 9 of the 27 questionnaires sent to the authorities in the EU countries were returned (Kok & van Steen, 1994b).

The most important finding is that the greatest difference between countries is found in the frequency of responses, and not in the information obtained. One part of the explanation is the variance in how the survey was managed in the participating countries. However, the major reason is probably due to cultural factors.

It is important to note that most of the respondents (69%) were from Finland and Sweden, and that the Nordic biased material will probably not represent a European average. However, it can be noted that in general there are not great differences in the results from the different countries, even though variations exist on specific issues (Whetton & Schabel, 1997; Harms-Ringdahl & Jansson, 1997).

Resources and ambitions

In an OECD report (1995) focusing on chemical accidents and small companies, it was concluded that *"small and medium-sized enterprises (SMEs) are less likely to have the same access to information, expertise, and other resources related to chemical safety available to larger companies".* Furthermore, *"it was thought that SMEs might present a particular risk since they are often located in or near populated areas".* This reflects the rather common view on SMEs – that they have difficulties in handling safety, health and environmental (SHE) issues due to their limited financial resources and personnel. This has also been confirmed by several studies (e.g. Tuskes & Key, 1988; Fonteyn et al., 1997). Furthermore, it is often argued that techniques and solutions to SHE problems have been developed in a large company perspective and do not particularly suit SMEs.

The overall impression of the SPASE material was that most respondents viewed SHE considerations to be important. Compared with the OECD view, they were actually surprisingly ambitious, for example, about half of the responding companies already had certified quality systems.

Table 2 shows that about two thirds of the companies believed that they had enough resources to deal with SHE issues – and more than half expected to use more resources in the future. On the other hand, the same table indicates that about 20% of the companies might have resource-related problems. Companies with an interest in SHE issues can be assumed to be more willing to answer this type of questionnaire than companies that do not bother about SHE matters. As the response rate is low, one can therefore argue that the true portion of companies with resource-related problems could be much higher than 20%. This is, however, contradicted by the fact that the replies from Sweden, which had a rather high response rate, did not differ significantly on these issues from the replies of the other countries.

According to a related question, a majority of the companies answered that they had a good control of their safety, health and environmental risks. However, the interpretation of the replies on risk control is difficult. The perception and understandings of risk varies in industry, which gives a diversity of meanings of "risk control" (Holmes et al., 1998). There can also be a difference in the estimates of risk between employers and employees, which have been studied in small companies (Holmes et al., 1997). The employers tended to rate risk for immediate injury higher than the employees, while the latter gave higher rates to risks with delayed disease effects. In a study (Johansson & Johansson, 1992), a conclusion was that directors at small companies lack both knowledge of how a good environment can be created and the state of the work environment.

The importance of size in SHE performance

The data was used to study the importance of company size on SHE performance. This was based on comparisons with the results from the ACRONYM study, which was focused on larger companies (Kok and van Steen, 1994a,b). The data can be found in Table 3 and 6. There were several similarities between the large and small companies.

For example, both groups found *"pressure from authorities"* and *"to comply with regulations"* to be important as reasons for SHE management.

A prominent difference concerned the *"insurance companies"* – they were not considered to be important in SPASE, while they were quite important according to ACRONYM. This may be size dependent, but it could also be a difference in "insurance culture" between countries, as SPASE has a strong Nordic bias that is not found in ACRONYM.

An ongoing debate concerns the size of the companies and their corresponding accident risks. According to Salminen (1993), nine out of twelve previous studies showed accident risks to be several times higher in small companies compared to big ones. Other studies obtained results in which medium-sized companies had the highest risks, or that there was no difference between the large and the small companies (Salminen, 1993; Whetton & Schabel, 1997). In one Swedish investigation, no evidence was found that small workplaces show a higher risk for accidents (Bengtsson, 1995). That study indicated that the industrial sector might be a more important parameter than size in determining accident risks and safety problems in the working environment. Mendeloff & Kagey (1990) showed that accident frequency decreased with increasing company size in all branches except sawmills, paper mills and gray iron foundries, where the relationship was more complex.

The results of this survey did not contribute significantly to the discussion of the importance of company size. The responding companies seemed to have fewer problems than expected, but the low response rate makes it difficult to draw conclusions. The comparison with the results from the ACRONYM project indicates that company size is perhaps not such an important parameter in judging the capability to handle SHE issues.

Variations in SHE performance

The SPASE survey analysis indicates that the "average" small plant in the study may not have problems with SHE matters. However, around 10-25% of the companies seems to be less concerned with SHE issues. This is for example reflected in answers to the questions in Table 2, where around 20% did not have enough time to adequately deal with SHE-issues. Also the answers shown in Table 4 indicate problems, although the interpretation can be difficult. These figures are likely to be an underestimation, as a large number of companies did not respond to the inquiry.

A more thorough study was made of the group of potential problematic plants, in order to find out what could characterise these "tail companies". The question *"How important is SHE management to your business?"* was chosen as a possible parameter indicating the "tail". The hypothesis was that companies giving SHE management low importance would also have poorer performance on other questions. Investigating this could clarify if there is a stable group of companies, which consistently indicate problems with SHE issues.

However, no such pattern was found in the material. Different companies gave "low scores" on different questions, and it was not possible to distinguish a stable "negative tail" of companies with this approach. According to the companies' own views, the "consistently bad company" does not exist. It is, however, difficult to draw conclusions about the general population from this material.

Authority role

The responses on a number of questions indicated that the authorities were considered important by the small process plants. Complying with regulations was by far the most important reason for the companies' SHE activities. Most companies thought that they actually complied with regulations, but on the other hand they voiced concern that it was impossible for a small plant to know and follow all regulations.

Authorities were considered as a very important source of information, having a much higher medium score than e.g. *"consultants"* (Table 5). The companies also addressed a need for greater appreciation of the SMEs' problems by the authorities.

The overall picture is that the authorities and their activities are very important for good SHE performance in small process plants, but that the authorities and legislation are at the same time perceived as a large problem by these plants. This is obviously something that should be considered and studied further.

On problems and solutions

In the study a number of questions related to possible solutions and improvements were raised. One of the major themes for suggested improvements were *"simpler legislation"* and *"greater appreciation by the authorities of SMEs problems"*. On the questions in Table 6 about the effectiveness of different measures and policies, *"less legislation and bureaucracy"*, *"harmonisation of rules"*, and *"positive incentives"* were given the highest scores.

The importance of different sources of information is shown in Table 5. Answers from the survey also indicate a need for improved information material. The development of some tools for small plants has also been one of the goals for the project SPASE.

Several studies have highlighted the issue of communication with small companies (e.g. Fonteyn et al., 1997; Lamm, 1997; Mayhew, 1997). From the perspective of authorities and other actors, communication with small companies constitutes a problem – partly due to their large number. This issue was reflected in the interviews with inspectors performed in the SPASE project. The inspectors pointed at a lack of awareness at the companies and a lack of information.

As discussed above, there is an essential difference between companies' quality of SHE-management. One strategic consideration is how solutions should be directed at the needs of the "average" company. The authors' interpretation of the results from this study is, that it is very essential that also more efforts and considerations are given to plants with potential SHE-problems.

CONCLUSIONS

There are a great number of small process plants and, as for small enterprises in general, they are very important from several aspects, including, for example, on economic and safety grounds. The large number of small process plants can possibly make them difficult to reach with information and/or control.

In this study, the greatest difference between countries was found in the frequency of responses and not in the information obtained. It should be noted that most answers were obtained from Sweden and Finland, and that the data therefore has a strong "Nordic bias". The total response rate was 13%. It is not known how representative these responses are for European small process plants in general.

Many of the small process plants responding to the questionnaire seemed to have fewer problems than expected, and the average stereotype of small enterprises and small process plants seems not to generally be true. The companies attitude to SHE issues was positive. For example, a certified quality management system existed in almost half of the responding companies, and a further 30% of them planned to introduce one into their organisation. Even though few companies are certified in an environmental management system, many have planned to integrate one into their company. It seems as if the quality of SHE performance may be less related to the size of the company than what is commonly perceived.

The authorities seem to be the most important actor for small process plants. Compliance with regulations is by far the most important reason for the SHE activities of these companies. Authorities were also considered as a very important source of information. But still, about half of the companies thought that it is impossible for a small plant to know and follow all legislation. The responses to several questions pointed at the need for harmonisation of rules and for simpler legislation.

From a total risk perspective, the average SHE performance in small companies is less important than the performance of the few percentage of companies with problems. Even though the companies with serious problems may be a small percentage, this still constitutes a very large number of companies. It is suggested that the societal strategies for improving SHE performance in small plants should not be so focused on the "average companies", but more on the companies with problems.

Acknowledgements

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