The efficacy of strategies for chemical risk management in small enterprises in Europe: evidence for success?*

David Walters BSc (Hons) M Med Sci PhD, Cardiff University, UK

Abstract

The regulation of chemical products is in the process of major restructuring in Europe, as discussions take place concerning the development and implementation of the Regulation, Evaluation and Authorisation of Chemicals reforms. Some of these reforms are particularly relevant to small firms.

Despite the considerable regulatory attention paid to risk management strategies for chemical substances used at work, ensuring safety in their use in small enterprises remains a problem, largely because of the same multifaceted lack of resources in these enterprises that also make improving health and safety management in general a problem.

This paper examines current national and sectoral approaches to improving chemical risk management in small firms in several countries in the European Union, and considers the evidence of the effectiveness of current strategies and tools employed at these levels. It addresses the social and economic contexts in which the management of chemical risks takes place in small enterprises, and considers the success, sustainability and transferability of support for chemical risk management strategies and tools.

The paper finds that the available evidence points to the need for strategies and tools to address specific needs in relation to knowledge, understanding and support for improved preventive approaches to managing chemical in small firms. It further documents the substantial development of strategies and tools to achieve this in the different countries and sectors studied. It notes considerable variation in such approaches and also in the infrastructural support for them. It also notes that there has been little evaluation of the effectiveness of these approaches, especially in terms of the socio-economic factors that support or hinder application, transfer and sustainability. The paper argues that such evaluation is necessary if regulatory approaches, such as the Regulation, Evaluation and Authorisation of Chemicals reforms, are to be implemented effectively in relation to small enterprises.

Key words

Chemicals, regulation, risk management, small enterprises, strategies, sectors

Introduction

Controlling the risks of working with chemical substances is widely recognised as one of the major elements of preventive occupational safety and health. Not surprisingly, therefore,

*The author wishes to acknowledge the contributions to this paper from Ann-Beth Antonnson, Howard Fidderman, Günther Kittel, Mat Jongen and Henning Wriedt, some of the members of the international research team that undertook the research project, funded by CEFIC, on which the paper is based.

control strategies for chemicals used in the workplace feature prominently in both regulatory and voluntary approaches to improving the working environment. Partly because of the scientific, medical and technical elements involved in recognising, evaluating and controlling chemical risks, a considerable body of knowledge has developed to which disciplines such as occupational medicine, hygiene, toxicology and epidemiology have contributed. Consequently, there is a wide range of understandings concerning chemical hazards and the risks they pose, as well as a variety of control methods and systems intended to minimise the risk of harm to workers.

The result is a substantial regulatory profile for managing chemical risks coupled with considerable technical attention to the development of instruments for its implementation in workplaces. Currently, this profile is in the process of major restructuring in Europe, as discussions take place concerning the development and implementation of the REACH (Registration, Evaluation and Authorisation of Chemicals) reforms in European legislation. REACH is not limited to the workplace – it also has implications for controlling the environmental and consumer aspects of chemical production and use, as well as being concerned with systematising the authorisation of the use of chemicals. Nevertheless, the impact of its provisions and their means of achievement on the future regulation of occupational exposures to chemical substances is likely to be substantial and significant.

Despite the presence of a plethora of institutionalised technical and regulatory provisions on safety in the supply and use of chemical substances at work and their ongoing development, the most effective ways of evaluating and controlling the risks of hazardous substances in the majority of work situations remain the subject of some debate. This is especially so for small enterprises, which make up the majority of workplaces in which chemicals are used. Many are at some degree of remoteness from both the regulatory scrutiny and technical sophistication that are, arguably, necessary to support the approaches to chemical risk management that dominated regulatory and technical thinking on the subject in the past.

The study from which this paper draws was conducted with a view to examining the evidence of the effectiveness of current strategies for chemical risk management in small enterprises. With these changing regulatory and technical contexts in mind, its aims were to:

- comparatively review strategic approaches to achieving effective and sustainable risk management in the use of chemical substances in small enterprises, including the approaches of regulators, industry and other stakeholders to the provision of management advice on exposure and risk management
- identify the main factors that determine the effectiveness of such approaches
- explore what appears to support their application within the economic situations in which they occur.

The research focused on six countries in the EU: Austria, Germany, the Netherlands, Spain, Sweden and the UK. Based on a review of published and unpublished documentary sources in each country and at the level of the EU, as well as on interviews with key players, it:

- examined the extent of current knowledge on the use of chemical products in small enterprises and its consequences for health and safety outcomes for workers
- reviewed the nature of risks of working with chemical substances in small enterprises and the extent to which such risks are related to workplace size
- identified significant processes and actors, and explored evidence of their role in determining

best practice in managing the risks of using chemical substances in small enterprises. The actors include manufacturers and suppliers, regulatory agencies, insurance organisations, occupational health services, trade unions, employers' organisations and trade bodies
- considered the documented strategies of these actors to improve the management of chemical risks, evaluating evidence of their relevance and effectiveness in each case
- identified the main tools used in the implementation of the above strategies in workplaces in each country.

In analysing sources of information in these areas, the study was especially concerned to account for the social and economic contexts in which the management of chemical risks takes place in small enterprises. It attempted to understand the success, sustainability and transferability of support for chemical risk management strategies in the small business environment in these terms, since previous work on health and safety management in small enterprises more generally suggests that this approach helps to explain why some initiatives to improve health and safety lend themselves to application in small enterprises more than others.[1]

This paper briefly outlines some of the more significant elements of the scale and consequences of work with chemical substances in small enterprises, and then presents a typology of regulatory risk management strategies reviewed in the countries studied, as well as the tools for implementing them and an analysis of their institutional basis and actors involved. A discussion of the evidence for the success of these strategies and tools follows, with some indications of what might be considered useful future development.

The context of chemical risk management strategies in small enterprises

During the 20th century, the global production of chemicals increased from 1 million tonnes in 1930 to 400 million tonnes by 2001, when the European Commission published its White Paper announcing the need for legislative reforms.[2] There is little sign of these production trends diminishing in the early part of the 21st century. The EU chemical industry is responsible for about one-third of the total international output and as such is the largest chemical industry in the world. It has a 65 per cent share of world exports, a 53 per cent share of imports and contributes 2.4 per cent to the EU economy. In 2003, its estimated turnover in the 25 European Union member states (EU-25) was €556 billion.[3] It is Europe's third largest manufacturing industry, employing 1.7 million people directly, with a further 3 million jobs dependent on it. Between 1999 and 2004, overall chemical production grew by 3.3 per cent (1.1 per cent if pharmaceuticals are excluded). This compares with an all-industry growth of 1.5 per cent. Employment in the chemicals sector in the EU fell by 1.2 per cent between 1999 and 2004 (against an all-industry fall of 1.4 per cent).

Although large multinational corporations are dominant in terms of employment and production in the industry, in Europe there are also 36,000 small and medium-sized enterprises (SMEs) – over 95 per cent of the total number of chemical firms in Europe. Between them, they are responsible for 28 per cent of chemical production.[4] Table 1 shows the scale of SMEs in the industry. Firms with up to 500 employees employ half of the total working in the industry, account for 98 per cent of the enterprises and almost half of the sales. As with patterns of employment in small enterprises generally, these proportions vary between countries. In Spain, for example, nearly 90 per cent of employees in the chemical industry work in enterprises of fewer than 100, and over half in enterprises with fewer than 10 employees.

The EU chemical industry is mainly concentrated in Germany, France, Italy and the UK. The largest share is in Germany, with 26 per cent of total EU production, followed by France (17

per cent), the UK (14 per cent) and Italy (12 per cent). Aside from chemical production, the EU is also the single largest market for the chemicals industry.

In addition to the original manufacturers and importers of chemical products, formulators use chemicals supplied by their original manufacturers or importers in their own products before marketing them on to further users. There are also distributors of these products as well as those of the original manufacturers and importers.

The use of chemical products is, of course, not restricted to the chemicals industry. Chemicals are used in a huge number of workplaces across the spectrum of economic sectors, both private and public. Workers who may be at risk of exposure to hazardous chemicals will therefore be found throughout the economy. Table 2 shows the percentage of chemical consumption within the EU as an indication of the widespread use of chemicals at work.

Steady growth in the number of small firms in the 15 EU member states began in the 1980s. During the 1990s, both the number of small firms and the number of people employed in them continued to increase, so that by the end of the 1990s there were as many people working in micro-enterprises of fewer than 10 employees as in large enterprises of over 250 employees. Two predominant patterns are evident in the developing role of small enterprises in the economies of EU member states. In some countries, change in economic structure has

Table 1
EU chemical sector by size: enterprises, employees and sales (excluding pharmaceuticals)

	Size of enterprise (number of employees)		
	Small (0–49)	Medium (50–499)	Large (500+)
Employees per size category (%)	14	37	49
Enterprises per size category (%)	86	12	2
Sales per size category (%)	9	39	52

Table adapted from CEFIC and Eurostat

Table 2
EU chemical consumption by sector

Sector	Consumption (%)	Sector	Consumption (%)
Agriculture	6.4	Office machinery	0.7
Automotive	5.3	Other industry	10.3
Construction	5.4	Other manufacturing	6.1
Consumer products	30.3	Paper and printing products	4.5
Electrical goods	3.9	Services	16.4
Industrial machinery	1.9	Textile and clothing	6.3
Metal products	2.5		

Table adapted from CEFIC and Eurostat

resulted in an unprecedented growth of the proportion of the labour force employed in small enterprises. In others, small enterprises already formed the backbone of the economy. And while the restructuring processes at the end of the last century increased their dominant position, it did not alter the essential features of the productive system.[5]

Table 3 shows the dominance by different enterprise sizes in relation to total employment in the countries on which this study is focused.

Thus far, statistical information on the production and marketing of chemicals and on the role of small enterprises in the economy of the EU is fairly straightforward. However, when turning to the exposure to chemical substances and its health effects among workers in small enterprises, things are not so clear.

Surveys conducted by the European Foundation for the Improvement of Living and Working Conditions found that 22 per cent of respondents throughout the EU considered themselves to be exposed to dangerous substances for at least a quarter of their working time, while 16 per cent thought they handled dangerous substances daily.[6] In an earlier study it was estimated that some 32 million workers in EU countries were exposed to occupational carcinogens,[7] leading researchers in 2000 to conclude that a substantial proportion of workers in the EU were exposed to carcinogens.[8] There is further information from national surveys supporting this thesis. For example, an analysis of the French SUMER survey in 2003 indicated that 14 per cent of the French workforce were exposed to one or more of 28 carcinogenic substances in their place of work.[9]

How much exposure to chemical substances occurs in small firms is not systematically documented. Indeed, in only one of the countries in the study was there any systematic national survey of exposure to chemical substances by company size. The exception was the Netherlands, where TNO researchers have undertaken a secondary analysis of data from the 2003 Nationale Enquête Arbeidsomstandigheden (NEA), a periodic national survey that is based on employee responses.[10] Their findings are summarised in Table 4 and show a strong inverse relationship between exposure and company size. Although such systematic results were not available in the other countries studied, the patchy data that exist tended to point towards similar experiences in many sectors to those reported for the Netherlands.

Country	Number of enterprises (x1,000)	Occupied people per enterprise	Size/class dominance*
Austria	270	11	micro
Germany	3,020	10	LSE
The Netherlands	570	12	LSE
Spain	2,680	6	micro
Sweden	490	7	micro
United Kingdom	2,230	11	LSE

*Micro = employing fewer than 10 people; LSE = employing 250 or more

Table adapted from Eurostat

Table 3
Dominant form of employment in 2003 in the countries studied

Data that can be linked directly to the health effects of such exposure at work in small enterprises are limited. It has been estimated from EU aggregate data* that nearly one-third of all occupational diseases recognised annually in the EU are related to exposure to chemical substances, although this figure varies a lot between countries. In Sweden for example, only about 10 per cent are thought to be related to chemicals.[11] But it is also acknowledged that this is only a partial measure since officially recognised occupational diseases are themselves widely understood to be a gross underestimation of the effects of work on health. A major problem with measuring the extent of the health effects of working with chemicals is that since the hazards of many of the chemical products marketed in Europe are not themselves adequately researched, quantification of the risks to health from working with them is largely based on estimates that themselves are extrapolated from limited data.

By far the most prevalent health effects of working with chemicals are diseases of the respiratory system and the skin, of which asthma and chronic obstructive pulmonary disease (in the case of the respiratory system) and contact dermatitis (in the case of the skin) are the most common. Diseases of the central nervous system are also associated with such exposures, as are allergies and reproductive, developmental and endocrine disorders. Cancer is also associated with exposure to chemicals at work. However, in all cases, there are no reliable data concerning the full occurrence of such conditions on a European scale. Nor is there anything like complete data on exposure in any individual country – although there are specific cases of very good exposure databases at the sectoral level.† Most significantly for the purpose of this study, there are no reliable data on the proportion of the morbidity and mortality from such conditions that can be attributed to work in small enterprises.

Table 4 Relationship between exposure to hazardous substances and company size

Exposure type	Frequency	Company size (number of employees)						
		1–9 n=1,516	10–49 n=2,782	50–99 n=1,525	100–499 n=2,278	500–999 n=623	1,000+ n=1,262	Total n=9,986
Skin	Daily/weekly (%)	45.3	33.5	33.6	27.4	28.4	23.7	32.4
	Only monthly (%)	11.3	9.5	7.3	8.3	4.2	5.4	8.3
	Never (%)	43.4	57.0	59.0	64.3	67.4	70.9	59.3
Respiratory	Daily/weekly (%)	50.0	43.5	43.0	36.1	33.1	29.4	40.3
	Only monthly (%)	10.0	9.7	8.1	9.4	8.8	9.0	9.3
	Never (%)	40.0	46.8	49.0	54.5	58.1	61.6	50.5
Total	Daily/weekly (%)	58.4	50.0	48.8	41.5	39.8	33.6	46.4
	Only monthly (%)	9.6	8.8	7.7	9.0	8.2	8.0	8.7
	Never (%)	31.9	41.2	43.5	49.5	52.0	58.4	44.9

Source: Kremer[10]

*Available from Occupational Diseases in Europe in 2001. *Statistics in focus. Population and social conditions no. 15*. Eurostat, 2004. http://europa.eu.int/comm.eurostat>Publications.

†Such as the database DOK-MEGA, run by the BGIA and the BGen in Germany.

Some indications of the extent of the toll of these conditions can be gained from individual estimates. For example, calculations carried out by trade union organisations using occupational disease compensation statistics (see Table 5) suggest that 88 per cent of occupational skin disease cases and 36 per cent of occupational respiratory disease cases are related to chemical exposure.

Recent estimates of the most prevalent of these diseases – respiratory and skin diseases – suggest that, for example, there is an approximate occupational asthma incidence rate of 200–400 per million per year, equivalent to 40,000–80,000 new cases per year in the EU-25.* In the case of skin diseases, the same authors suggest a figure of 200 cases per million per year for an EU-25 workforce of 200 million as the incidence of occupational skin disorders they believe attributable to substances that would be covered by the proposed REACH regulations.[12]

In the case of cancer, the most widely used approach to estimating the extent of mortality due to occupational causes is that of Doll & Peto.[13] Their calculations estimated that 4 per cent of the overall proportion of cancer in the US was attributable to occupational causes (with a range of uncertainty between 2 to 8 per cent). Their methods have been followed in a variety of subsequent estimations and have informed national and European strategies for dealing with occupational cancer.[14–17] In a review undertaken to inform the European Commission in its deliberations on the introduction of REACH, Postle *et al.*[18] used the same basis to estimate that 3.5 per cent of the total cancer mortality in the EU was associated with occupational exposure. The Doll & Peto estimates are not without their critics. For example, Landrigan & Baker[19] identified several limitations to their data and the calculations they used. They pointed out that Doll & Peto relied on epidemiological studies of workers in large industries or broad categories of employment, but failed to consider exposures in smaller workplaces or from indirect contact with carcinogenic substances such as asbestos in maintenance operations. In other contributions, Landrigan *et al.*[20] and Davis *et al.*[21] note that Doll & Peto limited their analyses to deaths in those under age 65,

Occupational diseases	% linked to chemical exposure	% among all recognised diseases	% chemicals-related among all recorded diseases
Cancers	4–90*	5	0.2–4.5*
Neurological diseases	2	8	0.2
Respiratory diseases	36–89*	14	5.0–12.5*
Skin diseases	88	14	12.3
Total			18–30*

*including chemical dust (asbestos, silica dusts, wood dusts)
Source: Musu[11]

Table 5 Estimated percentage of occupational diseases related to exposure to chemical substances

*This is corroborated by separate national estimates such as that of the HSE in the UK, which indicates incidence rates of occupational asthma of 5,000 per year. The UK labour force is roughly one-tenth that of the EU-25.

thus missing effects seen in older people whose cancers may have been caused by exposures while working. These authors suggest that an estimate of 10 per cent of the proportion of cancer attributable to occupational exposures is more plausible, based on their review of the literature and clinical experience. A recent review by Clapp *et al.* argues that the Doll & Peto calculation:[22]

> ... probably underestimates the occupational exposure contribution by a factor of two to four in both the US and the UK.

Clapp *et al.* suggest that a more realistic estimate of the proportion of cancer attributable to occupational causes is within the range of between 8 and 16 per cent.

While in all cases it is not known how much of such ill health is the result of exposure in small workplaces, research on the inadequacy of health and safety management generally in small enterprises, and specifically in relation to chemical risk management, leads to the assumption that it is a considerable proportion. Several good reasons for this are outlined in the following section.

Why small is not beautiful for chemical risk management

The literature on health and safety in small enterprises establishes a persuasive case to anticipate poor health and safety outcomes. Health and safety performance of small enterprises (in terms of serious injuries and fatalities) is proportionally worse than that in larger enterprises dealing with similar hazards.[23] The heterogeneity of small enterprises makes generalisations suspect. Nevertheless, their health and safety problems are much more related to their poor management of risk than with the absolute seriousness of the hazards represented.

The 'structures of vulnerability' that help define work in small enterprises mean that the 'general and multifaceted lack of resources' experienced gives rise to:[24]

- limited development of safety management resources such as competency, information, training, and safe and sound plant and equipment
- restricted access of workers to the autonomous representation of their interests through works councils and trade unions
- limited access to external health and safety services
- limited experience on the part of both workers and their employers because of the short life of many small enterprises
- infrequent inspection and control.

However, poor health and safety conditions are not simply an issue of poor management. Conditions are often aggravated by further kinds of vulnerability, such as that associated with job insecurity and the weakness of organised labour, which in turn leads to psychological insecurity and economic vulnerability in the omnipresent threat of unemployment. Additionally, the considerable illegal (and consequently unregulated) work in the small enterprise environment and the disproportionate representation of disadvantaged groups engaged in such activities further diminish risk awareness and concern for health and safety. The sheer number of small enterprises makes inspection and follow up a daunting task for the regulatory agencies and preventive services that have to cope with limited resources.

The regulatory strategies in the EU that address the management of health and safety hardly apply to the organisation and operation of work in small enterprises and similar situations.

The means by which good management practices are achieved in large enterprises rarely work in small enterprises and are even less likely to be relevant in micro-enterprises. In these situations, the employment relationship, employment structure and the organisation of work are such that questions of health and safety are, at best, easily overlooked and at worst deliberately – and for the same reasons equally easily – avoided.

With such an unpromising scenario for health and safety management generally in small enterprises, it is hardly surprising that research focusing more specifically on the prerequisites for the effective management of chemical risks in such enterprises has found them to be underdeveloped. If the extent of analysis undertaken to date is reviewed, it is clear that there is considerable evidence supporting conclusions about the limitations of strategies for chemical risk management in small enterprises that are dependent on a twin set of assumptions concerning the will and capacity of owner-managers to manage chemical risks effectively and the quality of support necessary to do so, whether provided by suppliers, or by occupational health services and consultants. Numerous studies across the range of northern European countries demonstrate that owner-managers of small enterprises do not understand suppliers' information or use it appropriately, they frequently do not understand the application of chemical risk management strategies aimed at exposure assessment and control, and are unwilling or unable to employ their expertise to do so.

At the same time, many studies have pointed to the inadequacies of this information, both with regard to labelling and safety data sheets (SDSs) – considerably more so in the case of the latter – identifying severe limitations in the quality of information and of its accessibility for small enterprises.[25–28] They also demonstrate that occupational health services and/or consultants have limited usefulness for these enterprises, partly because of restricted access and partly because of reduced availability of expertise. In addition their usefulness is limited because such services and consultants often themselves fail to appreciate the context in which their expertise is required in small enterprises. Invariably, they do not understand the way in which business is undertaken and work gets done in small enterprises or, therefore, the priorities of owner-managers in these establishments and related situations.[29] Even if there is access to such services, evidence suggests that small enterprises are neither aware of what they can be used for, nor do they understand that there might be problems in their workplaces that need expert attention to be identified, evaluated and controlled.[30]

Finally the studies show that the regulatory surveillance of small enterprises fails to provide the necessary support or incentives to improve their performance because inspectorates are generally unable to reach sufficient numbers of such enterprises to be an effective presence.[31] Instead they tend to rely on arm's-length techniques, for which there is little evidence to support their efficacy in achieving compliance. In this study we also found a suggestion among inspectorates themselves that inspectors may not be sufficiently skilled or equipped to deal adequately with seeking compliance with regulatory requirements for chemical risk management.

What is to be done? – The development of current approaches to risk management in small enterprises

Much of this is not new. As documented elsewhere, there has been a growing realisation in a number of northern European countries that all has not been well with the application of regulatory strategies to manage chemical risks in small enterprises since the late 1990s.[32] To understand the significance of this development, however, first requires a step back to the previous decade when process regulation in health and safety really took hold at the level of

the EU and in most northern EU member states. Regulatory approaches to achieving systematic risk management were increasingly advocated, both in relation to health and safety generally and for specific hazards such as chemical exposures. Regulatory requirements began to emerge at EU and national levels in which good occupational hygiene practices were emphasised as a framework for systematic chemical risk management. Where safer substances or processes could not be introduced, concepts of controlling exposure were advocated, standards were required against which exposures could be monitored, and the risks to workers controlled. The levels at which such standards were set and the balance of economic and scientific influence on the process were subject to debate from the outset. However, the transformation of the role of these standards – from being tools for specialist practitioners in occupational hygiene to being an important cornerstone of regulatory strategies – intensified such debate and gradually unforeseen weaknesses in this approach were highlighted.

It became increasingly apparent, for example, that the effective implementation of systematic approaches to chemical risk management was dependent on several preconditions. They included, not least, good quality information concerning the hazards of substances, clear criteria on which exposure standards could be set, good systems for communicating this information to duty holders, sufficient technical capacity to monitor, evaluate and control risks in workplace scenarios, sufficient grasp of what was required and how it should be achieved by duty holders, as well as adequate inspection and control. Yet the reality was that information on the hazards of the vast majority of substances used in European workplaces was far from complete, exposure standards were set for comparatively few substances, and the criteria used were subject to variation and debate. The quality of communication on hazard information to duty holders – as well as that between duty holders and their employees – was poor, especially in small enterprises. Technical capacity was limited to large enterprises or external services that met the requirements of large enterprises, and there was growing evidence that a substantial proportion of duty holders (again mostly from small enterprises) neither understood what was required of them, nor possessed the capacity to deliver the systematic approaches framed by regulation. It was also becoming evident that regulatory inspectorates lacked the capacity to check compliance adequately across the range of duty holders subject to regulation.

It was, in short, a situation in which there was mounting evidence of regulatory failure. This was hardly surprising, given that the model on which the regulatory approach had been based was that which applied in large workplaces that were themselves a small and diminishing proportion of the situations where such regulation applied.

Strategies to address this regulatory failure have developed separately in several of the countries included in this study. At the European level, elements of REACH also demonstrate a similar strategic approach. These developments have taken place against an increasingly neoliberal political and economic background in the EU in which governance has generally favoured non-regulatory approaches to risk management. The effects of this influence on the trajectory and orientation of regulation are unmistakable and also need to be considered. The capacity of the health and safety system and its infrastructure to support regulatory strategies also needs to be taken into account. As the preceding section demonstrates, this is clearly problematic in the case of small enterprises.

Strategies to support chemical risk management in small enterprises

To understand the new strategies aimed at improving chemical risk management in small

enterprises, it is important to locate them within the overall approach to improving health and safety in these enterprises. Over the last decade, a convergence of several themes, both in relation to health and safety generally in small enterprises and managing hazardous chemicals in particular, seems to have occurred at national and EU levels. In summary, for health and safety management on the whole, these have included a growing awareness that health and safety performance in small enterprises is a significant issue that cannot be successfully addressed solely through traditional means, for reasons to do with both the multifaceted lack of resources in small enterprises and the limited resources for regulatory inspection and control. Therefore, an interest has developed in identifying and exploiting additional means to promote and sustain health and safety improvements that supplement state-led inspection and control. The search for such means has involved identifying actors, mainly in the market environment of small enterprises and in the networks of production in which they are located, in whose (largely economic) interests it is to promote and/or support health and safety improvements in these enterprises. Some of the ways in which they, and the processes with which they interact with small businesses, can apply leverage to small enterprises to achieve such ends have been explored and promoted by state agencies. At the same time these developments also acknowledge that the orientation of actors, tools and processes for improving health and safety need to be relevant to the ways things are done in small enterprises if they are to be effective. None of these developments can be properly understood in isolation from the wider economic and political climate at the EU level and in most member states in which they have occurred, where governmental responses to globalisation have increasingly focused on market-based reforms in which self-regulatory approaches have been encouraged and the emphasis on state-led regulation, inspection and control has been contained, if not actually reduced.

In our study we found these underlying themes much in evidence among current strategies for chemical risk management. As the previous analysis of regulatory failure demonstrates, efforts have sought to account for the limited relevance of regulatory approaches on chemical risk management to the realities of the way things are done in small enterprises and in related forms of work. As already noted, the regulatory frameworks for chemical risk management that emerged in the 1980s were grounded in good professional practice and provided a framework for successful chemical risk management in scenarios such as those found in larger, well-managed enterprises where they could be applied correctly and completely. However, they assumed levels of awareness, understanding and capacity that are not commonly found among the owner-managers of small enterprises.

This, coupled with insufficiently resourced inspectorates and limited prevention services, meant that the vast majority of small enterprises using hazardous chemicals were beyond the reach of either regulatory surveillance or professional help. Acknowledgement of this led to strategies to improve chemical risk management in small enterprises that addressed the known features and limitations of managing health and safety in these enterprises. This development has not (as yet) resulted in an entirely coherent European approach.* Rather, it consists of several elements applied in different combinations in different countries and sectors.

These include reorientation of regulatory approaches to chemical risk management in some countries to maximise relevance to small enterprises. In the UK, for example, the production

*However, it is important to acknowledge its links to the ideas in REACH concerning the role of the supply chain and two-way communication within it.

of *COSHH Essentials*, the recasting of requirements on exposure limits and the recent reorientation of the Control of Substances Hazardous to Health (COSHH) Regulations have all occurred within a policy debate at national level concerning the problem of achieving improved chemical risk management in small enterprises in which the weaknesses referred to above have all been aired.[33,34] Similar debates appear to have taken place more recently in Germany, explicitly addressing the need to make the legal framework for regulating chemical risk management 'more SME friendly' and have influenced Hazardous Substances Ordinance 2005, which also reflects an acknowledgement of some of the supply chain communication requirements found in REACH. Within the recently re-established Committee on Hazardous Substances (Ausschuss für Gefahrstoffe (AGS)) for example, there is a working group to develop proposals to improve the accessibility of support tools directed at SMEs.

In the Netherlands, while regulatory requirements are unchanged, new strategic approaches to effect compliance included a national programme from the Ministry of Social Affairs and Employment, the Versterking Arbeidsomstandighedenbeleid Stoffen (VASt) programme, which is specifically aimed at small enterprises, requiring employers, in sectors with previously identified relatively high risks from hazardous chemicals, to prepare action plans at the sectoral level for their reduction. Each action plan should contain sectoral improvement activities regarding:

- substances, exposure and measurements
- communication in the supply chain
- the knowledge infrastructure.

By March 2006, 25 such action plans had been written, of which 24 had commenced.

Another major Dutch strategy initiated by the Ministry of Social Affairs and Employment, aimed at improving systematic approaches to OSH in general, but with some overlapping relevance to chemical risk management, is the introduction of covenants (Arboconvenanten). These are agreements between employers and trade unions at the sectoral level, supported by the Ministry, that set voluntary targets for the improvement of a range of health and safety issues relevant to the sector, that are considered achievable by their signatories. There were 62 such covenants at the beginning of 2005. Handling hazardous chemicals was one of the issues identified in the action plans of 14 covenants.[35]

Sweden introduced an early shift in regulatory philosophy, moving towards requirements for management of risks, rather than detailed technical ones. This took place in 1991 with measures for systematic working environment management and was simultaneously implemented for chemical risk (Chemical Hazards in the Working Environment, AFS 2000:4, is the latest version). The main strategy is to effect a shift from detailed rules for specific substances, and some general demands for good housekeeping and hygiene, to a more comprehensive set of rules reflecting the demands for proactive risk management for chemicals, combined with more specified rules for specific substances. There are no regulatory measures or documented strategies aimed at small enterprises. However, there is a substantial body of knowledge that identifies the problems of chemical risk management in these enterprises and the difficulties are well known.[36]

There is no single study that grasps the entire range of problems encountered, but collectively several studies and experiences give a picture of the extent of the challenge. They suggest, for example, that there is much more limited knowledge in smaller companies concerning

substitution and control measures than present in their larger counterparts.[37] The ECLIPS study showed only 20 per cent of SDSs had no deficiencies of one sort or another.[38] Given such findings, the information base for chemical risk management in small companies is clearly problematic, a finding that is further confirmed by research on labelling.[39] A series of interviews in 2002 showed important differences between the risk management of chemicals in small and large companies, including the absence of specialist staff and routines in smaller organisations, and a concern with fulfilling broad regulatory requirements rather than more subtle aspects of chemical risk management.[40]

Regulatory inspection campaigns focused on chemical risk management – such as the one conducted in the autumn 2003,* despite prior notice of inspection, and an instruction to be fairly open minded in what they accepted as evidence of chemical risk management – caused inspectors to serve notices to improve chemical risk management on between 59 and 81 per cent of companies in the sectors concerned (ie printing, construction, engineering and carpentry, in which there was a high percentage of small enterprises). They found on average that one in three companies did not have access to Swedish SDSs for all the labelled chemical products that it used. Employers are expected to keep inventories of substances used in their workplaces, yet the inspection campaign found that more than 60 per cent of inspected companies were not in compliance either with regard to the possession of an inventory, or it being up to date. Few similar studies of inspection campaigns are available in other European countries, but there is no reason to suspect that the Swedish situation is markedly worse than in other European countries. Indeed, given that statistics imply that the frequency of work-related accidents and disease – including those related to chemicals – in Sweden are among the lowest in Europe, it would be surprising if this were the case.

In a statement in April 2005, the Swedish Work Environment Authority concluded that in many companies it is not possible to evaluate risks because of lack of measurements.† The number of compulsory measurements reported to the Swedish Work Environment Authority has decreased by about 50 per cent since the beginning of the 1980s. A factor certainly affecting the extent of measurement is the decrease in the number of occupational health services and the decline in the number of safety engineers working for them. Although none of these issues have prompted new regulatory strategies, they have strongly influenced the development of approaches and instruments that are mainly focused on achieving improvements in these areas of perceived weakness to help implement chemical risk management in small firms.

In the case of Austria, in keeping with its membership of the EU, the legislative position on chemical risk management has moved towards a greater emphasis on regulating more systematic management of risk. This has not occurred without some concerns about the nature of this change and its implications for the status and stringency of regulation, as well as about issues of flexibility, voluntarism and the role of compulsion in its achievement. Representation of the interests of small enterprises has tended to focus around issues of the cost-effectiveness and appropriateness of what are perceived as more 'bureaucratic' approaches to compliance with health and safety standards. Underlying such concerns are important questions about the

*The results from the campaign have not yet been published. The information presented in this report is based on personal communication with Maria Cronholm-Dahlin at the Swedish Work Environment Authority.
†Presentation by Claes Trägårdh, Swedish Work Environment Authority, at the Swedish Association of Occupational and Environmental Hygiene conference on 28 April 2005.

capacity of small enterprise owner-managers to implement regulatory requirements for OSH management developed around assumptions reflecting the experience of larger enterprises. It is certainly clear that the adequate operation of measures on chemical risk management in small enterprises cannot be inferred simply from their existence on the statute book.

In terms of suppliers' information, for example, the ECLIPS study revealed considerable deficiencies in the labelling of hazardous substances and in SDSs.[41] Further observations show that, in Austria, users frequently find they must request up-to-date and/or correct SDSs from suppliers, rather than being supplied with them in the first instance.[42] Equally significant for small enterprises is the evidence that users do not understand many parts of the SDS and that a large number of SMEs in Austria are not even aware of the existence of SDSs. Moreover, when drafting SDSs, suppliers take little account of the ability of SMEs to understand them.[43–45]

It is widely held that small enterprises have problems accomplishing the risk assessment process and its documentation, a situation that is supported by the many representations small enterprises and their organisations have made concerning the 'bureaucracy' of risk management requirements. According to the labour inspectorate, the practice of filling in templates for risk assessment and then filing this document so it can be produced during inspections is a common experience, which does not provide a good basis for risk communication within companies. Reasons for poor compliance with regulatory requirements have also been linked to the general lack of OSH infrastructure in both company operation and personnel in small companies compared to larger organisations. This is especially so for those in weak economic situations in sectors with structural problems, such as in building-related trade and textile production.[46,47] Experts in the major social insurance organisation for occupational risks in Austria, the AUVA, see the information deficit and the belief that OSH is expensive and labour-intensive as barriers to the practical implementation of preventive elements in SMEs. They conclude that there are still many gaps in SMEs regarding OSH management.[48] They further estimate that these gaps lead to specific problems in managing chemical risks, especially in those enterprises where chemicals play a peripheral and infrequent role in production.[49]

Limited resources mean that inspection alone is not sufficient to address these problems. Regulatory strategists in Austria are not unaware of this overall situation or that it requires a response.[50] It was to address some of these challenges posed by risk management in small enterprises that, in 1999, the AUVAsicher ('AUVAsafe') system was established.

Increasingly evident in national and European discussions on strategies to improve chemical risk management in small firms is the potential of the supply chain as an important influence and support. Suppliers of chemical products are well placed to deliver support for their customers in the safe use of their products and, indeed, they have legal obligations to do so. This is also emphasised by the provisions of REACH, which will require communication between suppliers and users concerning arrangements for the safe use of chemical products. The power of the supply chain rests in the economic dependencies within it and their potential for manipulation to require good practice on health and safety. However, one of the most prominent research findings on the operation of chemical risk management in small enterprises concerns users' difficulties with suppliers' information, suggesting that despite their advantageous position, many suppliers have not delivered such support. And as the findings of the ECLIPS study also demonstrate, information provided is often incomplete or misleading. It is also notable that the same economically dependent position of small enterprises, that potentially enables suppliers to influence them, also makes the small enterprise far less able to

require the same degree of conformance to their own requirements from their suppliers. Indeed, this may constitute a potentially significant barrier to achieving effectiveness in the two-way communication envisaged by REACH.

A further important point is that risk management is not only affected by suppliers of chemical products. Many chemical hazards are affected by the equipment used, either because it produces chemical contamination itself, or because it is not equipped with proper controls such as suitable exhaust ventilation. Recent Swedish findings include several examples of suppliers not having enough knowledge about the chemical risks associated with the equipment they market and sell, and thus not giving the appropriate advice.[51] Therefore, problems of insufficient knowledge about chemicals concerns not only the users, but evidently also at least some manufacturers of chemicals and equipment.

Despite the extensive research that identifies the limitations in the provision and use of the chemical supply chain to support good chemical risk management practices in small enterprises, regulatory agencies in some countries have made use of supply chain relationships to promote advice and information on chemical risk management. This is especially the case in countries such as the UK, where market-based approaches to compliance in recent years have been advocated strongly by regulatory policy-makers. Particular attention has been paid to the potential role of intermediaries in the economic networks of small businesses to promote or reinforce health and safety messages. To help spread *COSHH Essentials*, for example, the Health and Safety Commission (HSC) and the Health and Safety Executive (HSE) used intermediaries such as the Trades Union Congress (TUC), the Chemical Industries Association (which ran nationwide seminars through its 'Responsible care' network), the Institution of Occupational Safety and Health (IOSH), and the HSBC and National Westminster banks (which reached over 300,000 small firms and new businesses with features in their business newsletters).

Research consultancy firms such as Greenstreet Berman, used extensively by the HSE to undertake research that underpins health and safety policy in the UK, note that clients who make health and safety a precondition for their suppliers can have a significant impact on them, especially in comparatively heavily regulated sectors such as chemicals.[52] In his study of small firms, Briggs[53] found that the supply end was the most common source for information on the chemical products. Two in three users cited container labels, closely followed by suppliers and sales representatives. Briggs also found that the most influential source of information on the safe use of chemicals came from supplier sales representatives (38 per cent of respondents). Official literature was cited by only 6 per cent of the respondents in his study. His report also looked at the information that managers and one-person businesses would use to make sure they were adhering to general health and safety standards. Again, the two main sources were suppliers (49 per cent) and supplier safety data sheets (45 per cent). Formal guidance, such as that issued under the COSHH Regulations, was cited as a source they used to ensure their compliance with standards by just 20 per cent of respondents, and Approved Codes of Practice (ACoPs) by a mere 6 per cent.

In all the countries studied, the chemical industry utilised the supply chain to inform the safe use of its products. Two programmes in particular, 'Responsible care' and 'Product stewardship', have been vigorously promoted within the industry internationally. 'Responsible care' is largely focused on environmental matters and participating companies commit themselves to reducing their emissions and to search for processes that will be less of a burden to the environment. 'Product stewardship' concerns the sound management of the safety,

health and environmental effects of a product during its entire lifecycle through continuous improvement. It is the products and supply chain-oriented part of the 'Responsible care' programme of the international chemical industry and extends marketing efforts for a product to the environmental effects that take place beyond the sales process and until the end of the product's lifecycle. This requires co-operation in the company between management and employees, as well as with other stakeholders such as dealers and users. The programme is intended to offer an early warning system for safety, health or environmental risks of a product, allowing problems to be tackled proactively and in co-operation with other involved parties. It should lead to increased trust between suppliers and customers, and greater confidence throughout the whole product chain, as well as acting as a motor for continuous innovation that will enable incorporation both of new regulatory and market developments.

While recent policy development, with its emphasis on supply chain relationships, creates considerable expectations of the self-regulatory role that the industry will play in chemical risk management through initiatives such as 'Responsible care' and 'Product stewardship', a reported weakness with the current application of these approaches concerns the limitations of their role outside the industry itself. In particular, the management of the safety of chemical products used in small enterprises is remote from the voluntary application of chemical industry control and somewhat beyond the reach of its economic power. Although the industry has evaluated the outcomes of its initiatives generally, we could find no evaluation addressed to these concerns, nor indeed were we able to identify any evaluation that focused specifically on the situation of small firms within such initiatives.

Tools to support the delivery of chemical risk management strategies for small enterprises

The strategies mentioned in the previous section are supported in all the countries studied by a range of instruments aimed at helping employers and employees in small enterprises to improve their management of chemical risks. Indeed, there are an enormous number of such instruments. In the Netherlands alone, for example, the research institute, TNO, has compiled more than 140 implementation tools in a single brochure. In Germany, various authorities in some federal states have produced similar compilations of German-sourced instruments.

The instruments cover a considerable spectrum of support ranging from information on hazards and risks that merely duplicates or supplements that which should be provided by suppliers, to quite extensive information, advice and guidance on detailed aspects of chemical risk management, including generic approaches to risk and exposure assessment and control. It was not the purpose of our study to catalogue the range of available support these instruments represent. We were more interested in features that link them to the new approaches to supporting chemical risk management in small enterprises outlined in the previous section, the extent to which their uptake has led to discernible improvement in the control of chemical risks in these enterprises, and what factors in the environment of small enterprises support this. There is, after all, a great deal of difference between the existence of tools to support chemical risk management and their uptake and use with positive effect in small enterprises.

One way of categorising the various support instruments is to consider them in terms of the ways they are intended to support the achievement of compliance with regulatory requirements. Although there are some differences of detail, most countries in the EU have broadly similar requirements for chemical risk management, derived from, or harmonised by, EU provisions. They include:

- substitution – obligatory for some substances in some countries. In most countries there is an obligation on duty holders to consider whether there may be safer products available
- risk assessment – this requires appropriate suppliers' information, ie on labels and in SDSs, but also the capacity to understand it and to consider the tasks for which chemical products are required. It also requires inventories of substances used. More technically, it requires exposure assessment
- information and training for workers about risks to health and safety and risk prevention and control measures, often interpreted as written working instructions
- implementing control measures according to the established hierarchy of good practice for control
- health surveillance where necessary.

For each of these broad requirements there is a plethora of instruments available to support employers. Although they originate separately in different sectors and different countries, many are very similar.

For example, there are several that help employers to review their purchasing policies, helping them consider both whether their use of hazardous chemicals is in all cases necessary and whether substitution by safer alternatives may be possible. In the Netherlands, there are well-developed instruments to aid in the calculation of likely exposure scenarios in the use of paints which help to inform the choice of products. In Germany, the Kooperationsstelle Hamburg has for several years engaged in projects supporting the development of tools for substitution, several of which were performed as European co-operation initiatives. They have been mostly focused on vegetable oils as substitutes for cleaning agents based on volatile solvents in offset printing, in the metal industry and in industrial processes in general, and as substitutes for mineral, oil-based concrete mould release agents in the construction sector. Its most recent project, CLEANTOOL, is focused on solutions for the degreasing of metal surfaces and is intended as an aid to SMEs. It is claimed that optimised solutions provided by the project should help to save costs while at the same time improving the quality of cleaning results and taking both environmental and health and safety aspects into account.[54]

Another German example, the BGIA-Spaltenmodell is a well-known scheme for the assessment of substitution, also known as the 'Column model' (Spaltenmodell). The tool allows a comparison of risks posed by different substances or preparations which could be used for the same task.[55] In its latest version, the scheme is based on six parameters, compared separately for the chemicals in question. If a chemical scores better in all six categories, it should be chosen for the task assessed. If a chemical rates better in some categories but worse in others, it is necessary to assess which hazards lead to a lower risk in the particular situation and choose the chemical accordingly. A more user-friendly online version of this tool is provided on the website of the Institute for Occupational Medicine, Safety Technology, and Ergonomy (Institut für Arbeitsmedizin, Sicherheitstechnik und Ergonomie eV (ASER)).

Tools to assist small companies to deal with suppliers' information exist in all the countries studied, since the inadequacies of such information are widely recognised. Suppliers' information is necessary for the first stage of risk assessment and the various instruments available often provide alternative and fuller sources of information about hazards and risk and more accessible instructions and advice on safe use. They support employers in assessing the risks of the use of substances in the situations in which they are intended to be used. It follows, therefore, that many such instruments have been developed by sectorally based interests with detailed knowledge of conditions at this level. In Austria, for example, there is a web-based support tool for general risk

assessment that is designed for smaller companies. This database is derived from a model project about sector-related basic risk assessments (supported by the AUVA and the social partners). The website is intended to be useful for SMEs in all sectors. It targets a wide range of risks and includes many chemical-related situations. The database can be searched by workplaces or sectors, and contains around 400 assessment documents for a broad spectrum of working environments, including the description of workplaces, tasks and OSH measures, documents for risk evaluation and the identification of necessary measures. There are complementary materials such as CD-ROMs on risk assessment and videos for specific sectors (eg hairdressing, metal and skin protection). There is a close connection with the AUVAsafe system, in which the ASER website is used as an instrument suitable for smaller companies.

In the Netherlands, the 'Stoffenmanager' ('Chemicals manager') and the older *Chemicakaartenboek*, an initiative of the former Veiligheidsinstituut (Safety Institute) and the Dutch chemicals industry, provide information on the hazards, risk assessment and safe use and storage of a range of substances.

Tools to deal with specific issues, such as the choice of personal protective equipment, are also numerous. For example, a German tool, developed specifically for the printing industry – designed to help small enterprises in the selection of appropriate personal protective equipment for use with chemical substances – was developed with the support of the insurance association of the printing industry and aids the selection of protective gloves and skin care products.[56] Introduced in 2004, the 'BASIS-Modul Hand- & Hautschutz' ('BASIS module on hand and skin protection') is the first module of BASIS, a sectoral occupational health information system for print shops and paper-processing enterprises ('Branchen- und Arbeitsschutz-Informations-System für Druckereien und Papier verarbeitende Betriebe').

Of somewhat greater relevance to current regulatory strategies are the 'complete tools' that exist in most countries, supporting small enterprises through the whole process of chemical risk management. Perhaps the most well known is the UK's *COSHH Essentials*, which was developed in tandem with the critical review of regulatory strategy on chemical risk management undertaken by the UK authorities in the late 1990s.[57] *COSHH Essentials* represents a web-based, comprehensive approach to chemical risk management in small firms.* In response to studies indicating that the single most important source of information used by duty holders in small enterprises is that provided by suppliers, the approach of *COSHH Essentials* utilises information used on suppliers' SDSs and on labels required by law. Using the steps outlined below, this information helps to establish accessible assessment and control criteria through a simple system of generic assessment based on the suppliers' hazard information ('R-phrases' and so on) combined with likely use scenarios. Generic approaches to health hazards and potential exposure are matched by equally generic approaches to control, using three basic control methods – general ventilation, engineering control, containment – and a fourth approach signalling that special controls needing expert advice are required. In emphasising accessibility and ease of understanding, as well as the use of readily available hazard information, the scheme is particularly geared to the needs of SMEs.† Its objective is to provide clear advice on good practice

*However, its focus on risk assessment, supported by advice on control measures, without addressing understandings of SDS or labelling, or the register of chemical products required in many EU countries, leads some critics to question the extent to which it is a 'complete' tool.

†But a recent study conducted in India indicated that *COSHH Essentials* was too complicated for SMEs. See www.saioh.org/ioha2005/Proceedings/Abstracts/SSI/AbstractI1_3.pdf and www.saioh.org/ioha2005/Proceedings/PPT/SSI/I1_4PPTweb.pdf.

in relation to appropriate controls and their selection. The HSE research on which the guidance is based argued that it was possible to determine a range of adequate control strategies and advice based on analogies with substances with similar hazardous properties.[58] In essence, therefore, the approach represents a process in which hazards and exposure potential (based on the extent of their likely use) are grouped in various combinations that generate appropriate control measures.

R-phrases defined under regulations are grouped into bands covering the range of seriousness of health effects resulting from inhalation, skin and eye contact. Each band signifies a different level of control measure required.

The basic scheme is presented as simple step-by-step guidance with checklists to take the reader through the process of assessment and a means of identifying the appropriate control guidance sheet for whatever operation the user requires. Although not comprehensive, it is fairly wide ranging in its coverage. It is intended that access to this guidance be supported by exploiting existing information routes that are used by owner-managers of SMEs, such as suppliers, trade associations, trade union representatives and OSH professionals.

Such complete tools are by no means restricted to the UK. In Sweden, the *KemiGuiden* ('Chemical guide') and the brochure *Kemitermometeren* ('Chemical thermometer') are typical 'working materials' providing support for chemical risk management that are designed for use by any company, regardless of sector, and with a focus on small companies. They were developed with support and financing from trade unions and employers' organisations. The *KemiGuiden* is an interactive tool designed to help small companies identify the requirements they need to fulfil on chemical risk management and giving advice on how to do so. It is made available through the joint employers–trade union organisation, Prevent.

The *KemiGuiden* gives tailored advice to companies based on answers to a set of questions that investigate in detail both the provisions and requirements with which the company has to comply, what routines are present in the company, and what control measures are needed. Both the Work Environment Authority and the social partners have assisted in marketing the *KemiGuiden*, and the Authority and several trade unions and employers' organisations have links to it on their homepages. The *KemiGuiden* covers not only requirements related to the work environment but also requirements from other authorities. It is, therefore, a holistic tool that in many ways meets the needs of small companies.

The most significant development of tools, both complete and specific, is found in Germany. Recent initiatives to support the new Hazardous Substance Ordinance include developing generic guidance in programmes such as the 'Einfaches Maßnahmenkonzept' ('Easy-to-use workplace control') scheme at the federal level, which is strongly influenced by the approach of *COSHH Essentials*. There are a large number of other tools developed within sectors and federal states of which the following examples are illustrative.

In Rhineland-Palatine, sector-specific guidance documents have been developed jointly by various institutions such as the labour inspectorate, the regional chambers of skilled crafts, the regional chambers of industry and commerce, and regional branches of liability insurance associations.[59] The instruments include checklists and specific examples that allow enterprises in respective sectors to check whether they are conforming to obligations under environmental and occupational health legislation and, if they are not, to eliminate deficits. Guidance documents were provided free of charge on CD for the metal sector in 2000 and for the wood and construction sectors in 2003.[60] By mid-2005, about 4,000 CDs had been distributed.[61] The three

guidance documents can also be downloaded from the Internet.[62] Guidance to the printing sector is currently under preparation. All four documents will be made available on a single CD.[63] The guidance document for each sector comprises seven modules, one of which deals with hazardous substances.[64] It addresses the inventory of hazardous substances, as well as the storage and handling of sector-specific substances. Under 'inventory', the obligatory substitution check is also covered.[65]

'Pragmatisches Management von Gesundheit und Sicherheit in kleinen Unternehmen' (PragMaGuS) ('Pragmatic management of health and safety in small enterprises') is an Internet portal providing another example of integrated systems developed at federal state level. It was part of a research project organised by the Social Research Institute Dortmund (Sozialforschungsstelle Dortmund (sfs)) between 2001 and 2004 and supported by insurance associations, trade bodies, trade unions and federal state agencies.[66,67]

The project aimed to establish a health and safety management approach that was simple, yet complied with legal obligations, evaluation and the transfer of its results. Chemical products are addressed as one of the 24 thematic building blocks of the project.[68] Generic information with regard to the use of chemicals presented for employers covers relevant issues, including the definition of 'hazardous substances', substitution, acquisition, and risk management measures for use, storage and disposal. In line with the conceptual approach of PragMaGuS, support provided on specific obligations is limited to explanations. For additional or more in-depth questions, users are referred to other sources, since the repetition of otherwise available support was not intended.[69]

Originating in North-Rhine Westphalia, the 'Gefahrstoffe im Griff' ('Hazardous substances under control') Internet portal was established in April 2004 as part of a project 'building a support network for SMEs'.[70–72] It provides well-structured access to information supplied by various German institutions.[73] Comprehensive information is accessible via four different modes:[74]

- through links to support tools for the design of control measures in a number of crafts, branches or sectors[75]
- through links to a wide range of general management tools, eg for substitution, forms for inventories of hazardous chemicals, forms for written work instructions and for oral instructions[76]
- through a search engine for various issues related to hazardous substances and to their management[77]
- through access to the KomNet website,* through which online advice by a network of experts is provided.

A comprehensive collection of links to such tools is available, comprising:

- databases and data collections related to hazardous substances

*The KomNet online advice system offers the opportunity to either pose questions to experts, electronically or by phone, or to search a database in which problems previously addressed are documented for all areas of health and safety including hazardous substances. Currently, the KomNet database contains nearly 2,400 so-called 'dialogues'. These are questions posed addressing specific problems, and the responses given. About 250 of these dialogues are related to hazardous substances. There is some evidence that a substantial proportion of these are initiated from small enterprises.

- a database of safety data sheets and tools for both the compilation and interpretation of safety data sheets
- tools for substitution checks and databases with solutions for substitution
- tools for risk assessment
- model forms for inventories of hazardous chemicals
- model forms for written work instructions
- support tools for oral instructions
- collections of legal and statutory texts.

The search engine 'Info-System Gefahrstoffe' is targeted exclusively at selected websites with dedicated information in German on hazardous and non-hazardous chemicals and on substitution products. Currently, more than 5,600 documents are included.

Another earlier project with the same name was developed in Aachen by the labour inspectorate ('Staatliches Amt für Arbeitsschutz Aachen') in co-operation with trade bodies and guilds, insurance associations, the regional Centre for Technological Advice and a number of painters who were members of the Painters' and Varnishers' Guild. The original Aachen project comprised both a set of Internet-based support tools and their promotion through leaflets and information meetings. If requested, advice was also provided to individual enterprises.[78] This offer was taken up frequently and simple, effective support provided.[79] The guidance is characterised by a pragmatic approach in five steps to the management of hazardous substances. Under a single portal, basic support tools are designed for the specific needs of five crafts and trades (painting and varnishing, tile fitting, building and office cleaning services, car repair and maintenance, carpentry) and address five tasks:[80]

- identification of substances as hazardous
- acquisition of safety data sheets
- introduction of an inventory of hazardous substances
- drafting of written work instructions
- oral instructions to employees.

Information is offered for each task, on a separate website, and is complemented by four model forms in electronic format and by a list of institutions, both in the area and in the state which may be contacted for additional advice.[81] In order to keep the tools simple, certain issues are not, or only indirectly, addressed, such as the substitution of hazardous substances and the obligation of controlling the exposure levels in the workplace.

One of the more internationally known German instruments for supporting chemical risk management is the 'Gefahrstoff-Informationssystem der Berufsgenossenschaft der Bauwirtschaft' (GISBAU) ('Hazardous substance information system of the insurance association for the construction industry'). A comprehensive system for the management of hazardous substances has been available since 1989 and is targeted primarily at SMEs. The core instrument of GISBAU is the WINGIS database and software package, available free of charge on CD. About 60,000 copies of the latest version of WINGIS (published in 2005), including the new Hazardous Substances Ordinance, have been distributed.[82] To assess its potential impact, this figure has to be compared to about 300,000 enterprises in the construction industry, which are members of the liability insurance association. Until October 2005, WINGIS was solely provided on CD. Complementary tools, however, could be accessed on the Internet.[83] In October 2005, an Internet version of WINGIS was launched.

The WINGIS CD is normally distributed to enterprises by the technical inspectors of the insurance association who have been trained in the use of the system. WINGIS provides task-specific information on a wide range of chemical products used in the construction industry, differentiated for four different groups of users – employers, occupational physicians, occupational hygienists and works councillors. It is based both on information on the ingredients collated by GISBAU and on product information provided by the suppliers via SDSs and technical instructions.[84] Issues covered for each product comprise:

- classification and occupational exposure limits
- exposure measurement methods
- health hazards
- toxicological characteristics
- occupational hygiene
- information on substitution
- technical and organisational control measures
- personal protective equipment
- first aid measures
- medical examinations
- handling, storage, disposal, spillage and transport.

Thus, differentiated support for risk assessment and the selection of control measures is offered. Furthermore, the WINGIS package facilitates the compilation of an inventory of chemicals and provides model work instructions in 13 different languages.[85]

The WINGIS system is complemented by so-called 'product codes' for up to 13 groups of chemical products widely used in the construction industry. For each of the groups or sub-groups, categories are defined according to criteria. The categories are arranged in such a way that the lower the number of a category within a group or sub-group, the lower are the hazards of the products included. Selection of the least hazardous product type necessary for a specific task is facilitated in a straightforward way by this system. For each category, model work instructions are available, sometimes also differentiated according to a variety of tasks if the products of the respective category can be used in various work procedures for which different control measures apply. On the GISBAU website, all model instructions are provided in both German and English.

The categorisation has been validated by a large number of exposure measurements and analyses of product samples.[86] As the working conditions described therein represent what is currently technically feasible, enterprises achieving these conditions are in compliance with the Hazardous Substances Ordinance. According to GISBAU experts, large manufacturers of chemical products for the construction industry report that their customers request products for which a product code has been allocated.[87] It is further estimated by the various supply associations for the painting trade that about 80 per cent of the paints and lacquers they supply exhibit a product code.[88] These observations suggest that, at least in the craft part of the construction sector, product codes are a popular tool.

Linking tools with strategies

As important as all these instruments may be, a more significant feature likely to influence the success with which such tools are adopted concerns the extent to which they are integrated into other elements of support in the environment of small enterprises. The Dutch VASt programme, for example, requires employers' engagement with preparation of

sectoral-level action plans in high-risk sectors that identify specific improvement activities. Alongside the other major Dutch strategy introducing covenants (Arboconvenanten) between employers and trade unions at the sectoral level – that set achievable targets for improvement of health and safety issues – this provides a framework for institutional support in which more specific tools for chemical risk management can be deployed.

In Sweden, the *KemiGuiden* was developed with support and financing from trade unions and employers' organisations. It is made available through the joint employers–trade union organisation, Prevent. Both the Work Environment Authority and the social partners have assisted in marketing the *KemiGuiden*, and the Authority and several trade unions and employers' organisations have links to it from their homepage. It is therefore delivered with the active institutional support of the regulatory authorities, employers and trade unions.

In Austria, the AUVAsicher ('AUVAsafe') system is provided by the AUVA, the major social insurance organisation for occupational risks in Austria. In response to the lobbying from small enterprises and their representatives, it established the AUVAsafe system as a free preventive support service for worksites with up to 50 employees in enterprises of no more than 250 employees. Employers in such worksites can call on the services of the OSH personnel of a prevention centre run by the AUVA. The programme in effect represents a redistribution of financial resources from bigger to smaller companies, since it is supported from the contributions paid by all companies insured against occupational accidents by the AUVA. Its primary objective is to reduce the number of work-related accidents and diseases. Chemical risk management is not the only part of its programme, since it covers a wide range of OSH issues, but it is nevertheless a central one.[89] In 2004, the programme focused its main activities on the 27 economic sectors with the highest accident rates. This led to sector-specific company visits in which detailed measures on sector-characteristic chemical risks were implemented.[90]

Many of the support tools in Germany have been jointly developed at sectoral and federal state level by organisations and agencies of the health and safety system (including insurance associations and regulatory inspectorates) and other sectoral and regional organisations (such as trade bodies, employers' associations and trade unions, university departments, health and safety information centres and prevention services). In many cases, these organisations also support their promulgation and are a major influence on their uptake. Indeed, while it cannot be substantiated systematically because of the absence of properly conducted evaluation, it was the impressionistic view of the research team that the most developed and operational of national approaches to supporting chemical risk management was found in Germany. This is not necessarily because of the degree of strategic development or because of the appropriateness of the instruments to implement it (though these are certainly both present in Germany), but because of the institutional support for implementation that is a feature of the environment of small firms, especially at the sectoral level in the country, where there appear to be well-developed opportunities to mix detailed sectoral- and branch-level understandings together with supply chain actors.

These observations are important. They support the notion that chemical risk management strategies aimed at small enterprises benefit from the engagement of intermediary actors and processes. However, in countries such as Germany, Austria and the Netherlands, it is noticeable that comparatively highly developed institutional engagement of this sort at the sectoral level comes from bodies such as insurance organisations, trade and employers' organisations, trade

unions and regulatory bodies. These are all traditional actors in the health and safety system and their engagement demonstrates the importance of active sectoral infrastructures in supporting chemical risk management. It is not obvious that in other countries – such as the UK and those in southern Europe, with far less developed sectoral infrastructures – there is the same kind of support or motivation for the engagement of intermediary actors and processes in supporting chemical risk management in small firms.

In summary, therefore, it is clear that the challenges of achieving effective management of the risks associated with using chemical products in small enterprises are widely acknowledged in northern European countries. And as the material in the previous two sections demonstrates, there are both strategies and instruments now in place to address these challenges. The effectiveness with which they do so is obviously an important question, and it is to the issue of evaluation that we now turn.

The evidence for success?

Despite a discernible strategic approach to dealing with chemical risk management in small enterprises and a plethora of tools to implement it, this review found only a limited number of properly conducted studies measuring the success, sustainability and transferability of these new approaches. The evaluation that exists indicates support for ideas concerning the advantages of simplicity, ease of use and relevance of the new generic tools for chemical exposure and risk assessment and control. For example, there has been a strand of technically orientated research modelling exposure assessment that has helped to underpin the development of ideas on more generic approaches to assessment and its role in determining strategies on managing chemical risk at national and EU levels.[91–94] Although limited in quantity and scope, technical studies on exposure assessment and control have been fairly positive concerning the levels of protection offered by such generic risk exposure and assessment.[95–99]

Others have pointed to the need to refine or target strategies for exposure and risk assessment to ensure efficiency in distinguishing between risk and hazard (see, for example, ECETOC 2004[100] for this approach and a review of others). Further studies have shown strengths in using multi-media approaches to reinforce information use and achieve improved control measures.[101] While these evaluations are important, they only address a small part of the problem of the uptake and use of instruments to improve approaches to exposure assessment and control in small enterprises, since they do not really deal with how the dynamics between actors have an impact on the effectiveness of the take-up of the strategies, ie what, in practice, supports or constrains the implementation of chemical risk management strategies by SMEs.

Evaluation, such as it is, of the effectiveness of the various supports to implementing chemical risk management points to several conclusions. To begin with dissemination, the evaluation of sources of information, guidance and advice, other than that involving human interaction, has been mostly limited to counts of the quantity of uptake users and use, such as with the records of distribution of paper guidance and CDs or with counts of visits to Internet-based guidance such as the *KemiGuiden* in Sweden,* *COSHH Essentials* in the UK,[102] the distribution of inquiries on the KomNet database, and the number of visits to the 'Gefahrstoffe im Griff' portal in Germany. Sometimes, where such source tools are interactive, inferences are drawn

*For example, by April 2006, more than 3,500 interactive guides had been completed resulting in tailored advice according to needs in enterprises. Additionally, the website and some of the main pages receive about 5,000 to 10,000 hits every month.

about use from time logged onto a site or following multiple visits of a particular user to the same site. However, apart from such quantitative measures of interest, little is known about the quality of use beyond the studies referred to previously, which were largely undertaken during the piloting of particular instruments and were arguably carried out in conditions that are not representative of those found more widely among the small enterprise business community.

This leads to consideration of the impact of interventions in terms of the outcomes that are targeted. Clearly, safer and healthier use of chemical products is the desired outcome of chemical risk management, but there are few examples of evaluation of effectiveness in such terms. Recognising the problems of determining reliable trailing indicators that are practicable to measure, it is anticipated that leading indicators of improvements would be used as their proxies. However, this may not be entirely straightforward in small firms in which conventional approaches to management activities do not apply. Whatever the reason, it appears that existing evaluations are conducted with only limited reference to either form of indicator.

Research demonstrates that the provision of tools and sources of information alone is insufficient to motivate owner-managers in small enterprises to ensure their effective use. However, there are no widely applicable conclusions concerning the effectiveness of the various incentives and pressures on owner-managers, or on the detailed processes by which such incentives and pressures might operate. In studies on health and safety arrangements for small enterprises more generally, actors and processes in the economic, social and regulatory environment of small enterprises are highlighted as significant levers in improving health and safety management. Face-to-face contact with change agents is regarded as the most important influence on the behaviour of employers and workers in small enterprises, whether such agents are the conventional actors of the health and safety system such as inspectors, worker safety representatives, OSH practitioners and consultants, or less conventional intermediaries such as supply chain actors bearing health and safety messages.[103] However, there has been little evaluation of this aspect of promoting new approaches to chemical risk management in small enterprises. Nor has there been much in the way of systematic study of the resource implications of the engagement of these actors and processes in support of instruments to improve chemical risk management. There are a few studies that have addressed the dynamics of interaction between actors within small workplaces or between them and providers of information, inspection and control in relation to chemical risk management. Some relevant work has been undertaken in the UK concerning employers' and employees' capacity to handle suppliers' information,[104,105] as well as on the flow of information between firms and their environment, and its effect on the influence of regulatory intervention.[106] There is some evidence from Scandinavian countries, especially from Sweden, concerning the role of occupational health services and consultants as change agents in small enterprises,[107] but little specific information concerning their role in relation to chemical risk management, although it is thought by observers that, for reasons previously outlined, this role is likely to be limited.[108]

Attempts have also been made in the UK to model the interface between expert and user information on chemicals that the researchers claim aids understanding of risk communication, and demonstrate that difficulties in the application of information on chemical risk management in small enterprises is far more complex than simply the poor understanding of information by users.[109] They further point out that risk communication alone will not necessarily overcome strongly embedded practices and needs to be integrated with other approaches to be effective, including training regimes, regulatory change and technical innovation.[110,111]

There are only a few recent studies on the role of regulatory inspection and control in relation to chemical risk management, and those that exist reach inconsistent conclusions. In the UK, the HSE has collated some information on enforcement of the COSHH Regulations. Although not analysed by enterprise size, they show that, in 1997–2000, between 12 to 21 per cent of enforcement notices concerned these Regulations, indicating that a substantial amount of the regulatory agency's time and resources were taken up with addressing compliance with chemical risk management.[112] A more recent study concerning compliance of small enterprises with, *inter alia*, the COSHH Regulations, demonstrated that the influence of regulatory inspectors was positively associated with compliance with prescriptive regulatory requirements, while compliance with those involving process-based risk assessment and control activities were more influenced by the requirements of economically significant clients.[113] However, other research on the compliance behaviour of small enterprises more generally has emphasised the importance of the threat of inspection and the influence of the regulatory agency in perceptions concerning reasons for compliance among small businesses.[114] Largely anecdotal material presented by inspectors in Italy emphasised the importance of advisory approaches by inspectors and regional- and sectoral-level co-operation between inspectors, small firm trade associations and trade unions in securing better chemical risk management in certain sectors in northern Italy. In the same study, similar experiences were reported as occurring in the Netherlands and Sweden.[115]

In Sweden, and to a lesser extent in Italy and Norway where there are statutory requirements covering them, the role of trade union regional health and safety representatives is linked with the provision of effective advice and awareness-raising on health and safety in small enterprises. Researchers reviewing their activities in Sweden point to the relatively large numbers of such representatives in the country and demonstrate that employers and workers in small enterprises have far greater access to them than to other agents of the health and safety system, such as regulatory inspectors or occupational health services. However, despite studies demonstrating their effectiveness generally in small enterprises, there are no studies of their role in relation to chemical risk management specifically.[116,117]

Another major consideration that emerges from the evaluation of experiences to date concerns the question of the specificity of the new approaches to exposure assessment and control. Despite the attraction of the potential widespread use of generic approaches to chemical risk management, the reality is that both they and the supports for their application are often highly sector specific and dependent on this specificity for the preconditions that underpin their success. While there is evidence that some approaches developed for specific sectors are transferred to a wider range of sectors, or the extension to other trades is intended or under way, if an integral part of the approach in question involves the existence or the installation of a support structure, the issue becomes more complex. Such is the case of the 'Gefahrstoffe im Handwerk' approach in Germany, for example, where adaptations to technical or process-related specifics of the sectors or trades to which the approach is to be extended have been shown to be necessary preconditions, while the underlying methods of the approach may remain the same. Therefore, not only must the traditions and the social and organisational conditions in the additionally targeted sectors and trades be taken into account, but the local or regional specifics also have to be considered, as such support structures are typically based at local or regional level.

For certain approaches and strategies, therefore, only the underlying method can be applied whereas the concrete details have to be adapted to the particularities of the sector or the process. Examples include sector agreements and sector- or process-specific solutions such as

the substitution of volatile organic solvents by vegetable oils in various applications as pursued by the 'Kooperationsstelle Hamburg', or certain elements of the hazardous substance information systems established by German insurance associations.

In this sectoral context, further strategic differences between approaches pursued in different sectors are relevant, such as where there is a background of different levels of technology predominant in different sectors. For example, some of the differences between the GISBAU system in the construction industry in Germany and branch agreements in the printing industry in the same country can be understood in this way. Whereas the chemicals used in the construction industry are mainly applied independently of complex technical equipment, the situation is different in the printing industry. Thus, when considering the substitution of chemicals in the print industry, restrictions imposed by the use or the treatment of highly valuable equipment, such as printing presses, have to be taken into account. Manufacturers have to be involved as additional actors in the development of viable substitution solutions.

For many applications, such equipment-induced restrictions do not exist and, thus, substitution solutions can evolve bilaterally between user of chemicals and supplier. It could be hypothesised, therefore, that for a setting including only two major actors – user of chemicals and supplier of chemicals – the introduction of a rather simple tool such as a product code is sufficient to initiate substitution or other control processes in the sector. Whereas for the more complex setting including three major actors – user of both chemicals and technical equipment, supplier of chemicals and supplier of technical equipment – an external promoter, such as the insurance association in the German case, is needed to initiate and moderate the control processes.

Some wider concerns for evaluation

There is also a need to undertake evaluation at a different level. As the study discussed here demonstrates, implicit in current strategic thinking is the notion that somehow the environment of the small enterprise can be utilised to support and sustain the implementation and effective operation of approaches to chemical risk management in ways that will enhance the traditional roles of regulation, inspection and control, and of organised labour. It is supposed that there is a set of relevant institutional supports in the business environment of small enterprises – based largely around supply chain relationships between the enterprise and its suppliers and clients, but also including sectoral organisations, financial backers and advisers, education and training providers, and even public interest groups – with the potential to be brought to bear as levers and supports to ensure the implementation and operation of chemical risk management at the level of the enterprise. While it is true that there are examples of most of these forms of engagement in the countries under review, there is a need for a more thorough investigation and evaluation of how they actually work and what they achieve in practice. It is necessary to understand why some approaches work well in certain sectors and processes but will not work in others. It is equally important to know what the costs of such engagement are, both to the actors involved and to the bodies that are seeking to involve them, and to determine if such approaches are really as cost-effective as they are supposed to be or whether they are simply transferring costs within the economy overall. To inform evidence-based policy, therefore, a more structured and targeted approach to the evaluation of all these factors is desirable, in which underlying principles can be distinguished and institutional and infrastructural influences that help to determine outcomes more clearly determined.

A related important consideration is the need for a better understanding of the effectiveness of the role of the chemical industry itself in relation to the small enterprise downstream users of its products. It is clearly evident that in all countries and at the level of the EU, implicit in

current policy development – with its emphasis on supply chain relationships – are considerable expectations of the self-regulatory role that the industry will play in chemical risk management. The industry initiatives such as 'Responsible care' and 'Product stewardship' acknowledge its responsibilities. However, in most countries there appear to be continued problems of quality and access to suppliers' information. The opinions of users (and to some extent of regulators too) are that there remain differences between the quality of experiences within the industry and those of downstream users. In many interventions to improve chemical risk management, mediation between the information from the industry and the delivery of risk management within the small enterprise are the major foci. There may be ways in which the chemical industry can engage further in this process through improved risk communication and through working more closely with intermediary organisations. Better quality in SDSs and a more structured and targeted strategy on the part of the industry may be required in relation to the dissemination of information on hazardous substances. Greater attention needs to be paid not only to the needs and capacities of downstream users but also to the production networks in which they operate, the institutional supports on which they draw for the implementation of chemical risk management, and the dynamics of the social and economic interactions that are their basis.

Implicit here is the need to know more about the scale and coverage of new initiatives to improve chemical risk management in small enterprises. A major weakness of previous approaches, as we have identified, is the limitations of their coverage of small enterprises, brought about largely because of the limited resources of specialist agents of the health and safety system such as regulatory inspectors and occupational health services. Indeed, one of the reasons why newer approaches are proposed is the notion that they will extend improved chemical risk management to situations that are hard to reach by traditional means. The arguments for this are theoretically persuasive but to date the evidence for their achievement has not been convincingly presented. There is much scope for the further development of the role of suppliers in risk communication and in the dissemination of control strategies for their products. Indeed, support for the two-way exchanges that are a prominent feature of the new regulatory policies underpinning REACH would seem to require the further development of their role in such directions. Yet despite these major departures from previous regulatory approaches, to date there is very little evidence on which to predict their success.

It is also clear that there is much duplication of effort among the various relevant approaches and the instruments employed. While in some countries and in some sectors there are cases of good communication allowing the development and promulgation of practices across regions and sectors, with few exceptions the overall profile of chemical risk management initiatives for small enterprises remains low. Information about the many individual cases of good practice that are in existence in northern European countries remains largely specialist knowledge and general access to it is limited. Indeed, complaints concerning the inaccessibility of such information by small enterprise owner-managers appear to be almost as significant an element of recent research findings as they were in the studies that led to the current generic strategies on exposure assessment and control. While it is by no means a panacea to resolve such problems, perhaps some steps could be taken in this direction through better information access and dissemination at the EU level and greater attention to this matter by agencies such as the European Agency for Safety and Health at Work, as well as for actors within the European chemical industry. In the run up to the implementation of REACH, with its emphasis on supply chain relationships and EU-wide networks involving manufacturers, suppliers and users, there is a need to provide small firms with a far more co-ordinated and conspicuous information service to support good practice than appears to be the case at present.

Conclusions

The overarching conclusion concerning the evaluation of strategies to support chemical risk management in small enterprises is that evaluation itself is very limited and in many cases non-existent. There has been some properly conducted research on the technical aspects of exposure assessment modelling, generic risk assessment and control of chemical hazards, which has been used to inform policy development. However, there has been far less properly undertaken evaluation of initiatives to effect such assessment and control in practice in relation to small enterprises. Such evaluation that exists is firstly often limited to self-evaluation in which participants with vested interests in the success of such schemes, not surprisingly, find them to be successful. Secondly, these evaluations are frequently limited to the narrow circumstances of the application of a particular initiative and rarely seriously consider supports and constraints relevant to its wider use. There remain significant questions concerning how evaluation should be undertaken and what should be evaluated. Clearly, it is important to determine the extent to which programmes and tools work effectively in implementing improved chemical risk management at the level of the workplace. Questions that need to be posed include:

- how reliable are they?
- do the generic approaches they use always provide for safe and cost-effective management of chemical risks?
- what safeguards are there to ensure the correct use of such approaches?
- are there conditions in which their use would be inappropriate and, if so, how common are such situations?

Most of the limited evaluation undertaken so far has focused on some, but not all, of these aspects. More than this, however, there is a demonstrable need to consider the dynamics of the social processes at work in small enterprises and the networks of production in which they are located, which determine the uptake and application of such approaches and their instruments. It is further necessary to understand more about support for their sustainability and transferability. In so doing it is particularly important to acknowledge that small enterprises are not a homogenous group of organisations sharing a similar set of features. It is therefore extremely unlikely that, in the case of strategies for chemical risk management, 'one size fits all'. Therefore, properly structured and targeted approaches that account for such differences are likely to be required.

Finally, elements of evaluation need to be connected. This study has found few cases where this is so. Its reports on the national situations conclude that, while in each country it is possible to identify relevant broad regulatory principles on the management of hazardous substances – and, in most cases, principles governing improving OSH management in small enterprises – it is less easy to demonstrate a clear or explicit relationship between the two. They all identify accounts of the methods and tools used to support chemical risk management in small enterprises and report some evidence of their effectiveness in particular situations. However, such evidence is quite limited and often not generalisable beyond the situation to which it applies. There are no substantial evaluations of support from other institutions and processes in the economic and regulatory environment of the small firm, even though it is quite clear that the operation of chemical risk management methods and tools are ultimately dependent on their engagement for long-term success. Therefore, there is relatively little evidence of effective transferability of these methods and tools. Neither is there much evidence of the development of the necessary systematic approaches to tackling these issues at the level of the EU, which are necessary if the approaches envisaged in the regulatory discourse surrounding REACH are to be implemented successfully in the future.

References

1. Walters D R. *Health and safety in small enterprises*. Brussels: PIE-Peter Lang, 2001.
2. Commission of the European Communities. *White paper: strategy for a future chemicals policy*. COM (2001) 88 final. Brussels: 27/2/2001.
3. CEFIC. *Facts and figures. The European chemical industry in a worldwide perspective*. 2004. www.cefic.org/factsandfigures.
4. Commission of the European Communities. *White paper: strategy for a future chemicals policy*. COM (2001) 88 final. Brussels: 27/2/2001.
5. Walters D R. *Health and safety in small enterprises*. Brussels: PIE-Peter Lang, 2001.
6. European Foundation for the Improvement of Living and Working Conditions. *Third European Working Conditions Survey*. Luxembourg: Office for Official Publications of the European Community, 2001.
7. Kogevinas M. *Estimation of the burden of occupational cancer in Europe*. Europe against Cancer, 1998.
8. Kauppinen T *et al*. Occupational exposure to carcinogens in the European Union. *Occupational and Environmental Medicine* 2000; 57: 10–18.
9. DARES. Les expositions aux produits carcinogens. *Premiere Syntheses Informations* 2005; 28 (1).
10. Kremer A. Gevaarlijke stoffen. *Deelresultaten van de Nationale Enquête Arbeidsomstandigheden, 2003* ('Hazardous substances. Part of the results of the National Survey on Working Conditions, 2003'). TNO. Not yet published.
11. Musu T. REACHing the workplace. *How workers stand to benefit from the new European policy on chemical agents*. Brussels: TUTB, 2004.
12. Pickvance S, Karnon J, Peters J and El Arifi K. *The impact of REACH on occupational health*. Brussels: ETUI-REHS.
13. Doll R and Peto R. The causes of cancer: quantitative estimates of avoidable risks of cancer in the United States today. *Journal of the National Cancer Institute* 1981; 66 (6): 1191–1308.
14. Kogevinas M. *Estimation of the burden of occupational cancer in Europe*. Europe against Cancer, 1998.
15. Morrell S, Kerr C, Driscoll T, Taylor R, Salkeld G and Corbett S. Best estimate of the magnitude of mortality due to occupational exposure to hazardous substances. *Occupational and Environmental Medicine* 1998; 55: 634–641.
16. Greenberg R S, Mandel J S, Pastides H, Britton N, Rudenko L and Starr T B. A meta analysis of cohort studies describing mortality and cancer incidence among chemical workers in the United States and Western Europe. *Epidemiology* 2001; 12 (6): 727–740.
17. Leigh J, Macaskill P, Kuosma E and Mandryk J. Global burden of disease due to occupational factors. *Epidemiology* 1999; 10 (5): 626.
18. Postle M, Vernon J, Zargianis P and Salado R. *Assessing the impact of the new chemicals policy on occupational health*. Final report for the European Commission, Environment Directorate General. Looden, Norfolk: Risk Policy Analysts Ltd, 2003.
19. Landrigan P J and Baker D B. Clinical recognition of occupational and environmental disease. *Mt Sinai Journal of Medicine* 1995; 62 (5): 406–411.
20. Landrigan P J, Markowitz S B, Nicholson W J and Baker D B. Cancer prevention in the workplace. In: Greenwald P, Kramer B S and Weed D L (eds). *Cancer prevention and control*. New York: Marcel Dekker, Inc, 1995: 393–410.
21. Davis D L. Trends in cancer mortality in industrial countries. Report of an international workshop, Carpi, Italy, October 21–22, 1989. *Annals of the New York Academy of Sciences* 1990; 609: 4.
22. Clapp R, Howe G and Jacobs Lefevre M. *Environmental and occupational causes of*

cancer: a review of recent scientific literature. UMASS Lowell, September 2005. www.sustainableproduction.org.
23. Walters D R. *Health and safety in small enterprises*. Brussels: PIE-Peter Lang, 2001.
24. Nichols T. The sociology of industrial injury. London: Mansell, 1997.
25. Samways M. Functionally illiterate worker also has right-to-understand. *Occupational Health and Safety* 1988; 57 (1): 49–50, 52–53.
26. Research International. *Industry's perception and use of occupational exposure limits*. HSE CRR no. 144. Sudbury: HSE Books, 1997.
27. Geyer A, Kittel G, Vollebregt L, Westra J and Wriedt H. *Assessment of the usefulness of material safety data sheets (SDS) for SMEs*. Final project report. Linz: PPM, 1999.
28. Chemical Legislation European Enforcement Network (CLEEN). *ECLIPS European classification and labelling inspections of preparations, including safety data sheets*. Final report. 2004. www.cleeneu.net/projects/ECLIPS_Final_report.pdf.
29. Walters D R. *Health and safety in small enterprises*. Brussels: PIE-Peter Lang, 2001.
30. Antonsson A-B, Birgersdotter L and Christensson B. *Varför vidtas (inte) arbetsmiljöåtgärder? En systemanalys av åtgärder mot isocyanater i bilverkstäder* ('Why are control measures (not) implemented? A system analysis of control measures that reduce isocyanates in car bodywork repair'). IVL-report B1668, 2006 (English summary).
31. Lamm F and Walters D R. Regulating occupational health and safety in small businesses: some challenges and some ways forward. In: Bluff L, Gunningham N and Johnstone R (eds). *OHS regulation for a changing world of work*. Sydney: Sydney Federation Press, 2004.
32. Walters D R and Grodzki K. Beyond limits? *Dealing with chemical risks at work in Europe*. Oxford: Elsevier, 2006.
33. Topping M. Occupational exposure limits for chemicals. *Occupational and Environmental Medicine* 2001; 58: 138–144.
34. Russell R, Maidment S, Brooke I and Topping M. Introduction to a UK scheme to help small firms control health risks from chemicals. *Annals of Occupational Hygiene* 1998; 42 (6): 367–376.
35. Jongen M, Marquart H, Nossent S and Visser R. *Prioritering van branches en ketens voor de versterking van arboleid rond gevaarlijke stoffen* ('Prioritisation of branches and chains for the enhancement of the OSH policy concerning hazardous chemicals'). TNO, 2003: 16.
36. Norrby C. *Hur ska vi nå de minsta företagen? Kemikaliearbete* ('How shall we reach the smallest companies?' Chemical work). IVF report 97850. IVF, 1997.
37. Alvarez de Davila E and Cerne O. *Substitutionsarbete vid svenska företag* ('Substitution of chemicals – how is it done in Swedish companies?'). IVL-report B1316. 1999.
38. Chemical Legislation European Enforcement Network (CLEEN) 2004.
39. Förstår forbrugerna – Advarselmaerkningen af husholdningskemikalier. Produktkontrollgruppen, Köpenhamn. *Nordiska ministerrådets miljörapport* 1986: 7.
40. Alvarez de Davila E, Antonsson A-B and Frostling H. *What support do companies and organisations need regarding chemicals*. A pilot study. IVL-report B1511. www.ivl.se/rapporter/pdf/B1511.pdf. (in Swedish)
41. UBA (ed.). ECLIPS. Europäisches Projekt zur Kontrolle der Einstufung und Kennzeichnung sowie der Sicherheitsdatenblätter von gefährlichen Zubereitungen. *Österreich-Beilage. Zusammenfassung des Projektes und Auswertung der Österreichischen Ergebnisse*. Vienna: UBA. www.umweltbundesamt.at/fileadmin/site/umweltthemen/chemikalien/ECLIPS_Oesterreich_Bericht.pdf.
42. AUVA (Püringer Joe (ed)). CD-ROM. *ArbeitnehmerInnenschutz expert*. Informationssystem ArbeitnehmerInnenschutz. Wien: Verlag Jusline, 2005. (latest update).

43. EU OSHA (ed.). Dangerous substances – Handle with care. *Magazine* 6. Bilbao: EU OSHA, 2002. http://agency.osha.eu.int/publications/magazine/6/magazine6-en.pdf.
44. Geyer A and Kittel G. *Beurteilung der Verwendung und Brauchbarkeit von Sicherheitsdatenblättern für Klein- und Mittelbetriebe. Endbericht Österreich*. Linz: PPM, 1999.
45. Geyer A, Kittel G, Vollebregt L, Westra J and Wriedt H. *Assessment of the usefulness of material safety data sheets (SDS) for SMEs*. Final project report. Linz: PPM, 1999.
46. ÖNBGF (ed). *Health at the workplace in small and medium-sized companies*. Linz: Österriechisches Netzwerk Betriebliche Gesundheitsförderung, nd. www.netzwerk-bgf.at/.
47. Kranvogel E, Sperr H, Bautzmann A, Pochobradsky E and Schleicher B. *Managementsysteme für den Sicherheits- und Gesundheitsschutz in Kleinbetrieben*. Wien: ÖBIG, 2000. http://at.osha.eu.int/good_practice/oebig-kmu.pdf.
48. Bochmann F, Hartlieb D, Meffert K, Mur J M, Nold A, Pils P and Stamm R. Work-related health risks: research and company practice. ISSA prevention series no. 2049. Paris: INRS (International Social Security Association), 2004. http://research.prevention.issa.int/product/GTBoch_En.pdf.
49. Bochmann F, Hartlieb D, Meffert K, Mur J M, Nold A, Pils P and Stamm R. *Work-related health risks: research and company practice*. ISSA prevention series no. 2049. Paris: INRS (International Social Security Association), 2004. http://research.prevention.issa.int/product/GTBoch_En.pdf.
50. Kranvogel E, Sperr H, Bautzmann A, Pochobradsky E and Schleicher B. *Managementsysteme für den Sicherheits- und Gesundheitsschutz in Kleinbetrieben*. Wien: ÖBIG, 2000. http://at.osha.eu.int/good_practice/oebig-kmu.pdf.: 40ff.
51. Antonsson A-B, Birgersdotter L and Christensson B. Varför vidtas (inte) arbetsmiljöåtgärder? *En systemanalys av åtgärder mot isocyanater i bilverkstäder ('Why are control measures (not) implemented?* A system analysis of control measures that reduce isocyanates in car bodywork repair'). IVL-report B1668, 2006. (English summary).
52. Wright M, Marsden S and Antonelli A. *Building an evidence base for the HSC strategy to 2010 and beyond: a literature review of interventions to improve health and safety compliance*. RR 196. Greenstreet Berman. Sudbury: HSE Books, 2003.
53. Briggs D and Crumbie N. *Characteristics of people working with chemical products in small firms*. CRR278/2000. WS Atkins. Sudbury: HSE Books, 2000.
54. CLEANTOOL Consortium (ed). 2004 CLEANTOOL. *Innovative evaluation and design of industrial surface cleaning processes*. Project summary. Extract from the final report. Hamburg. www.cleantool.org/xct/downloads/summary_finalversion_041018.pdf.
55. BIA (Berufsgenossenschaftliches Institut für Arbeitssicherheit) (ed). *Das Spaltenmodell. Eine Hilfestellung zur Gefahrenermittlung und Ersatzstoffprüfung nach § 16*. Sankt Augustin: Gefahrstoffverordnung, 2001: 6. www.hvbg.de/d/bia/pra/spalte/index.html. English version: The column model. An aid to risk identification and substitute assessment. www.hvbg.de/e/bia/pra/spalte/index.html.
56. Branchen- und Arbeitsschutz-Informations-System der Berufsgenossenschaft Druck und Papierverarbeitung (ed). *Modul Hand- & Hautschutz*. Wiesbaden, 2004. www.basis-dp.de/als/index.html.
57. Walters D R and Grodzki K. *Beyond limits? Dealing with chemical risks at work in Europe*. Oxford: Elsevier, 2006.
58. Russell R, Maidment S, Brooke I and Topping M. Introduction to a UK scheme to help small firms control health risks from chemicals. *Annals of Occupational Hygiene* 1998; 42 (6): 367–376.
59. Ministerium für Umwelt und Forsten und Ministerium für Arbeit, Soziales, Familie und Gesundheit, Land Rheinland-Pfalz (ed). *Über das Projekt SGU*. Mainz: Vorwort, 2000.

www.sgu-rlp.de/Ueber_das_Projekt_SGU/P0B80A443-536B-4844-81EB-2782F772C70E.htm.
60. Ministerium für Umwelt und Forsten und Ministerium für Arbeit, Soziales, Familie und Gesundheit, Land Rheinland-Pfalz (ed). *Neues aus der Fachkommission SGU*. Mainz, 2003. www.sgu-rlp.de/Neues_aus_der_Fachkommission/P744D348A-AB34-42BC-991B-78A4D0122389.php3.
61. Schulte-Hubbert P. Ministerium für Umwelt und Forsten Rheinland-Pfalz. Personal communication, 12 October 2005.
62. Ministerium für Umwelt und Forsten und Ministerium für Arbeit, Soziales, Familie und Gesundheit, Land Rheinland-Pfalz (ed.) *Download-Bereich*. Mainz, 2003. www.sgu-rlp.de/Download/P4C9372F9-A468-4573-9727-7898318BBDC2.php3.
63. Schulte-Hubbert P. Ministerium für Umwelt und Forsten Rheinland-Pfalz. Personal communication, 12 October 2005.
64. Ministerium für Umwelt und Forsten und Ministerium für Arbeit, Soziales, Familie und Gesundheit, Land Rheinland-Pfalz (ed). *Über das Projekt SGU. Aufbau des Leitfadens*. Mainz, 2000. www.sgu-rlp.de/Ueber_das_Projekt_SGU/PDE4D9ACA-0C22-474B-957D-6B8D30624C75.htm.
65. Ministerium für Umwelt und Forsten und Ministerium für Arbeit, Soziales, Familie und Gesundheit, Land Rheinland-Pfalz (ed). *Schnupperversion. Schnupperversion des Leitfadens Metall*. Mainz, 2000. www.sgu-rlp.de/Schnupperversion/P8F479F33-13D5-4217-A8EE-C13B7C56E8BE.htm.
66. Landesinstitut Sozialforschungsstelle Dortmund (sfs) (ed). *PragMaGuS. Praktisches Management von Gesundheit und Sicherheit in kleinen Unternehmen. Dokumentation der PragMaGuS-Tagung: Qualität der Arbeit in Kleinbetrieben – ein Verbundmodell in der Region Dortmund stellt sich vor am 5.6.2003*. Beiträge aus der Forschung, Band 140. Dortmund: 63.
67. Projekt PragMaGuS (ed). *Regionales Netzwerken*. Dortmund, 2004. www.pragmagus.de/main.html.
68. Projekt PragMaGuS (ed). *Arbeitsverfahren, -mittel: Arbeitsstoffe*. Dortmund, 2004. www.pragmagus.de/gb/index.php?PHPSESSID=12c8bb97f6d9698478b94fb3aa1f4e2d&site=/module/unternehmer/u13/u130&status=unternehmer&modul=arbeitsstoffe.
69. Landesinstitut Sozialforschungsstelle Dortmund (sfs) (ed). *PragMaGuS. Praktisches Management von Gesundheit und Sicherheit in kleinen Unternehmen. Dokumentation der PragMaGuS-Tagung: Qualität der Arbeit in Kle*inbetrieben – ein Verbundmodell in der Region Dortmund stellt sich vor am 5.6.2003. Beiträge aus der Forschung, Band 140. Dortmund: 33.
70. Institut ASER e.V. (ed). *KMU-Netzwerk, Gefahrstoffe im Griff – Umsetzung und Verankerung eines pragmatischen Gefahrstoffmanagements in KMU*. Wuppertal, 2004. www.aser.uniwuppertal.de/pdf_files/projekte/3/lfd/314.pdf.
71. European Agency for Safety and Health at Work (ed). *Funding scheme 2003/2004. National projects. 'Dangerous substances under control': building a support network for SMEs*. Bilbao, 2004. http://sme.osha.eu.int/publications/fs2003/2004/en/index_15.htm.
72. Netzwerk gefahrstoffe-im-griff.de (ed). KMU-Gefahrstoffportal. Wuppertal, 2004. www.gefahrstoffe-im-griff.de/.
73. Lang K-H *et al*. KMU-Netzwerk-Portal 'Gefahrstoffe im Griff', Sicher ist sicher. *Arbeitsschutz aktuell* 2004; 55: 344–347.
74. Gemeinschaftsinitiative Gesünder Arbeiten e.V. (ed). *Gesünder Arbeiten – auch mit Gefahrstoffen*. Düsseldorf, 2004. www.gefahrstoffe-im-griff.de/pdf_files/Gefahrstoff-im-Griff-GiGA-Folder.pdf.

75. Netzwerk gefahrstoffe-im-griff.de (ed). *Berufe/Branchen*. Wuppertal, 2004. www.gefahrstoffe-im-griff.de/4.htm.
76. Netzwerk gefahrstoffe-im-griff.de (ed). *Nützliche Instrumente*. Wuppertal, 2004. www.gefahrstoffe-im-griff.de/7.htm.
77. Netzwerk gefahrstoffe-im-griff.de (ed). *Info-System Gefahrstoffe*. Wuppertal, 2004. http://132.195.14.44/cgi-bin/gef/asinfo.cgi.
78. Staatliches Amt für Arbeitsschutz Aachen (ed). Electronic risk prevention tool for craft trade. In: European Agency for Safety and Health at Work (ed). *European Week for Safety and Health at Work. The practical prevention of risks from dangerous substances at work*. Bilbao, 2003. http://agency.osha.eu.int/publications/reports/106/index_15.htm.
79. Lynen E. Staatliches Amt für Arbeitsschutz Aachen. Personal communication, 4 January 2005.
80. Staatliches Amt für Arbeitsschutz Aachen (ed). *Sicherer Umgang mit gefährlichen Arbeitsstoffen im Handwerk. Praktische Hilfen per (Maus)Klick!* Aachen oJ, 2003.
81. Staatliches Amt für Arbeitsschutz Aachen (ed). *Gefahrstoffe im Handwerk?* Aachen oJ, 2004. www.gefahrstoffe-im-handwerk.de/.
82. Kluger N. Gefahrstoff-Informationssystem der Berufsgenossenschaft der Bauwirtschaft, Frankfurt am Main. Personal communication, 31 October 2005.
83. Gefahrstoff-Informationssystem der Berufsgenossenschaft der Bauwirtschaft (ed). *Service. Broschüren. GISBAU – Eine Kurzvorstellung*. Frankfurt am Main, 2005. www.gisbau.de/service/brosch/kurzvors.pdf.
84. Kluger N. Gefahrstoffe in der Bauwirtschaft. *Sichere Arbeit* 1997; 1: 16–20.
85. Gefahrstoff-Informationssystem der Berufsgenossenschaft der Bauwirtschaft (ed). GISBAU – an information system for small companies in construction. In: European Agency for Safety and Health at Work (ed.) *European Week for Safety and Health at Work. The practical prevention of risks from dangerous substances at work*. Bilbao, 2003. http://agency.osha.eu.int/publications/reports/106/index_14.htm.
86. Kluger N. Gefahrstoffe in der Bauwirtschaft. *Sichere Arbeit* 1997; 1: 16–20.
87. Kluger N. Gefahrstoff-Informationssystem der Berufsgenossenschaft der Bauwirtschaft. Frankfurt am Main. Personal communication, 31 October 2005.
88. Rheker R. Gefahrstoff-Informationssystem der Berufsgenossenschaft der Bauwirtschaft. Frankfurt am Main. Personal communication, 31 October 2005.
89. Friedl W. Occupational safety and health protection in small and medium-sized enterprises in Austria. In: *FORUM News* 16 (Bulletin of the European FORUM of insurance against accidents at work and occupational diseases). Vienna: AUVA 2000: 13–15. www.europeanforum.org/pdf/forumnews_nr16_ed.PDF.
90. Pfoser W and Peer H. *Beratungsschwerpunkte – Betreuung AUVAsicher: AUVA intern ASQS-Sondernummer, S.12–14*. 2004. www.auva.at/mediaDB/75242.PDF.
91. Cherrie J W, Tickner J, Friar J, Creely K, Soutar A, Hughson G, Rae R, Warren N and Pryde D. *Evaluation and further development of the EASE model 2.0*. Institute of Occupational Medicine. Sudbury: HSE Books, 2003.
92. Bredendick-Kamper S. Do EASE scenarios fit workplace reality? A validation study of the EASE model. *Applied Occupational and Environmental Hygiene* 2001; 16: 182–187.
93. Northage C. Commentary: EASEing into the future. *Annals of Occupational Hygiene* 2005; 49 (2): 99–101.
94. Money C. European approaches in the development of approaches for the successful control of workplace health risks. *Annals of Occupational Hygiene* 2003; 47: 533–540.
95. Russell R, Maidment S, Brooke I and Topping M. Introduction to a UK scheme to help small firms control health risks from chemicals. *Annals of Occupational Hygiene* 1998; 42 (6): 367–376.

96. Maidment S. Occupational hygiene considerations in the development of a structured approach to select chemical control strategies. *Annals of Occupational Hygiene* 1998; 36; 601–607.
97. Brooke I. A UK scheme to help small firms control health risks from chemicals: toxicological considerations. *Annals of Occupational Hygiene* 1998; 42 (6): 377–390.
98. Tischer M, Brendendiek-Kamper S and Poppek U. Evaluation of the HSE COSHH Essentials exposure predictive model on the basis of BauA field studies and existing substances exposure data. *Annals of Occupational Hygiene* 2003; 47 (5): 557–569.
99. Tijssen S and Links I. *Ways for SMEs to assess and control risks from hazardous substances*. Report of an international workshop held on 26 and 27 November 2001. RR 014. TNO, HSE Books, 2002.
100. ECETOC. *Targeted risk assessment*. Technical report no. 93. Brussels: European Centre for Ecotoxicology and Toxicology of Chemicals, 2004.
101. Creely K, Leith S, Graham M, Cowie H, Hughes J, George P and Cherrie J W. *Effective communication of chemical hazard and risk information using a multimedia safety data sheet*. RR 72. University of Aberdeen. Sudbury: HSE Books, 2003.
102. Wiseman J and Gilbert F. *COSHH Essentials: survey of firms purchasing this guidance*. CRR 434. Sudbury: HSE Books, 2002.
103. Walters D R. *Health and safety in small enterprises*. Brussels: PIE-Peter Lang, 2001.
104. Briggs D and Crumbie N. *Characteristics of people working with chemical products in small firms*. CRR 278. W S Atkins. Sudbury: HSE Books, 2000.
105. Creely K, Leith S, Graham M, Cowie H, Hughes J, George P and Cherrie J W. *Effective communication of chemical hazard and risk information using a multimedia safety data sheet*. RR 72. University of Aberdeen. HSE Books, 2003.
106. John Kingston Associates. *Development of an information-based approach to self-regulation of health and safety in small firms*. CRR 330. Sudbury: HSE Books, 2001. www.hse.gov.uk/research/content/crr/index.htm.
107. Antonsson A-B, Birgersdotter L and Bornberger-Dankvardt S. Small enterprises in Sweden – Health and safety and the significance of intermediaries in preventive health and safety. *Arbetet och Hälsa* 2002: 1. http://ebib.arbetslivsinstitutet.se/ah/2002/ah2002_01.pdf.
108. Antonsson A-B and Schmidt L. *Småföretag och företagshälsovård – ska berget komma till Muhammed eller Muhammed till berget?* IVL-report B1542. www.ivl.se/rapporter/pdf/B1542.pdf.
109. Cox P, Fischhoff B, Gerrard S, Niewöhner J, Pidgeon N and Riley D. *Developing a methodology for designing messages about chemical risks in the workplace using the mental models approach*. Report no. RSU 4048/R64.061. London: HSE, 2000.
110. Cox P, Niewöhner J, Pidgeon N, Gerrard S, Fischhoff B and Riley D. The use of mental models in chemical risk protection: developing a generic workplace methodology. *Risk Analysis* 2003; 23 (2): 311–324.
111. Niewohner J, Cox P, Gerrard S and Pidgeon N. Evaluating the efficacy of a mental models approach for improving occupational chemical risk protection. *Risk Analysis* 2004: 24 (2): 349–361.
112. HSC. *COSHH enforcement and the role of OELs*. Annex 4. Discussion Document on Occupational Exposure Limits (OEL) framework. London: HSE, Chemical Risk Assessment Unit, 2002.
113. Fairman R and Yapp C. *Making an impact on SME compliance behaviour: an evaluation of the effect of interventions upon compliance with health and safety legislation in small and medium sized enterprises*. HSE Research Report 366. Sudbury: HSE Books, 2005.
114. Vickers I, Baldock R, Smallbone D, James P and Ekanem I. *Cultural influences on health*

and safety attitudes and behaviour in small businesses. RR 150. Sudbury: HSE Books, 2003.
115. Walters D R, Grodzki K and Walters S L. *The role of occupational exposure limits in the health and safety systems of EU member states*. HSE Research Report 172. Sudbury: HSE Books, 2003.
116. Frick K and Walters D R. Worker representation on health and safety in small enterprises: Lessons from a Swedish approach. *International Labour Review* 1998; 137 (3): 367–389.
117. Walters D R. Worker representation and health and safety in small enterprises in Europe. *Industrial Relations Journal* 2004; 35 (2): 169–186.