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From research to practical tools—developing assessment tools for safety management and safety culture

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This article illustrates how the findings from research work have been used to develop practical tools for the assessment of safety management systems and attitudes to safety at Major Hazard sites. In describing the process of developing such tools some mention is made of the research work itself, although this is mainly by reference to published material, and some reference is made to the process of initiating research work and managing it. The paper, therefore, seeks to emphasise the practical utility of research work in the field of health and safety. The author fully acknowledges the wide range of contributions made by other workers to the outcomes of the work. © 1997 Elsevier Science Ltd. All rights reserved

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Introduction

This article discusses some examples of how the findings from research work commissioned by The Health and Safety Laboratory (HSL) have been used to develop practical tools. The research discussed is concerned with causes of loss of containment accidents and aspects of safety culture as measured by attitudes to work-place safety. The practical tools are assessment methods for safety management and a safety attitudes survey questionnaire. In describing the process of developing such tools some mention will be made of the research work itself, although this will mainly be by reference to published material, and some reference will be made to the processes of initiating research work and managing it. Research has a crucial role to play in the field of health and safety, and how research is initiated, managed and used is an important topic.

Research studies

The Health and Safety Executive (HSE) uses Quantified Risk Assessment (QRA) as a basis for giving advice to Local Planning Authorities concerning the use of land around Major Hazard sites. The Health and Safety Laboratory has collaborated with The Major Hazards Assessment Unit in HSE to develop a range of computerised risk assessment tools, called RISKAT, to inform such land-use planning advice. During 1988 work was in hand to develop a RISKAT methodology for liquefied petroleum gas (LPG) [1]. This work was an extension of the RISKAT methodology, which had previously been developed for toxic hazards only [2]. RISKAT makes use of generic failure rates, which in this context describe a failure rate derived from both historical data and theoretical models and which may contain elements of engineering judgement and caution. A single or generic value is taken to be representative of these data. The generic failure rates are used to estimate off-site risks to people from hypothetical releases of hazardous materials. There was interest in these generic failure rates and the extent to which they included human and organisational failures as well as failures of engineering systems.

This interest led the Research and Laboratory Services Division of HSE* to commission and manage research into the contribution to pipework failure frequencies of human error and 'sociotechnical' failures [3,4]. This was later extended to include the underlying causes of loss of containment incidents for vessels, hoses

*Research and Laboratory Services Division (RLSD), now the Health and Safety Laboratory (HSL), an Agency of HSE.

and couplings [5–8]. The work was carried out by Four Elements Ltd and managed for HSE by The Health and Safety Laboratory (HSL). Close liaison was maintained between Four Elements and HSL throughout the work and progress reported by HSL to HSE's Major Hazards Assessment Unit, Field Operations Division and other interested parties in HSE.

Figure 1 shows some of the results from the work which analysed over 500 incidents involving loss of containment from pipework. The figure shows the percentage contributions of pipework failures according to underlying cause of failure and failure of potential preventive mechanisms. These results were very interesting because they illustrated how previous loss of containment incidents had occurred and pointed to practical actions to prevent future incidents.

For example, the figure shows loss of containment during maintenance to be a cause of 38% of the incidents. In the judgements of the researchers these incidents could have been potentially prevented by reviews of human factors, e.g. task analysis (15%); checking of maintenance tasks (13%) and routine checking such as inspection (10%). It is interesting to note that this work was also used to form the basis of advice to plant managers on reducing incidents and in this context was independently described by an author who had taken no part in the research work or its management but who nevertheless wished to highlight the results of the work [9].

The Health and Safety Laboratory also commissioned and managed for HSE a contract carried out by the Safety Research Unit (SRU) at Liverpool University to help quantify the contribution of attitudinal and management factors to risk in the chemical industry [10]. Again, close liaison was maintained between SRU and HSL throughout the work and progress reported by HSL to interested parties within HSE. This was a carefully researched report which developed a safety attitude survey questionnaire (SAQ) from a theoretical base including an analysis of major hazard failures. The SAQ was designed specifically for the measurement of attitudes to safety at chemical and major hazard plants and included specific questions developed for that purpose [11]. Its application to other industry sectors was not considered by the researchers at Liverpool.

The development of STATAS

The practical utilisation of the above research work on loss of containment (but not the use of the SAQ) is described in three articles in the *Loss Prevention Bulletin* by Ratcliffe [12–14]. He explains how the original research work had been commissioned and managed by HSL and how HSL together with The Hazardous Installations National Interest Group of the Field Operations Division (FOD) of HSE had developed a structured audit technique from the research and finished the first of a series of trial audits. The system as developed for FOD is known as STATAS (Structured Audit Technique for the Assessment of Safety Management Systems).

Subsequently, STATAS has been reworked within the framework described in Successful Health and Safety Management; HS(G)65 [15]. STATAS is not a stand alone system but is now included within a set of tools and techniques known as 'The FOD Guide to the Inspection of Health and Safety Management' (The FOD Guide). A recent paper at The XIVth World Congress on Occupational Safety and Health [16] describes the development of the FOD Guide and how it incorporates the results of the research work.

The paper describes the current state of development of a suite of practical tools and techniques which

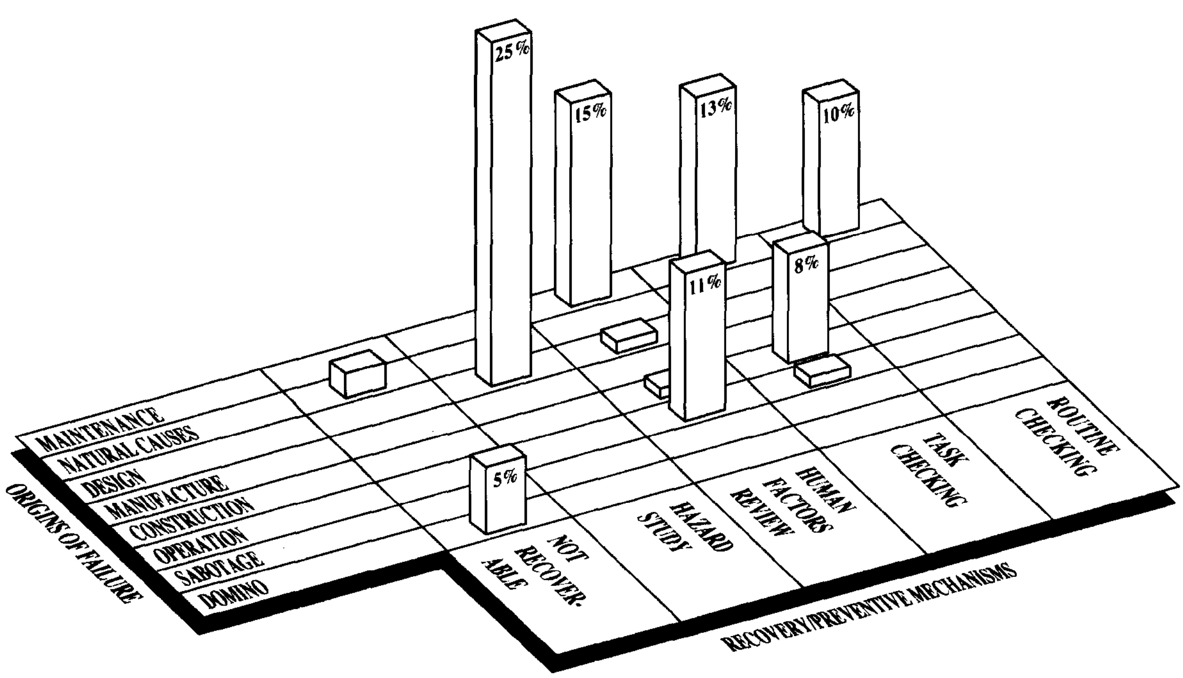

Figure 1 Underlying causes of pipework failures[4]

provide for (1) assessment of management arrangements, (2) assessment of risk control systems, and (3) assessment of safety culture. Management arrangements are the managerial methods by which an organisation sets out to determine and provide adequate controls of hazards. Risk control systems set out the way systems and workplace precautions are implemented and maintained. In the best companies, management arrangements, risk control systems and workplace precautions support each other. They form a logical structure resulting in effective control of risks. STATAS is one method described in The FOD Guide, by which information on risk control systems may be collected when loss of containment is particularly relevant.

With respect to the safety attitude survey questionnaire developed by SRU, development work would be needed to convert the research work into a practical tool for use by operational inspectors to support assessment of the health and safety management system.

The development of STATAS from the research has required a considerable effort from within HSE and HSL but the SAQ was provided in a form in which the university researchers already had considerable experience of its use and had developed a database of company results. However, the use by operational inspectors, as opposed to university researchers, has not taken place within the Major Hazards field and the implications of such an activity have not been investigated. This would require additional effort within HSE, and would be needed to develop the research into a practical tool for inspectors.

Work in Europe—The PRIMA System

As explained above, an initial reason for looking at underlying causes of loss of containment incidents was to identify the contribution made by human error and other causes, such as design problems and maintenance errors, to generic failure rates. The aim was to include these factors in QRA such that standards of safety management were made explicit in the QRA process. The thinking behind this was that standards of safety management will determine standards of plant design, operation and maintenance, for example, and so standards of safety management will directly influence risk. References [17–21] discuss these issues in detail.

This aim, to develop explicit links between standards of safety management and estimated risk levels at Major Hazard sites, led to the development of an audit system called PRIMA (Process Risk Management Audit). This was used together with the SAQ at seven Major Hazard sites in four European countries within the context of a CEC DGXII research project [22]. The tools provide quantitative measures of safety attitudes and safety management performance. It is beyond the scope of this paper to describe this European work fully but some of the interesting findings from the work can be listed:

- A strong statistical correlation was found between the quantitative results of the two survey tools.
- Quantitative measures of safety management performance as measured by PRIMA varied by a factor of 16 for the seven sites studied.
- Company cultures may have strong influences on safety attitudes as well as national cultures.
- The use of quantitative estimates of safety management standards in QRA caused the participants no fundamental problems.

Reference [22] contains a full account of this work.

Discussion

This paper has described some examples of how the findings from research work have been used to develop practical health and safety tools. Some of the interesting findings from the research are mentioned and extensive reference is made to published work where full details are available. The development of PRIMA and STATAS audit tools are described which, although distinct systems, are both underpinned by the same research work. In considering the development of practical tools this paper has therefore illustrated by the use of examples the role of research in the overall process. This process begins with the initiation of work and continues through to the development of practical tools.

Of course research also advances 'the state of the art' in any field, although this paper seeks to emphasise the practical utility of research work in HSE. In addition there has been very considerable use made by SRU and Four Elements of the research findings in advancing health and safety in their work with industry which, of course, is very important when considering the overall benefit of the research. Indeed, the research work has been applied widely in both the UK, Europe and worldwide and may find important applications outside the UK. For instance, the Dutch Ministry of Housing (VROM) is currently looking at the utility of the PRIMA system and of using modified failure rates in land-use planning, especially within the context of the anticipated SEVERSO 2 Directive. The Department of Occupational Safety and Health, Malaysia, is also considering the PRIMA system and has practical experience of its use in Malaysia.

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