WORKING FOR A HEALTHY FUTURE

HISTORICAL RESEARCH REPORT

Research Report TM/86/02
1986

Occupational exposure limits and their economic costs

Cherrie J

WORLD HEALTH ORGANISATION
COLLABORATING CENTRE
FOR OCCUPATIONAL HEALTH

HISTORICAL RESEARCH REPORT
Research Report TM/86/02
1986

Occupational exposure limits and their economic costs

Cherrie J

INSTITUTE OF OCCUPATIONAL MEDICINE
Research Avenue North, Riccarton, Edinburgh, EH14 4AP
Tel: +44 (0)870 850 5131 Fax: +44 (0)870 850 5132
e-mail publications@iomhq.org.uk

Report No. TM/86/2
UDC 615.9.003.12

OCCUPATIONAL EXPOSURE LIMITS AND THEIR ECONOMIC COSTS

by

J.W. Cherrie

April 1986

This report is one of a series of Technical Memoranda (TM) published by the Institute of Occupational Medicine. Current and earlier lists of these reports, and of other Institute publications, are available from the Librarian at the address overleaf.

For further information about the Institute's facilities for research, consultancy and teaching on occupational health and hygiene please contact the Director.

TM/86/2
UDC 615.9.003.12

OCCUPATIONAL EXPOSURE LIMITS AND THEIR ECONOMIC COSTS

by

J.W. CHERRIE

Institute of Occupational Medicine,
Roxburgh Place, EDINBURGH, EH8 9SU.

Telephone: 031-667 5131

April 1986

INSTITUTE OF OCCUPATIONAL MEDICINE

OCCUPATIONAL EXPOSURE LIMITS AND THEIR ECONOMIC COSTS

by

J.W. CHERRIE

CONTENTS

INSTITUTE OF OCCUPATIONAL MEDICINE

OCCUPATIONAL EXPOSURE LIMITS AND THEIR ECONOMIC COSTS

by

J.W. CHERRIE

SUMMARY

This report reviews the procedures for setting occupational exposure limits in five countries (USA, German Federal Republic, United Kingdom, Sweden and Alberta, Canada) with particular emphasis on the assessment of the economic impact of the limits on industry. The methods range from complex data gathering and consultative procedures such as that adopted by the USA to the much simpler and quicker methods used by Sweden and Alberta. In the former situation considerable efforts are made to ascertain the economic cost of proposed regulations whilst in the latter cases little attention is given to the financial implication of introducing occupational exposure limits.

A number of other systems for controlling exposure to hazardous materials have been proposed, including self regulation, no liability compensation for industrial injury or performance standards. The report discusses these options and concludes that these systems are unlikely to provide generally applicable systems for regulating harmful exposures.

Data relating to economic cost of introducing occupational exposure limits are only available in the USA, although all of the countries made some assessment of the financial implications of their occupational exposure limits. This lack of information can only hinder the proper interpretation of the standards adopted.

OCCUPATIONAL EXPOSURE LIMITS AND THEIR ECONOMIC COSTS

A Summary of the Standards derivation
procedure in five countries

1. INTRODUCTION

Occupational Exposure Limits are intended to set hygenic standards for exposure to harmful agents in the workplace. There are many factors which may be taken into account during the setting of these standards with the nature and severity of the injury to the worker's health, practicality of measurement of the agent, feasibility of controlling exposure and social pressures all affecting the finally adopted level. One aspect which is increasingly being considered when setting such standards is the financial cost of their implementation.

The costs of protection afforded to workers is directly related to the degree of control. What is required is a means of balancing these two parameters to achieve the optimum for society as a whole.

Traditionally the occupational health professions have concentrated their efforts on elucidating the adverse health effects associated with exposure to harmful materials or problems in measurement of exposure, with other aspects receiving less attention.

This report summarises the procedures adopted by five countries in Europe and North America (USA, German Federal Republic, United Kingdom, Sweden and Alberta, Canada) for setting occupational exposure limits, with particular emphasis on the importance assigned to economic cost.

2. PROCEDURES USED TO SET OCCUPATIONAL EXPOSURE LIMITS IN FIVE COUNTRIES

2.1 The United States of America

It is appropriate to begin any historical discussion of occupational exposure limits (OELs) with the USA: the first systematic national list of OELs originated with the American Conference of Governmental Industrial Hygienists (ACGIH) in the early 1940s with a list of Maximum Allowable Concentrations (MACs) for airborne contaminants. From the outset the MACs were defined as health based standards 'which could be tolerated by man with no bodily discomfort, nor impairment of bodily function, either immediate or after years of exposure' with the proviso that a balance be struck 'between a suitable maximum allowable concentration and the effect of attaining this value upon the manufacturing operation or process' (ACGIH, 1947).

The first list was published in 1950 and the term Threshold Limit Value (TLV) was coined in place of MAC. The philosophy and documentation behind the numerical list developed rapidly during the 1950s and early 1960s; particularly the definition of the TLV as a maximum average concentration for an eight hour day.

By 1968 the TLV list had grown from the original 160 values to over 400. The list continues to be published annually after a review by an independent committee composed of personnel from government agencies or educational institutions. The ACGIH list has been extremely influential in the setting of OELs internationally. The majority of countries in Europe, and all of these considered in this report, have at some time in their history used the published ACGIH TLVs.

1970 saw the promulgation of the Occupational Safety and Health Act which was designed to stimulate improvements in the field. Under the Act the Occupational Safety and Health Administration (OSHA) was created, within the Department of Labor, with the prime responsibility of encouraging employers and employees to reduce workplace hazards. In carrying out

their duties OSHA is responsible for promulgating new standards - termed Permissible Exposure Limits or PELs - either on its own initiative or on petition from other parties, including stage and local governments, employers, employees, the National Institute for Occupational Safety and Health (NIOSH), or any other interested party. NIOSH is a government agency in the Department of Health and Human Sciences charged by the OSH Act with conducting research in occupational health.

When promulgating standards OSHA has a complex set of procedures which it follows. Notice of the intention to propose, amend or delete a standard is published in the Federal Register[1] as a 'Notice of Proposed Rulemaking' or an 'Advance Notice of Proposed Rulemaking'. Written comments are generally requested within a fixed time followed by a public hearing. At the completion of this process OSHA must publish in the Federal Register the full text of the standard with a detailed explanation of the reasons for its implementation - based only on the information collected during the standard setting process. After the standard has been promulgated it may be challenged, and usually is, in the US Circuit Court of Appeals by any interested party.

Section 4(b)(2) of the OSH Act initially allowed the automatic adoption of national consensus standards, which for OELs was basically the 1968 ACGIH list. These standards had the advantage of being given the full force of law but the consequent disadvantage that they could only be changed through the lengthy review procedure outlined above. The subsequent implementation of OELs has been less impressive, between 1972 and 1981 OSHA took major health initiatives on only 12 hazardous agents. This lack of standards implementation has been attributed to the protracted consultation procedures and the challenge of adopted standards in the courts.

The major court challenges of occupational health standards have centred around the interpretation of the general duty clause of the OSH Act, i.e. 'to assure so far as possible every working man and woman in the nation, safe and healthful working conditions'.

[1]The Federal Register is the official journal for publication of presidential and Federal Agency documents.

The 1980 challenge of the benzene standard centred on the interpretation of the phrase 'healthful working conditions'. The court concluded that the reduction in the PEL to 1 ppm had not been shown to be 'reasonably necessary to provide safe and healthful employment'. The argument that the OSH Act gave an absolute mandate to reduce risks was rejected in favour of the interpretation that Congress had intended OSHA to focus on 'significant risks'.

The issue of the economic costs involved in the implementation of new standards was addressed in the challenge of the cotton dust standard, in 1979, by the Americal Textile Institute. The Supreme Court upheld the standard by interpreting the feasibility condition in the OSH Act as being 'technically capable of being done but not justifiable in cost benefit terms'. This has one proviso that the court noted that Congress had not intended to protect employees' health by putting whole industries out of business. The costs of compliance should not be so high as to threaten the overall viability of the regulated industry.

Although OSHA has been directed to pursue a broadly health based policy as a result of specific interpretation in the courts, there are other pressures which require some assessment of economic impact. Since 1974 there have been requirements on Federal agencies, such as OSHA, to estimate the costs and economic effects of major new regulations. This process has generally been based on cost benefit analysis, carried out by the Council on Wage and Price Stability (CWPS), an agency within the Executive Office of the President. The CWPS assessment are filed at the public comment stage of the introduction of a new regulation and hence must be considered in the drafting of the standard. The review procedure was strengthened in 1978 by President Carter with the publication of E012044 which required that agencies show that 'alternative approaches have been considered and that the least burdensome of the acceptable alternatives has been selected' i.e. the most cost effective solution. Much of the recent debate of standards implementation in the US has centred on trying to change the traditional emphasis of OSHA from engineering control measures towards less costly personal protection.

Shortly after President Reagan took office the CWPS was abolished and the review task was undertaken by the Office of Management and Budget. Reagan also instigated a formal cost benefit test for proposed regulations.

HOPKINS (1976) has argued that OSHA treated the review procedures as a 'hurdly to overcome in promulgating regulations'. Alternatively it has been suggested by McCAFFERTY (1980) that OSHA did not want to estimate benefits because of the controversial nature of 'calculating the number of lives saved' but that they recognised that a careful consideration of the cost and in particular the cost of alternative means of control could aid the efficiency of standards.

Table 1 shows the estimated annual cost of a number of major standards proposed by OSHA. These estimates were generally derived from extensive survey data collected by independent consultants. For example, the US Department of Labor financed a survey of 69 plants covering one half per cent of all the workers in US manufacturing industry to assess the impact of proposed noise regulations. A judgement was maded for each plant as to the feasibility of reducing noise exposures and the possible costs. These figures were then grossed up to give an estimate of the total cost for the whole of the manufacturing industry. Benefits were assessed only in terms of the potential reduction in the numbers of workers suffering hearing loss. The total cost of this study was $200 000, 1973 prices!

This type of cost estimate has been subjected to much criticism, for example, GIDEON (personal communication) has reviewed the projected and final costs of implementing the OSHA standards for vinyl chloride (VCM) and acrylonitrile and concluded that the eventual costs were much lower than originally suggested. For VCM the estimated costs were $104 million annually with an initial capital investment of $250 million. The actual annual costs were considerably lower ($23m annual and $130m initial) although the final exposure limits were between two and ten times lower than those used in the estimates. Much of the saving was due to innovative engineering controls stimulated by the new regulations. Initial estimates of the cost of the acrylonitrile regulations were $109m capital and $29m annual running costs. The Industry complained at the public hearings that they would have impossible compliance difficulties. In the event costs were again much lower than the estimated figures because of technology transfers from the VCM industry.

TABLE 1 Summary of the economic impact of selected OSHA regulations - after Viscusi (1983)

Standard	OEL	Economic impact* ($ million)	Date proposed
Acrylonitrile	2 ppm	298	1978
Arsenic - inorganic	10 µg/m³	313-976	1975
Asbestos	1 fibre/ml	4000	1975
Coke ovens	150 µg/m³	3000	1975
Cotton dust	Various	2500	1976
Lead	Various 50-200 µg/m³	660-750	1975
Noise	85 dBA	4100	1974
VCM	1 ppm	561	1974

* Based on 1981 prices

2.2 The German Federal Republic

The German Federal Republic is arguably the country where occupational exposure limits were first developed. HENSCHLER (1984) cites the work of KB LEHMANN who at the end of the 19th century established quantitative standards for short term exposure to some organic solvents, irritant gases, halogens and acid fumes. Germany certainly has the oldest formal systems of OELs in Western Europe, the Maximale Arbeitsplatzkonzentrationen or MAKs, developed by the Committee of the Deutsche Forschungsgemeinschaft. The MAK values are defined as 'the maximum permissible concentration of a chemical compound present in the air within a working area which according to current knowledge generally does not impair the health of the employees nor cause undue annoyance' (DFG, 1979). These values are usually based on measurements made on an eight hour time weighted average basis.

The definition continues by stating that 'Scientifically based criteria for health protection are adopted, rather than their technical or economic feasibility, are employed'. Hence only irritation, acute or chronic health effects and analytical sensitivity are taken into account during the derivation of MAK values.

The German list was first published, by the German Ministry of Labour, in 1955. Initially the ACGIH TLV list was adopted with only a few values being changed on the personal experience of the committee. In 1969 the list was extensively revised, independently of the ACGIH or any other national list. Currently the MAK list comprises in excess of 400 materials.

Proposals for changes or additions to the list come from industry or from members of the committee. The proposals are published in the literature calling for information, an extensive review of the scientific literature is undertaken and a monograph is prepared by a sub-committee.

Alterations are adopted annually by the full committee.

The final list is then submitted to the Minister of Labour who may or may not accept them as official standards. To date all recommendations have been accepted without change.

For carcinogenic or mutagenic substances the MAK committee has considered it impossible to set limit values, in these situations the substance is listed as carcinogenic. Three reasons are given by HENSCHLER (1984) for this:

1) Cancer and/or mutations occur many years after first exposure and the changes which occur are of a cumulative nature, with little or no indication of or to what extent repair takes place.
2) The results from animal experimentation are inadequate because of the large numbers of animals which must be exposed to assess the effects at low dose, which in any case may not be applicable to man.
3) Epidemiology studies in human populations are generally inadequate because of lack of information on past exposure levels and difficulties in obtaining suitable controls.

To overcome these problems a list of 'Technische Richtkonzentrationen' (Technical guide-concentrations or TRKs) is published. These are defined as '...that concentration of gas or vapour or airborne particulates which serves as a directive for necessary protective measures and surveillance by measuring techniques'. It is clearly stated that these limits are intended 'to reduce risk of health hazards but cannot completely eliminate'. The TRK Values are set by a separate organisation, which is affiliated to the Ministry of Labour, the Committee for Hazardous Materials (or AGA). This committee seeks a consensus standard in consultation with trade unions, employers, consumer organisations and government agencies, based on three factors:

1) The sensitivity of the analytical techniques used to measure in the workplace.
2) The state of the art in industrial control technology, including economic feasibility.
3) The absence of adverse medical evidence from the workplace.

More detailed criteria for setting these TRKs have not been published. Before a TRK is released a position paper is produced containing information relating to the above topics (HENSCHLER, personal communication). These documents are not released for public comment.

2.3 The United Kingdom

In the UK the first independent attempts to set occupational exposure limits were undertaken by the British Occupational Hygiene Society (BOHS). The BOHS Hygiene Standards Committee was set up in 1965, and the first standard on chrysotile asbestos was published in 1968. Standards for Amosite asbestos, flax, cotton, wideband noise etc., followed.

These standards were developed by specialist sub-committees composed of medical, hygiene, toxicological and industry representatives, but with no trade union involvement. ROACH (1970) has said that the sub-committee on asbestos took into account 'the economic consequences of any recommendations made as well as the benefits to health' although in the final standard they justify the adoption of 100 fibre years/ml on the basis of reducing 'risk of contracting asbestosis to less than 1%' with no further economic qualification.

Since the early 1960s the Factory Department of the Ministry of Labour had published the ACGIH TLV list in the form of a Technical Data Note to provide recommendations to industry but no other official role was adopted.

In 1972 the situation changed with the publication of the Robens Report on Safety and Health at Work (COMMITTEE ON SAFETY AND HEALTH AT WORK, 1972). Robens recommended setting up a new structure for regulating Health and Safety in the workplace based on a tripartite committee structure (The Health and Safety Commission, HSC) and a centralised inspectorate (The Health and Safety Executive, HSE). As part of this reorganisation a new tripartite committee, the Advisory Committee on Toxic Substances, ACTS, was established to advise the HSC on 'the establishment of standards and on the application of regulations and codes of practice' (COMMITTEE ON SAFETY AND HEALTH AT WORK, 1972).

The Robens committee also noted the relative neglect of the cost of health and safety measures and recommended that the HSE shoiuld be 'suitably equipped to pursue research into costs and benefits in order to assist in a more cost-effective approach...'. In 1974 the Health and Safety at Work etc. Act was promulgated to provide the general regulatory framework envisaged by Robens. ACTS was set up with the remit to review the appropriateness of standards and the medical division of the HSE charged with the role of reviewing the toxicological data.

Other background information is sought from public consultation procedures, e.g. through the publication of discussion documents. The final standard is agreed by ACTS on the bais of discussion between the parties involved.

The most carefully documented example of the workings of the UK system may be found in the final report of the Advisory Committee on Asbestos (ACA, 1969) - asbestos was of such public concern that a separate committee was set up. The committee comprised as chairman the chairman of the HSC, three Trade Union Council nominees, three nominees from the employers organisation the Confederation of British Industry (CBI), one representative from the consumer organisations, one local government

representative and seven independent medical or scientific experts. Five tripartite working groups were set up to consider the medical effects, environmental monitoring, legal and administrative control, production and use of substitutes. Written and oral evidence was solicited from the general public and other interested parties.

Detailed reports were published with a wide ranging series of recommendations and supporting medical, technical and economic data.

In 1980 the HSE set up an economic unit to assess the applicability of cost benefit analysis to health and safety legislation. The report of these investigations (MORGAN, 1981) recommended that:

1) Instructions be issued to all staff developing policy proposals to prepare and submit assessment of the economic implications of their proposals at all stages.
2) The economics unit of the HSE to issue guidance to all policy staff to assist them in preparation of such assessments.

One major justification for cost benefit analysis in UK Health and Safety legislation comes from the general duty clause of the Health and Safety at Work etc. Act 1974, Section 2(1).

> 'It shall be the duty of every employer to ensure, so far as is reasonably practicable, the health, safety and welfare at work of all his employees'.

The key phrase being 'so far as is reasonably practicable' which has been interpreted by the UK courts as 'narrower than physically possible and seems to imply that a computation must be made by the owner in which the quantum or risk is placed in one scale and the sacrifice involved in the measures necessary for averting the risk (whether in money, time or trouble) is placed in the other, and that, if it be shown that there is a gross disproportion between them - the risk being insignificant in relation to the sacrifice - the defendants discharge the onus on them' (Edwards v National Coal Board, 1949).

Subsequently the HSE issued a discussion document 'Cost benefit assessment of Health and Safety and Pollution Controls' (HSC, 1982) indicating that economic assessments were standard practice and outlining the methodology adopted. Economic assessments are made at the following stages of rulemaking:

1) When HSC approval is sought to start work on new regulations.
2) During consideration of proposals by ACTS.
3) When a consultative document is issued a detailed statement of costs and benefits is prepared, although only a summary is published.
4) When final proposals are put forward for regulation the economic assessments are revised.
5) When proposals are submitted to the Secretary of State for approval the cost benefit assessment is included as supportive evidence.

The HSE last published list of occupational exposure limits in guidance note EH15 in 1980 - primarily the ACGIH list of 1979. These have now been replaced with a new guidance note EH40 (HSE, 1984) comprising two lists, one of Control Limits and the other of Recommended Limits. The Control Limits are values which have been judged after detailed consideration of the available scientific and medical evidence - by ACTS - to be reasonably practicable for the whole spectrum of work activities in the UK. These limits will be legally enforceable.

Initially there were only ten control limits agreed by the HSC with the recommended limits being set at the levels published in the earlier guidance note EH15 (HSE, 1979).

In future recommended limits are to be set at levels which are considered to represent good practice and realistic criteria. These levels will be used by inspectors only as guidance in assessing compliance with general duty clauses of the Health and Safety at Work etc. Act and other statutory provisions.

Recommendations for changes or additions to either list will be made by a working group of ACTS and agreed amendments will be published in a quarterly HSE publication 'The Toxic Substances Bulletin'.

It is unlikely that amendments to the list of recommended limit values would be subject to the detailed toxicological or economic assessments of control limits.

2.4 Sweden

The Worker Protection Act of 1949 created Arbetarskyddslagen (ASV) as the government agency responsible for developing and enforcing policy and regulations in the field of occupational safety and health.

The development of occupational exposure limits in Sweden began in 1969 when an independent committee comprising representatives from government, industry and trade unions was set up.

The initial list comprised the ACGIH TLVs, with some minor alterations according to the committee's own experience. Probably the most important change was the setting of the trichlorethane exposure limit at 30 ppm rather than the 100 ppm recommended by ACGIH. This was based on experience that these levels could practically be attained with mechanized degreasing baths then in current use in Sweden.

In 1972 the work of preparation of occupational exposure limits was taken over by ASV (Office of Standards and Development).

KELMAN (1981) reports that initially most of the work was undertaken by Arne Westlin, Chief of the Office of Standards Development, in consultation with labour and industry representatives. This list was still predominantly based on the 1968 ACGIH TLVs with lower values assigned for solvents or materials where Westlin judged that levels could be reduced without much problem. The final list of 115 values was published in 1974 as a series of legally enforceable regulations.

Consultation between ASV and both sides of industry was initially ineffective, in one instance concerning the introducing of an occupational exposure limit for wood dust, the Health and Safety expert for the

Federation of Wood Products Employers recalls 'new regulations sometimes come as a complete surprise ... I found out about these proposals from a company which had heard about it. So I called up the Federation of Forest Products Employers and they didn't know anything' (KELMAN, 1981).

On 1 July 1978 the Work Environment Act came into force. This unified the existing research and enforcement agencies under a tripartite committee the National Board for Occupational Safety and Health (NBOSH). Revision of the occupational exposure limit regulations was placed on a formal footing with the establishment of a two stage system. Firstly, a criteria group composed of representatives from Labour and Management along with specialists from NBOSH and the Universities. This group produces a short criteria document reviewing the scientific literature and presents its results as dose-effect and dose-response data. No recommendations as to the magnitude of the limit value are made at this stage. The criteria document is then handed to the Supervision Department to form part of the background for detailed discussions with Unions and Management. Criteria documents are published in an occasional series in the NBOSH publication Arbeta och Halsa.

A working group of the Limit Values Regulations Group collects written evidence and opinions from both sides of industry concerning the economic and technical feasibility of any change in exposure limit. Based on the discussions of the main committee, the Supervision Department makes a recommendation to NBOSH for final approval.

Much consideration is given to the feasibility of control, if it is thought that in a new plant better control may be achieved then consideration may be given to setting a dual standard. For example toluene has an occupational exposure limit of 80 ppm in existing plants and 50 ppm for new plants or where an old plant is being reconstructed.

The background documentation on economic and technical feasibility is not published.

2.5 Alberta, Canada

In Canada, Occupational Safety and Health are primarily the responsibility of the various Provinces, each taking their own individual approach. Federal agencies, with responsibility for Energy, Agriculture, Transport, etc., have additional duties in this field. This report restricts discussions to the jurisdiction of the Province of Alberta.

In November 1973 a Royal Commission was set up to undertake a complete review of the structure of Health and Safety Legislation in Alberta. This was the 'Gale Commission'.

The limit values, designated as 'Occupational Exposure Limits', or OELs, follow the general definitions given by the Americal Conference of Governmental Hygienists in their TLV list, i.e. 8 hour time weighted average, 15 min short term exposure limits or ceiling limit values. The OEL list is also very similar to the ACGIH TLVs with only 12 values numerically different. Because OELs are contained within a set of regulations they have the advantage that they are legally enforceable.

Each year a list of substances is published where the OEL is to be reviewed. These include all the ACGIH changes plus any others which OHSD considers should also be reviewed. Comments are sought on both toxicity and ability to achieve compliance. OHSD also undertakes its own internal reviews of toxicity, compliance, and type and extent of usage in Alberta.

The proposed list is then passed along with documentation and comment to the Health Services Regulation Committee (HSRC). A public draft of the amendments is then issued and comments elicited. Based on these comments the HSRC prepares a legal draft for consideration by a cabinet sub-committee, the Social Planning Committee (SPC), prior to enactment.

The process is basically internal to civil service or governmental committees although public comment is considered. This results in a fairly rapid implementation of changes, i.e. it is normal for amendments to lag ACGIH publication by only 4 months.

No economic assessments are currently undertaken although the SPC may require a qualitative assessment of impact of regulations on industry, government and workers.

Discussion

It is clear that there are many diverse risks involved in everyday life, i.e. the extra risks attached to smoking or car travel are freely accepted. These additional risks are in general not sought out solely because of the risks per se but are accepted because they are offset by some compensating benefit.

Some economists argue that risks of this type will effectively be regulated by the market system, in such situations increased workplace hazards would result in higher pay. These concepts have been rooted in economic tradition; over two centuries ago Adam Smith observed that 'The whole of the advantages and disadvantages of the different employments of labour and stock must, in the same neighbourhood, be either perfectly equal or continually tending to equality... The wages of labour vary with the ease or hardship, the honourableness or dishonourableness of employment.

In practice there are many problems with this self regulation:

1) The first and probably the most important limitation is that workers are not fully aware of the risks involved in their employment nor the implications of ill health on their life. In fact VISCUSI (1983) argues that workers may actively prefer jobs where the risks are not clearly understood since these may be perceived as involving less risk.
2) Inadequate compensation by the employer for ill health caused at work means that some of the costs are external to the wage bargaining system.
3) The free market system does not take into account the costs to society, i.e. pollution, health care, etc.

These deficiencies imply that there must be some intervention, by Government, to compensate for this failure of the market system.

There are a number of methods which have been suggested for securing an optimal situation in the work environment. The least obtrusive form of intervention would be the provision of information about the magnitude and

type of risks so that management and workers could achieve a more realistic bargaining solution. The traditional role of Government in this area has been publication of illness or injury rate statistics.

The major drawback with this solution in relation to occupational exposure to harmful agents must be the lack of reliability of disease statistics. This is particularly the case for chronic illness which may taken decades to become apparent and may therefore not be linked with the causative occupation.

In addition to providing information the government could also attempt to regulate risk by compensating workers after their health has been impaired, where the compensation is funded by the employers. Such a 'no liability' compensation system operates in the FRG. The scheme was first introduced in the 1880s by Bismark as part of a range of social legislation. Employers in the same or related industries combined to form Industrial Injuries Institutes (die Berufsgenossen-schaften). These Institutes have the duty to prevent accidents and ill health at work and provide compensation and rehabilitation facilities. Insurance permiums are related to accident and industrial disease rates. This system works in conjunction with the legally enforceable MAK occupational exposure limits which provide a basic minimum level of control.

VISCUSI (1983) argues that one of the major drawbacks of such a system is that the more hazardous jobs become less unattractive and therefore the total number of workers willing to accept risky jobs and hence the overall number of injuries increases.

In practice almost all regulation of risks in the workplace is achieved through standards.

There has been much discussion about adopting performance standards in preference to specification standards, i.e. where the desired goal is set and the method of compliance is left to the individual employer rather than where the prime characteristics of the workplace are detailed. For example there is a general move away from lead in air as the primary standard towards controlling workers' blood lead levels.

One advantage of performance standards is that it allows each firm to choose the most cost effective solution to their particular problem, i.e. respiratory protective equipment, job rotation, engineering controls etc. Unfortunately this type of policy will only work where there are objective measures of adverse health effects which can be controlled. For example it would seem particularly difficult to achieve performance standards for carcinogens, because of the long latent period before onset of disease and the stochastic nature of the disease. Performance standards are also unlikely to be reliable methods of controlling any situation where the impairment of health is irreversible, i.e. noise induced hearing loss or carcinogens. It would seem reasonable to assume that occupational exposure limits will continue to be the primary tool of occupational hygiene.

There is a need to set occupational exposure limits so that there is a balance between the risks that workers are exposed to and the costs of averting these risks.

Another way of reducing the cost of regulations is to announce in advance the proposed change. In these circumstances employers have the opportunity to plan to upgrade their control technology to minimise their financial outlay, i.e. as part of plant modernisation. An example of long lead time before implementation of new standards come from the European Economic Community Directive on Noise (CEC, 1982). [N.B. CEC Directives must be incorporated into regulations by the member nations, i.e. UK, FRG, etc.]. Here the proposed daily sound level to which workers may be exposed is set at 85 dBA Leq (8 hr), with the proviso that 'where it is not reasonably feasible to comply with this ... the limit value may be increased to ... 90 dBA for a transitional period of a maximum of five years from the aforesaid date'.

There are also instances where, for the same contaminant, different levels are set for different industries or different processes, an example being the distinction made between new and existing plants for certain Swedish occupational exposure limits, i.e. xylene limit value reduced from 100 ppm to 50 ppm for new plants.

The methods of setting occupational exposure limits and the philosophy behind them varies considerably. In the five countries examined in this

report they range from the purely scientific assessment of the health effects and feasibility of measurement adopted for the MAK values of the FRG, to the control limit approach of the UK, where economic costs are explicitly considered. But do the vast differences in the systems result in vastly different standards? Table 2 shows the national occupational exposure limits for five agents (asbestos, vinyl chloride monomer (VCM), formaldehyde, noise and cotton dust). There is no consistent trend, for example although Sweden has a stringest standard for formaldehyde the limit for VCM is relatively high. Only NIOSH, whose health based limits are only recommendations and are not enforced, consistently produce lower values than in the national lists. Even if we compare the German MAK values with the values published by NIOSH, both of whom produce health based limits, there is a distinct difference with FRG levels being slightly higher. Examination of a larger list of chemicals (73) showed that in approximately 70% of cases the NIOSH limit was less than the MAK value and in only 3% was the NIOSH limit greater.

There is a need to balance the speed of the standards setting process with the degree of scrutiny applied. Most legislators recognise that implementation of legally binding occupational exposure limits can be time consuming and extremely difficult to change at a later stage. This is particularly true in the USA where the system imposed by the OSH Act can take several years to implement new standards. Much of the delay occurs because of the extensive data collection exercises undertaken and the adverse attitude taken by employers and labour representatives. One of the countries in the group examined shows that this need not be the case - Alberta revises 20-30 occupational exposure limits annually. This is achieved by retaining much of the momentum within the enforcing authority and limiting external influence to comment only.

One of the major problems encountered by the author when researching this subject was the lack of published information on economic and other non-health related data. Both in Sweden and in FRG (for TRKs) there are economic data collected and not published. In the UK the economic information is available in brief summary only. The USA is the only country where all the data used to set the standard is available for public scrutiny, in fact only information presented during the standards derivation process can be cited in the final document. This lack of public access to all of the information used to set occupational exposure limits can only hinder the occupational health community in their proper interpretation.

TABLE 2 Occupational Exposure Limits* for selected agents

	UK	USA (OSHA)	Alberta	FRG	Sweden	NIOSH
Asbestos :						
Chrysotile	2 fibres/ml	2 fibres/ml	2 fibres/ml	1 fibre/ml#	1 fibre/ml	0.1 fibres/ml†
Crocidolite	0.2 fibres/ml	2 fibres/ml	0.2 fibres/ml	1 fibre/ml	banned	0.1 fibres/ml
VCM	10 ppm TWA 39 ppm C	1 ppm TWA 5 ppm C	2 ppm TWA 10 ppm STEL	2-3 ppm TWA + (+)	5 ppm TWA 10 ppm STEL	MDL
Formaldehyde	2 ppm C	3 ppm TWA 5 ppm C	2 ppm C	1 ppm	1 ppm C	1 ppm C
Noise	90 dBA	90 dBA	85 dBA	90 dBA	85 dBA	85 dBA
Cotton	0.5 mg/m^3 less fly	0.25 0.75 mg/m^3(+)	0.2 mg/m^3	1.5 mg/m^3	0.5 mg/m^3	0.2 mg/m^3

(+) depending on location
* 1982
MDL = min detectable level
\# TRK

TWA = Time weighted average
STEL = Short term exposure limit
† = with 0.5 fibres/ml ceiling value
C = ceiling

Conclusions

1) The level of risk prevailing in the workplace is closely related to the economic cost of control. Since the resources available to control hazards are necessarily limited one must carefully consider the balance between cost and risk.
2) Self regulation through bargaining between management and labour is unlikely to achieve this balance, direct government intervention through the setting of national occupational exposure limits probably provides the only practical way of regulating exposure to harmful agents at work.
3) Few countries explicitly recognise the direct link between economic cost and level of risk at work (the UK being the exception in those investigated for this report) although most make some allowance for the economic impact of their regulations.
4) Although economic cost and other non-health based data are collected in most countries the information is not readily available for public scrutiny. This lack of information can only hinder the proper interpretation of any standards adopted.

Acknowledgements

The author gratefully acknowledges the assistance of all those who have provided information or commented on this report.

Financial assistance for travel connected with this work was provided by the Government of Alberta and the British Occupational Hygiene Society ESSO Travel bursary.

REFERENCES

ADVISORY COMMITTEE ON ASBESTOS (1979) Asbestos : final report of the advisory committee. London: HM Stationery Office.

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (1947) The 1947 MAC Values. Industrial Hygiene Newsletter; 7: 15-16.

COMMISSION OF EUROPEAN COMMUNITY (1982) Proposal for a Council directive on the protection of workers from risks related to exposure to chemical, physical or biological agents : noise. Official Journal of the European Communities; (C 289).

COMMITTEE ON SAFETY AND HEALTH AT WORK (1972) Safety and Health at Work : report of the committee 1970-72. London: HM Stationery Office.

DEUTCHE FORSCHUNGSGEMEINSCHAFT (1979) Maximum concentrations at the workplace. Commission for investigation of health hazards of chemical compounds in the work area. Bonn: DFG (Report No. XV).

EDWARDS v NCB (1949) 1 KB 704, [1949] 1 All ER 743, CA.

GIDEON (Personal communication) A retrospective analysis of the OSHA vinyl chloride and acrylonitrile standards.

HEALTH AND SAFETY COMMISSION (1982) Cost/benefit assessments of health, safety and pollution controls. London: Health and Safety Executive.

HEALTH AND SAFETY EXECUTIVE (1979) Threshold Limit Values. London: HM Stationery Office (HSE Guidance Note EH15).

HEALTH AND SAFETY EXECUTIVE (1984) Occupational Exposure Limits 1984. London: HM Stationery Offfice (HSE Guidance Note EH40).

HENCHLER D. (Personal communication) Letter: Occupational Exposure Limits.

HENCHLER D. (1984) Exposure limits: history, philosophy, future developments. Annals of Occupational Hygiene; 28: 79-92.

HOPKINS T. (1976) An evaluation of the inflation impact statement prepared for the Economic Policy Board. Washington: US Council on Wage and Price Stability.

KELMAN S. (1981) A comparative study of occupational safety and health policy. Cambridge (MA): MIT Press.

McCAFFERTY DP. (1980) OSHA and the politics of health regulation. New York: Plenum.

MORGAN P. (1981) Problems of assessing the costs and benefits of health and safety requirements and the techniques available. Health and Safety Executive, London.

ROACH SA. (1970) Hygiene Standards for Asbestos. Ann.Occup.Hyg. 13; 7-15.

VISCUSI WK. (1983) Risk by choice. Harvard University Press, Cambridge Massachusetts and London.

HEAD OFFICE:

Research Avenue North,
Riccarton,
Edinburgh, EH14 4AP,
United Kingdom
Telephone: +44 (0)870 850 5131
Facsimile: +44 (0)870 850 5132

Tapton Park Innovation Centre,
Brimington Road, Tapton,
Chesterfield, Derbyshire, S41 0TZ,
United Kingdom
Telephone: +44 (0)1246 557866
Facsimile: +44 (0)1246 551212

Research House Business Centre,
Fraser Road,
Perivale, Middlesex, UB6 7AQ,
United Kingdom
Telephone: +44 (0)208 537 3491/2
Facsimile: +44 (0)208 537 3493

Brookside Business Park,
Cold Meece,
Stone, Staffs, ST15 0RZ,
United Kingdom
Telephone: +44 (0)1785 764810
Facsimile: +44 (0)1785 764811

Email: iom@iom-world.org