WORLD SAFETY JOURNAL

ESP - Enhanced Safety Principles

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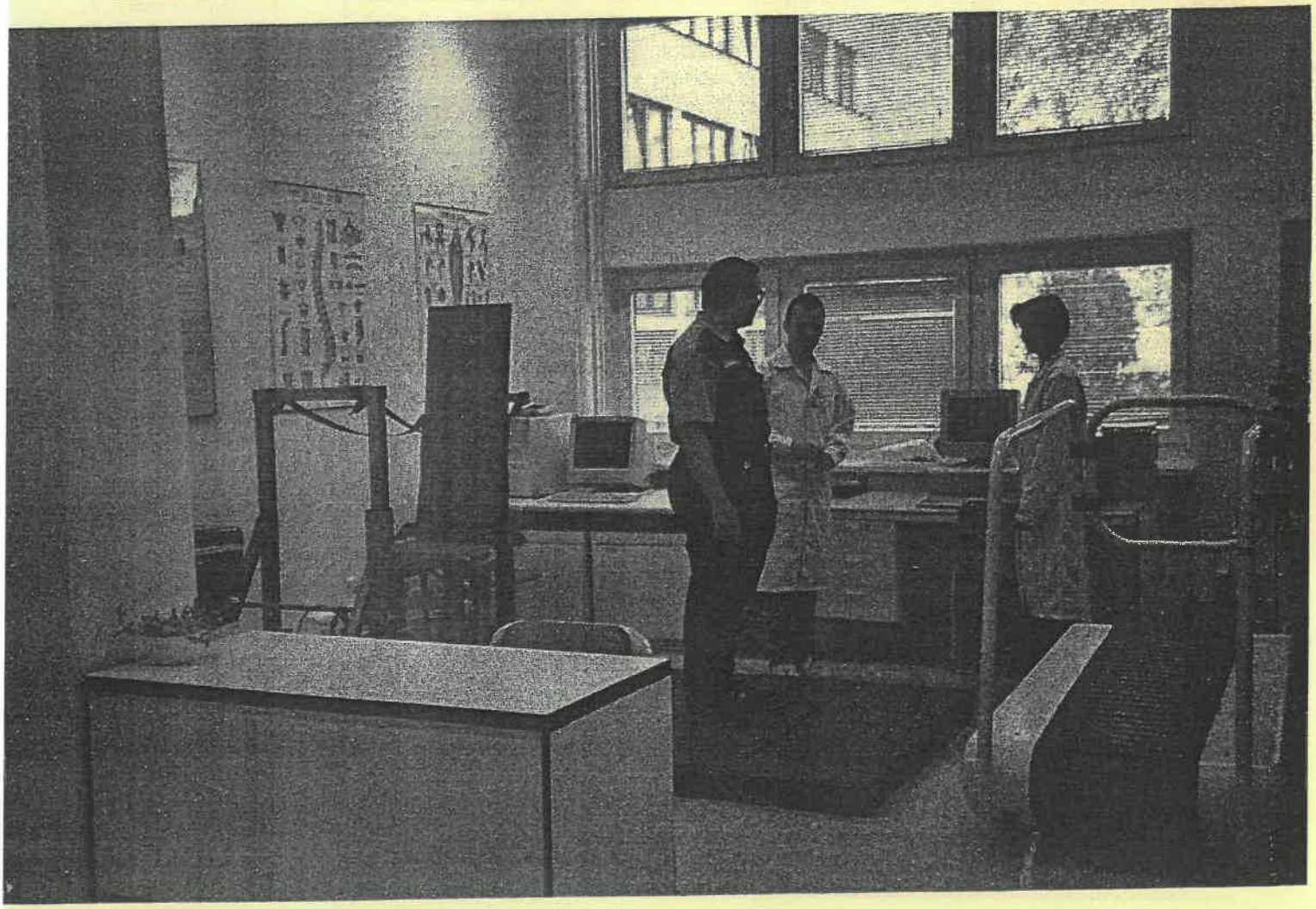
- **The Role of Safety Auditing in Mining Safety and Health**
- **Traffic Safety of Non-Urban roads In Lebanon**
- **Asbestos: The Hidden menace in Home Modifications**
- **Acoustic Shock & Call Centre Operators**
- **The Cost Effectiveness of Accident Preventions Systems**



Pictured above: Laboratory of Biomechanics in the WSO's International Office for Poland

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Profile

The WSO was founded in 1975 in Manila, The Republic of the Philippines, as a result of a gathering of over 1,000 representatives of safety professionals from all continents at the First World Safety and Accident Prevention Congress. The WSO World Management Center was established in the United States of America in 1987 to be responsible for all WSO activities, the liaison with the United Nations, the co-operation with numerous Safety Councils, professional safety/environmental (and allied areas) organizations, WSO International Chapters/Offices, Member Corporations, companies, groups, societies, etc. The WSO is a not for profit corporation, non-sectarian, non-political movement to **"Make Safety a Way of Life"**.

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Issue Dates

March
June
September
December

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Editorial

By: Dr Janis Jansz

In May 2004 I was invited by Professor Danuta Koradecka, Director of the World Safety International Office for Poland, to visit this workplace which is also an International Labour Organisation Research Collaboration Centre and the Central Institute for Labour Protection in Poland. The World Safety International Office for Poland employs 285 researchers. This organisation is responsible for the education of researchers, instructors and representatives of employers and employees in the field of Safety and Health in the working environment and for publishing information related to occupational safety and health. During my visit I had a look at the Research Centres' facilities and met Research Staff to identified joint research opportunities between the World Safety International Offices in Poland and Australia.

At this Polish Centre research is conducted in designing working conditions that conform to European Union Standards and in determining maximum admissible concentrations (MAC) and maximum admissible intensities (MAI) of agents harmful to health. Consultation and cooperation with enterprises is conducted to identify, eliminate and to reduce occupational hazards existing in workplaces. The Centre also conducts the testing and certification of machinery, manufacturing devices and both personal and collective protective equipment for compliance with European Union Safety Standards.

While at the World Safety International Office for Poland I visited some of the Research Laboratories. These included the Laboratory of Biomechanics (room 1) and the Laboratory of Physiology and Hygiene of Work (room 2) in the Ergonomics Department. The Laboratory of Mechanical Hazards (room 3) and the Laboratory of Virtual Reality (room 402) in the Department of Safety Engineering. The Laboratory of Filtration and Ventilation (rooms 11 + 18) and the Laboratory of Toxicology (room 603) in the Department of Chemical and Aerosol Hazards. The Laboratory of Noise, the Reverberation Chamber (room 14), the Hearing Protection Chamber (room 127), the Laboratory of active methods of noise reduction (room 129) in the Department of Acoustics and Electromagnetic Hazards. In all laboratories research was being conducted to improve occupational safety and health.

I enjoyed meeting with the Director of the World Safety International Office for Poland, Professor Danuta Koradecka, and the Department Heads to discuss opportunities for cooperative work. Areas of particular interest for research included improving the retention of nursing staff employed to work in hospitals and conducting research to identify the relationship between workers' safety culture and accidents, near accidents and employee health problems. Being part of the World Safety Organization provides excellent opportunities for the sharing of best practice ideas and for collaborative work internationally to improve occupational safety and health.

ARTICLE SUBMISSION

Articles for inclusion in this journal will be accepted at anytime. However there can be no guarantee that the article will appear in the following journal issue.

All articles shall be written in concise English and typed with a minimum font size of 12 point. Articles should have an abstract of not more than 200 words. Articles shall be submitted as Time New Roman print and on a 3.5" diskette with the article typed in rtf (rich text format) and presented in the form the writer wants published. On a separate page the author should supply the author's name, contact details, professional qualifications and current employment position. This should be submitted with the article.

Writers should include all references and acknowledgments. **Authors are responsible for ensuring that their works do not infringe on any copyright. Failure to do so can result in the writer being accountable for breach of copyright.** The accuracy of the references is the author's responsibility.

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Articles, where ever possible, must be up-to-date and relevant to the Safety Industry.
All articles are Blind Peer Reviewed by at least two referees before being accepted for publication.

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March	31 January	June	30 April
September	31 July	December	31 October.

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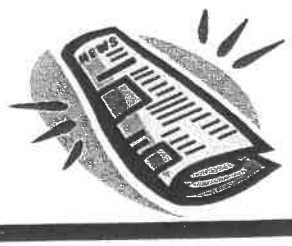

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The Role of Safety Auditing in Mining Safety and Health

by: Dr. Milos Nedved, M.Sc. (Eng.), Ph.D., an Associate Professor at the School of Nursing and Public Health, Edith Cowan University, Western Australia. Dr. Nedved is a Fellow, Safety Institute of Australia, and the Assistant Director of the World Safety Organization International Office for Australia. Address for correspondence: Associate Professor M. Nedved, Edith Cowan University, Joondalup Drive, Joondalup, Western Australia, 6027.

Abstract

This study has examined the significance of safety auditing in the prevention of accidents and ill-health at work. Major objectives, main elements and organisational aspects of safety auditing are discussed, together with the recent Western Australian mining industry experience in the development of safety auditing systems. The article deals with the development of audit protocols, rating systems and checklists for pre-audit surveys and for the actual safety audits. The development of self-audit systems enables the management in industrial organisations to regularly conduct consistent high quality assessment of occupational safety and health management systems and internal controls. Such self-assessment facilitates and verifies compliance with company and statutory requirements, and utilises best practices identified by benchmarking processes.

Introduction

Safety auditing has been playing over the last 10 years or so, a significantly increased role in the prevention of accidents and ill health at work. Over the same period and also previously, a variety of measures have been used to evaluate and measure the organisation's performance in this field. Most of these measures and relevant quantitative indices are reactive and calculated on the basis of consequences, ie, the accidents and occupational disorders we have not been able to prevent. Examples include lost time injuries, and also first aid injuries or medical treatment injuries, as well as restricted duty injuries.

System safety approach is concentrating on the preventive measures before occupational accidents and diseases occur. This is connected with the effort to develop predictive measures of the occupational safety and health performance. One of these predictive measures, and a very powerful one, is auditing of the critical range of the accident prevention processes. For some organisations this includes not only safety but also other loss prevention measures.

Safety Auditing.

In order to be an effective predictive technique, auditing must address not only the physical working environment, but also all management processes managing the physical working environment, ie, all relevant aspects of human factors. Therefore, auditing will give a reasonable indication of how well an organisation's occupational safety and health programme is working in all its aspects, eg.

- how hazards are being identified
- how hazards are being controlled
- how accidents are being avoided

In the U.S. a number of large companies which were noted for profitability as well as good safety records, were convinced that effective safety and loss prevention programmes were essential for a company's prosperity and accepted as an integral part of a good business.[1] One requirement of such programmes was that the efficiency should be checked by the introduction of safety audits to ensure that the company's assets were effectively safeguarded.

The potential for injury, occupational diseases and material losses in the mining and mineral processing operations is enormous. Examples would include fires, explosions, groundfall accidents in underground mines, accidents related to the operation of machinery and to machinery failure, transport accidents, occupational lung disorders and many others. Injury to the people would be one side of the coin. The other side of the coin would be heavy financial losses as a consequence of even a minor accident, which has lead to a lengthy downtime of the plant.

The major objective of safety auditing is to determine the effectiveness of the company's occupational safety and health management system. Detail objectives should cover the examination and assessment of all safety aspects of every occupational activity. These activities should include, among others:

- design and commissioning of the equipment
- technical operations
- operating procedures
- maintenance
- permit-to-work system
- personnel selection and placement
- job descriptions and job safety analysis
- emergency procedures
- investigation of accidents and near misses
- management and employee training
- purchasing
- housekeeping
- monitoring the work environment

Safety audits should carry out a systematic critical appraisal of all potential hazards involving personnel, machinery and equipment, operations and services including management and first line supervisors. The audits need to ensure that company's occupational safety and health systems as a minimum fully satisfy the relevant legal requirements.

Another essential requirement of a safety audit system is that it should originate with the policy-making chief executive who, together with other levels of management has to be fully committed. They also must be prepared to adjust their own safety and health activities in accordance with the results and recommendations of the audits. It is also essential that all relevant senior managers are directly involved in the review of audit reports, design and implementation of an action plan and in subsequent reviews of progress of such plan.

Since all company's activities should be subject to audit, auditing should involve individual employees at all levels not

only as a manifestation of management's interest and concern, but also to encourage comments and suggestions relating to the safety and health matters. Such close cooperation between management and workers encourages the discovery process of factors and conditions which need modification and improvement, to be brought up to a desired level.

Detailed arrangements for safety auditing depends on the size of a company, and the range of its activities. Every good safety auditing system should contain the five main elements ILO, 1986).

a) identification of possible loss – producing situations
b) assessment of potential losses associated with these risks
c) selection of measures to minimise losses
d) implementation of these measures within the organisation
e) monitoring of the changes

Organisational aspects of safety auditing generally vary from one company to another one. Several safety auditing systems, which have been successfully used in mining and mineral processing operations in Western Australia in, recent years are discussed below.

Safety Audit - major elements

The major elements of the occupational safety and health elements typically reviewed in safety auditing included:

- management involvement in the safety and health programme and the level of commitment to occupational safety and health across the organisation
- organisation and arrangements for the safety and health programme, and the assessment of the effectiveness of this programme across the entire workforce
- accident investigation procedures
- accident prevention programmes
- occupational hygiene programmes
- operational procedures
- safety training and education
- human factors at work, with the emphasis on the motivation to develop safe work practices

Safety Audit – assessment

According to Williams (1993) the above major elements were in Alcoa of Australia further broken down to 54 different subjects covered within the safety audit process. The company has been using four descriptors – excellent, good, fair and poor – for each subject being reviewed. The assessment guides have been developed in order to minimise the potential for personal bias or subjectivity of individual auditors. The ratings have been developed (not only in Alcoa, but in general) on the basis of the following:

a) world class programme (or its element) or the one which can be described as a benchmark, is usually rated as EXCELLENT
b) the programme (or its element) with no deficiencies, and where the compliance with the legislation fully exists, is usually rated as GOOD
c) some programme deficiencies, or where there are some legal compliance deficiencies, usually rates as FAIR
d) if many programme deficiencies exist, or there are greater legal compliance deficiencies, POOR rating is applicable

Safety Audit – preparation and protocols

The safety audit process is actually proceeding in two parts. The first part is an assessment of the fact whether the department or the plant has the appropriate systems in place to meet the relevant safety and health requirements. The second part of the safety audit process centres on the verification that those systems are really being adhered to by the plant personnel.

Some time before the safety audit is scheduled to take place; the safety audit team carries out a familiarisation visit to a department or plant to be audited. During this familiarisation visit, relevant safety and health documentation is identified as audit pre-reading materials. These materials should be related to both company safety and health programme, and to relevant legislation including local regulations.

After that, the audit protocols can be developed, or the existing audit protocols can be modified for the forthcoming safety audit. The protocols should assist the auditors in their task of assessing how well the plant or department under the audit is performing the particular activity under review.

The protocols should:

- outline the intent of each step of the safety audit
- establish the minimum actions needed
- guide the safety auditors' efforts
- guide understanding, then assessment and verification
- recommend observations and testing to increase the auditors' confidence in their findings
- be tailored to suit the local legislation framework

Just before the safety auditors' visit, all necessary documentation related to the occupational safety and health programme, as well as related to the legislation (State, Federal, or Local Authority regulations) must be available. During the safety audit commencement part, the auditing team needs to acquaint themselves with the technology, processes and operations in the plant under review. Then the auditors need to meet, in a structured manner, as many people as possible, to discuss various elements of the safety and health programme the auditors believe exist in the plant under review, and to what extent this programme is adhered to. The auditors' team works in this way systematically through all the programme elements that have been selected for the audit process, and arrives at the scores for each of the elements.

During the feedback session (after the completion of the safety audit), the review includes how well the plant or department has done, what scores it has achieved for various elements under review, and also some relevant comments and observations by the auditing team of the inadequacies observed during the process. Also the recommendations can be made on how to make improvements where poor or fair scores have been identified. Then the detailed confidential report covering all aspects of the department's or plant's safety and health performance in the elements under review is submitted to the manager of the plant under review.

The recommendations part of the audit

report in most high quality auditing systems becomes a system in itself for corrective action and continual improvement, set up for action to ensure:

- action is taken to address the system inadequacies
- a further audit/check is made to verify the effectiveness of the action
- the corrective action is "closed out".

According to Williams (1993) "Alcoa has derived a number of benefits from the safety auditing process, in particular significantly better understanding of safety and health practices. They have learnt a lot more about what makes people tick, how some programmes can be successful and how some can fall into a heap due to inappropriate direction or lack of support. From a plant perspective it is very clear that it helps the plant to identify its weaknesses and it also gives the plant significant kudos when excellent programmes are identified and publicised across the company. The plant management can establish where the plant is at that point of time as regards its safety programme, so that two or three years later having actioned the results of the audit report they can look back to see what progress has been made."

As an example, the audit protocol for very frequently discussed element of occupational safety and health programme - personal protective equipment (PPE) is being described.

Personal Protective Equipment - Audit Protocol.

I. Intent of the audit

To ensure that all occupational health and hygiene job hazards are identified and evaluated. To ensure that the appropriate personal protective equipment is selected to reduce the level of risk of injury and exposure to various working environment hazards. To ensure that the users are trained in the personal protective equipment use, and that the provisions are made for their maintenance.

II. Useful contacts for inquiries

- production and maintenance workers
- leading hands and first line supervisors
- occupational safety and health department
- store room attendant
- purchasing department
- production and maintenance managers

III. Verification

a) Inquiry - whom should the auditors talk to and what types of questions to ask

- By what mechanisms are personal protective suppliers selected?
- What processes are in place for the assessment of the needs for personal protective equipment?
- Who assesses such needs and what is the level of worker's involvement in the process of the protective equipment selection?
- Are the relevant hazard assessment and protective equipment selection properly documented?
- Is the personal protective equipment regularly inspected?
- Does it really protect?
- Who is responsible for the PPE maintenance?
- Are employees properly trained in the use of the PPE? How frequently?
- Is the use of all relevant PPE incorporated in the work procedures?
- How is the use of the relevant PPE monitored and such monitoring documented?
- Are there regular audits carried out related to the PPE usage and management?

b) Observations of practices and procedures

- Attempt to check the condition of the personal protective equipment currently in use.
- Do all the PPE in use appear to be clean and properly maintained?
- Are there procedures in place (equally systematic and strict) for the use of relevant PPE by contractors' employees and visitors?
- Is there a procedure in place for the cooperation between the line management and the occupational safety and health practitioners related to the assessment of hazards posed by the working environment?
- Is there a procedure in place for the cooperation between the line management and the occupational safety and health practitioners related to the PPE selection?
- Is all the personal protective equipment suitable and effective for the jobs and operations for which it is provided?
- Are all necessary items of PPE readily accessible to employees?
- Is there an immediate replacement available in case of damage?

c) Testing in order to increase the auditors' confidence in their findings

- Find out from the accident records whether any accidental injury had the deficiency in the PPE system as one of the contributory factors.
- Find out from the accident records whether the severity of specific accidental injuries was affected by the deficiency in the PPE usage.
- Find out whether operational procedures include relevant instructions on the proper use of the PPE.
- Review all relevant documentation in existence related to the assessment of the work environment hazards.
- Review all relevant documentation in existence related to the process of PPE selection and the training in the PPE usage.
- Find out whether regular audits of PPE usage take place. If yes, ask to see such audit reports.

Development of self-audit systems.

In Queensland, a "best practice" model health and safety management system has been designed by the Queensland Department of Mines and Energy.

The SafeGuard system has been designed to be useful for both external auditors such as the mining inspectorate and for the mining companies carrying out their own internal occupational safety and health audits, ie. for self-auditing. SafeGuard (Alexander, Hornsburg, Waters & Inglis, 1996) "has been developed to allow managers, supervisors and workers:

- To self-assess their health and safety management systems
- To use as a guide in setting up and improving health and safety management systems
- To encourage mines to carry out detailed self audits of their health and safety management systems using quality auditing principles
- To encourage audit team members to gain training and understanding in formal quality auditing principles."

The Chamber of Mines and Energy of Western Australia developed the Health, Safety and Environment self audit system already during early nineties (The Chamber of Mines & Energy of WA, 1993). The manual has been produced to assist the management at various levels to implement a health, safety and environment self audit system in their companies. The system "comprises three key elements:

- Self audit of the essential elements of a comprehensive health, safety and environment programme
- Identification of areas where performance is below that which the user believes is appropriate and determination of priorities for remedial action
- Development of a follow-up plan and identification of future targets."

The system advises the users to employ either the ratings on the scale from excellent to poor or the point scoring system (where excellent means 5 points, good 4 points etc.).

The self audit system audits 21 elements of the ideal health, safety and environment management system in a mining company.

The large organisations, and particular the multinationals, have been placing more emphasis on visible organisations' commitment to safety and health, which includes not only strong management leadership at the corporate and local levels, but also effective safety and health programmes enabling employee participation at all levels in health and safety training, development of safe work practices and instructions, workplace inspections, accident investigation, job safety analysis etc. Employees actively participate as members of self audit-teams and in various safety and health reviews.

Summary

Safety audit systems enable the company management to regularly conduct consistent high quality assessment of safety and health management systems with the emphasis on concentrating on preventive measures. The audits follow definite processes, ie determination whether systems are in place, verifying the systems implemented on the jobs, protocols used including rating systems, feedback, recommendations, reports, action plans, corrective action and improvement and "close out" of verification of actions.

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Traffic Safety of Non-Urban Roads in Lebanon

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Abstract

In general, roads should feature good facilities to enable safe travel and transport between countries, different parts of a county, or within smaller areas. This means that roads should offer good accessibility and transport quality, as well as allow journey times at low transport costs. In addition, roads should offer these characteristics under safe and environmentally-friendly conditions. Furthermore, roads should be of good quality in all parts of a country. All of the aforementioned objectives, including safety, must be regarded in all activities regarding the road network. The development and management (planning, design, construction, maintenance, and operation) of a road network should, therefore, aim at achieving an optimum balance, within prevailing budget constraints.

During the past decades, it has become clear in many countries that simply building more and more roads may not always be the best answer to traffic growth and other problems. For instance, the emphasis in several Western European countries is now getting directed towards making the best use of existing road networks and giving priority to sites where the worst accident, congestion and/or environmental problems exist.

In several countries, it is recognized that:

- good road and traffic engineering can reduce the risk and severity of accidents;
- the focus should be directed more towards targeted safety improvement programs, as well as demand and traffic management;
- with respect to local roads and streets, the focus should be directed towards coordinated planning, traffic calming measures, as well as road safety improvements to protect vulnerable road users, such as pedestrians and cyclists.

In Lebanon, the overall road safety situation is poor. The actual number of casualties is high in relation to the number of inhabitants and motor vehicle ownership, as compared to countries with good road safety records. The aim of this paper is to identify and analyze road safety problems in Lebanon, as based on available accident statistics. In this respect, however, it should be noted that the present accident statistics do not allow a detailed analysis to be made with respect to the circumstances surrounding accidents, due to under reporting and a lack of detailed information on road accidents. Further, another aim of this paper is to identify and analyze the safety deficiencies of non-urban roads in Lebanon, and develop proposals and guidelines on how to improve safety on these roads.

Introduction

Road Accident Statistics in Lebanon

In Lebanon, the Traffic Police of the Internal Security Forces is officially responsible for road accident statistics. Up to 2002, the Traffic Police used a simple form to collect data on road accidents, with only a few accident variables. In 2003, the accident form was expanded, and now also includes variables of interest to road safety. See Appendix 1.

Definitions and Under Reporting

The Traffic Police only looks at accidents resulting in personal injuries and fatalities. Damage-only accidents are not recorded by the police; these are recorded by insurance companies. Further, accidents involving army and police vehicles are not recorded in the official statistics; it is estimated that these accidents account for about 10% of all road-related fatalities.

The official statistics only include fatalities that occur at the scene of the accident; no accident follow-ups are carried out afterwards, which indicates that Lebanon does not follow the international definition of road fatalities, ie. fatalities within 30 days of the accident. If the latter were taken into account, it is estimated that the number of fatalities would be 30% higher than that given in the official statistics. The official figures from the Traffic Police paint a picture of a not so grave road safety situation in Lebanon; however, when adjusted for under reporting, a different picture emerges.

Total number of Injury Accidents, Injuries and Fatalities

Table 1 shows the total number of accidents, injuries and fatalities for the period 1996 to 2003. According to the Traffic Police, from 1996 to 2001, the number of injury accidents and injuries increased by 18%. In 2002, there was a dramatic decrease in the number of injury accidents and injuries, which continued in 2003 (see Figure 1). It is difficult to provide an adequate explanation for this phenomenon. However, there could be two reasons for this:

- either the road safety campaigns of recent years have been effective; or
- the road accident statistics are not that accurate.

From 1996 to 2002, the number of recorded fatalities remained more or less the same, followed by an increase in 2003. Based on the available statistics, the number of injured persons per accident is about 1.5, and the fatality index, or the number of fatalities per 100 injured persons, is 12. Considering the degree of under reporting in the official road accident statistics, the real numbers are probably higher. A comparison of the number of injuries, including fatalities, given in the official road accident statistics of the Traffic Police, for the period 2001 to 2003, with those compiled by the Lebanese Red Cross yields the results given in Table 2.

	1996	1997	1998	1999	2000	2001	2002	Est. 2003	-Oct. 2003
Accidents									
Absolute numbers	2,122	2,452	2,333	2,417	2,336	2,499	2,145	1,703	1,419
Index 1996 = 100	100	116	110	114	110	118	101	80	
Injuries									
Absolute numbers	3,265	3,463	3,424	3,529	3,582	3,865	3,206	2,760	2,300
Index 1996 = 100	100	106	105	108	110	118	98	85	
Fatalities									
Absolute numbers	343	377	343	358	313	323	334	349	291
Index 1996 = 100	100	110	100	104	91	94	97	102	
Injured per Accident									
	1.5	1.4	1.5	1.5	1.4	1.5	1.5	1.6	
Fatality Index									
	11	11	10	10	9	8	10	12	

Table 1. Total number of police-reported accidents, injuries and fatalities in Lebanon for 1996-2003 (the figures for 2003 were estimated by taking 12/10 of the actual reporting until October 2003). Source: Traffic Police

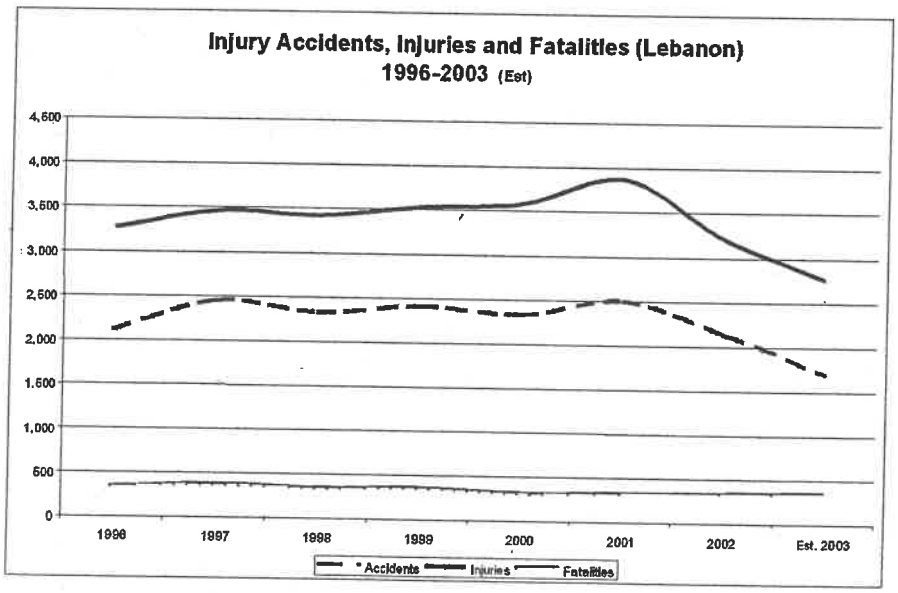

Figure 1. Injury accidents, injuries and fatalities in Lebanon, 1996 – 2003

As can be observed from Table 2, the statistics from the Traffic Police show a positive development with respect to traffic injuries, including fatalities, between 2001 and 2003. However, the figures provided by the Lebanese Red Cross paint a different picture, which shows a very serious development.

	2001	2002	2003 (est.)	-Oct. 2003
Red Cross	4,797	5,725	6,084	5,070
Traffic Police	4,188	3,540	3,109	2,591
Red Cross Index	100	119	127	
Traffic Police Index	100	85	74	

Table 2. Number of injuries, including fatalities, as reported by the Traffic Police and the Lebanese Red Cross for 2001–2003. **Source:** Lebanese Red Cross and Traffic Police.

Fatalities per 100,000 Inhabitants

The CIA World Fact book puts the population figure of Lebanon at 3.8 million for 2003. Table 3 shows the number of fatalities per 100,000 inhabitants for 1997 and 2003 (it should be noted that there is a large presence of foreign workers in Lebanon, which definitely affects the road traffic situation. Some sources put the number of these workers at well over one million). In Lebanon, road fatality rates are assumed to follow two scenarios: one that follows the official accident statistics, and one that considers an under reporting of fatalities, hereafter called UNDER.

	1997	2003
Population (million)	3.4	3.8
No. of fatalities	377	349
No of fatalities, UNDER	660	611
No. of fatalities/100,000 inhabitants	11.2	9.2
No. of fatalities/100,000 inhabitants, UNDER	19.6	16.1

Comparison: France 2001: 13.8, Sweden 2001: 6.2. Source: IRTAD.

Table 3. Number of fatalities per 100,000 inhabitants for 1997 and 2003. Source: Traffic Police.

According to the official accident statistics, Lebanon has about the same road fatality rate as that of OECD countries. However, when taking into account the under reporting of road fatalities, then the road fatality rate becomes higher than those of OECD countries.

Fatalities per 10,000 Vehicles

In 1997, the number of registered motor vehicles in Lebanon was 783,000; in 2003, this number had increased to 1.1 million, or an annual growth rate of 6.8%. That means that, in 2003, the degree of motorization in Lebanon was 290 vehicles per 1,000 inhabitants. According to the official accident statistics, the number of reported fatalities per 10,000 vehicles in Lebanon is slightly higher than that of many OECD countries. However, when taking into account the under reporting of road fatalities, then the fatality rate per 10,000 vehicles becomes much higher than that of OECD countries.

	1997	2003
No. of vehicles (in thousands)	783	1,103
No. of fatalities	377	349
No. of fatalities, UNDER	660	611
No. fatalities / 10,000 vehicles	4.8	3.2
No. fatalities / 10,000 vehicles, UNDER	8.4	5.5

Comparison: France 2001: 2.6, Sweden 2001: 1.2. Source: IRTAD.

Table 4. Number of fatalities per 10,000 vehicles for 1997 and 2003. Source: Traffic Police.

Fatalities per 1 Billion Vehicle Kms

Table 5 shows that the exposure or risk of getting killed in a road accident is higher in Lebanon than in France or Sweden. However, when taking into account the under reporting of road fatalities, the scenario becomes even worse.

	1997	2003
Vehicle Km (in billions)	12.3	17.4
Vehicles (in thousands)	783	1,103
Fatalities	377	349
Fatalities, UNDER	660	611
Fatalities/1 billion vehicle kms	30.7	20.1
Fatalities / 1 billion vehicle kms, UNDER	53.7	35.1

Comparison: France 1999: 14.8, Sweden 1999: 8.3. Source: IRTAD.

Table 5. Fatalities per 1 billion vehicle kms for 1997 and 2003. **Source:** Traffic Police.

Injured per 100,000 Inhabitants

Table 6 shows the number of injured per 100,000 inhabitants for 1997 and 2003.

	1997	2003
Population (in millions)	3.4	3.8
No. injured	3,463	2,760
No. injured, UNDER	6,928	5,520
No. injuries / 100,000 inhabitants	103	73
No. injuries / 100,000 inhabitants, UNDER	206	145

Table 6. Fatalities per 100,000 inhabitants for 1997 and 2003. **Source:** Traffic Police.

Lebanon has an injury rate per 100,000 inhabitants that is comparable to that of OECD countries (100 to 500).

Road Injury Accidents by Cause

Table 7 shows road injury accidents by cause for 2001 and 2002 (the figures for 2003 are not available).

	2001	%	2002	%
Speed	589	23.6	413	19.3
Inattention	944	37.8	855	39.9
Speed and inattention	425	17.0	406	18.9
Pedestrian violation	15	0.6	43	2.0
Mechanical failure	132	5.3	147	6.9
Skidding	69	2.8	29	1.4
Other	325	13.0	252	11.7
Total	**2,499**	**100**	**2,145**	**100**

Table 7. Road Injury Accidents by Cause for 2001 and 2002. Source: Traffic Police.

The specified "causes" are too general and few to allow a practical analysis. However, "Inattention" can be regarded as a cause of the majority of the road accidents in Lebanon; the term 'inattention', however, does not really say anything about the behaviour of the driver(s) involved, or describe the series of events that led to the accident. Speeding alone, or combined with inattention, is also a major cause of road accidents in Lebanon.

The 'pedestrian violation' figure shown in Table 7, a cause of 2% of the accidents in 2002, is probably underestimated since about 30% of the road injury accidents in Lebanon result from a collision between a motor vehicle and a pedestrian, as shown in the following section.

Road Injury Accidents by Accident Type

Table 8 shows road injury accidents by accident type for the period 1999 to 2002 (the figures for 2003 are not available).

	1999	2000	2001	2002
Multiple Vehicle	1,245	1,297	1,367	1,153
Vehicle / Pedestrian	749	584	672	642
Single Vehicle, Collision	181	203	214	158
Single Vehicle, Roll over	242	252	246	192
Total	**2,417**	**2,336**	**2,499**	**2,145**

Table 8. Road Injury Accidents by Accident Type for 1999–2002 (Absolute Numbers).
Source: Traffic Police

The majority of road injury accidents in Lebanon were multiple vehicle accidents. However, an exact description of collision type and motor vehicles involved is not available. As can be observed in Table 8, about thirty percent (30%) of reported road injury accidents were between a vehicle and a pedestrian.

Table 9 shows the index for road injury accidents by accident type for the period 1999 to 2002.

	1999	2000	2001	2002
Multiple Vehicle	100	104	110	93
Vehicle / Pedestrian	100	78	90	86
Single Vehicle, Collision	100	112	118	87
Single Vehicle, Rollover	100	104	72	79
Total	**100**	**97**	**103**	**89**

Table 9. Road Injury Accidents by Accident Type for 1999–2002 (Index 1999=100)

Source: Traffic Police

As can be observed from Table 9, all accident types experienced a decrease between 1999 and 2002. This reduction was particularly strong between 2001 and 2002.

Road Injury Accidents, Injuries and Fatalities by Gender

Table 10 shows road injury accidents by gender for 2002. As can be observed, about 92% of the drivers involved in road injury accidents were male. This can be explained by the fact that the majority of drivers in Lebanon are male and, thus, more at risk.

	Accidents	%
Male	3,126	91.7
Female	282	8.3
Total	**3,408**	**100**

Table 10. Road Injury Accidents by Gender for 2002
Source: Traffic Police

Table 11 shows the number of injured in road injury accidents by gender for 2002. As can be observed, three out of four persons injured were male, again reflecting the fact that the majority of drivers in Lebanon are male and, thus, more at risk.

	Injured	%
Male	2,376	74.1
Female	830	25.9
Total	**3,206**	**100**

Table 11. Number of Injured by Gender for 2002. **Source:** Traffic Police

Road Casualties by Age Group

Table 12 shows the number of road casualties by age group for 2002

Age Group	Fatalities	%	Injuries	%
0-5	11	3.3	62	1.9
6-9	13	3.9	89	2.8
10-14	28	8.4	126	3.9
15-17	16	4.8	192	6.0
18-25	72	21.6	1,072	33.4
26-40	66	19.8	886	27.6
41-50	28	8.4	338	10.5
51-60	24	7.2	191	6.0
61 and over	76	22.8	250	7.8
Total	**334**	**100**	**3,206**	**100**

Table 12. Number of Casualties by Age Group for 2002. Source: Traffic Police.

As can be observed from Table 12, and as in most countries, the young and the old in Lebanon are the most vulnerable road-user groups in traffic. For instance, twenty three percent (23%) of road traffic fatalities concerns persons over 60 years of age, and twenty percent (20%) a person younger than 18 years of age. As can also be observed from Table 12, the age distribution of injured persons shows a different picture: sixty percent (60%) of road traffic injuries concern persons aged between 18 and 25 of age, and between 26 and 40 years of age.

Road Injury Accidents by Vehicle Category

Table 13 shows road injury accidents by vehicle category for the period 1997 to 2002.

	1997	1998	1999	2000	2001	2002
Cars	1,864	1,819	1,846	1,853	1,952	1,648
Trucks	172	186	154	156	148	109
Motorcycles & Bicycles	416	328	417	327	399	388
Total	**2,452**	**2,333**	**2,417**	**2,336**	**2,499**	**2,145**

Table 13. Road Injury Accidents by Vehicle Category for 1997–2002. **Source:** Traffic Police.

Table 14 shows the index of road injury accidents by vehicle category for the period 1997 to 2002.

	1997	1998	1999	2000	2001	2002
Cars	100	98	99	99	105	88
Trucks	100	108	90	91	86	63
Motorcycles & bicycles	100	79	100	79	96	93
Total	**100**	**95**	**99**	**95**	**102**	**87**

Table 14. Road Injury Accidents by Vehicle Category for 1997–2002 (Index 1997=100). **Source:** Traffic Police.

As can be observed from Tables 13 and 14, the number of injury accidents for all vehicle categories experienced decreases between 1997 and 2002.

Table 15 shows the number of injured and fatalities in road injury accidents by vehicle category for 2002.

	Injured	%	Fatalities	%
Cars	2,580	80.5	258	77.3
Trucks	177	5.5	29	8.7
Motorcycles & Bicycles	449	14.0	47	14.1
Total	**3,206**	**100**	**334**	**100**

Table 15. Number of Injured and Fatalities by Vehicle Category for 2002. **Source:** Traffic Police.

As can be observed from Table 15, the highest percentage of injuries and fatalities are sustained in road injury accidents involving the vehicle category "Cars". While motorcycles constitute 3% of the vehicle population, Table 15 shows that, in 2002, about 14% of all road injury accidents concerned the vehicle category "Motorcycles & Bicycles", which makes it look like bicycles are to a greater extent involved in road accidents in Lebanon. However, this is not the case. Therefore, it is recommended that, in the future, to split the vehicle category "Motorcycles & Bicycles" into two.

SAFETY OF NON-URBAN ROADS

It is estimated that, in Lebanon, over 75% of road injury accidents occur on non-urban roads, due to excessive speeding, poorly maintained roads, lack of access control, poor road design, as well other factors which will be alluded to in the following.

Observed Problems and Deficiencies

Non-urban roads in Lebanon range from modern and well-equipped motorways to largely old and poorly maintained ordinary roads. From a safety point of view, the main deficiencies observed with respect to motorways and ordinary roads are given in the following.

Motorways:

- pedestrians often walk alongside or across the motorway;
- the maintenance of road surfaces and equipment (especially markings and guardrails) is often insufficient.

Ordinary roads:

- on major roads, the cross-sections are generally adequate. However, minor roads In mountainous terrain and other areas can be narrow, with varying widths and with non-existent or unpaved shoulders. At many locations, there are level differences between the carriageway and shoulders (either paved or unpaved), which could cause drivers to loose control. On some dual-carriageway roads, there is no median and/or 'physical' separation between opposing lanes (in some cases, two solid yellow lines are present. However, drivers often do not take any notice of these). This often leads to head-on collisions;
- at many locations, roadsides are unsafe as they feature high and steep slopes, concrete lined ditches, rock cuts and hazardous objects close to the carriageway (e.g. utility poles and trees). One special feature that can often be seen is U-shaped open culverts at the edge of the carriageway. Also, in medians on dual-carriageway roads, there exist solid objects without protection (e.g. lighting columns);
- as there are no climbing lanes, even when grades are steep, trucks are forced to drive slowly causing following traffic to undertake dangerous traffic manoeuvres;
- there is often a lack of special facilities for vulnerable road users (such as marked crossings, and separate lanes and tracks for slow-moving vehicles, mopeds, bicycles, pedestrians). On many roads, vulnerable road users are forced to share the road with motor vehicles, which leads to an increase in road accident risk;
- roads crossing built-up areas are often unsafe, as they allow high-speed operation and feature limited or inadequate facilities (pavements and marked crossings, etc.) for vulnerable road users;
- on many roadway sections, particularly on minor roads, both horizontal and vertical alignments are poor and sight distances inadequate, in may cases because of rough terrain, which often leads to dangerous overtaking manoeuvres, resulting in head-on collisions;
- junctions and roundabouts are often unsafe, due to their inadequate design;
- priority rules for drivers at junctions of different types, eg. at roundabouts, are not always clear and uniform;
- in general, access control is poor. Along semi-urban roads, there are very many locations with direct access to the road from adjacent land, (work) shops, petrol stations, etc. This leads to uncontrolled and dangerous traffic movements, by both vehicles and pedestrians;
- road markings are very often inadequate. On many roads, both minor and major markings are lacking;
- road signing is often rather poor. At some traffic islands, for instance, the mandatory sign "Proceed Right" is

missing, causing doubt as to which side vehicles should pass. In general, speed limit signs are rare, causing doubt as to what speed should be adhered to;

- guardrails are often lacking, both at roadsides and in medians. If they do exist, they are often too short for the obstruction(s) present. Another dangerous deficiency is represented by unprotected ends of guardrails;
- at some locations, the concrete or steel barriers to protect lighting columns are too short, which could be dangerous for the occupants of colliding vehicles;
- energy absorbing supports for road lighting and signs, etc., are often not present;
- road lighting is sometimes inadequate, as it varies in quality;
- the signaling at road works (during construction and maintenance) is often insufficient and inadequate. This results in a poor protection of road users and road workers alike;
- road surface maintenance is often not carried out, resulting in uneven surfaces with potholes, etc. In many cases, skid resistance/friction is very low, because of inadequate texture depth and polished stone aggregates. This is especially dangerous on steep grades and in wet or icy conditions;
- road equipment is often poorly maintained. On very many roadway sections, road markings are non-existent or in very poor condition, and the maintenance of guardrails is insufficient;
- on many roadway sections and junctions, trees and bushes obstruct or diminish sight distances. Also, new trees are often planted quite close to the carriageway;
- falling rocks and stones from mountain sides are sometimes left on the carriageway, thus jeopardising road safety;
- along major semi-urban roads, there are many advertising billboards close to the carriageway, causing distraction and, thus, jeopardizing road safety;
- due to a lack of speed limit signs, drivers tend to drive too fast for the prevailing road conditions.

Problems and Strategies

Land-Use Planning

Questions concerning transport and road investment planning (including matters of road safety) are not sufficiently well-coordinated and integrated into the land-use planning process. In Lebanon, suitable, up-to-date guidelines for land-use planning that address transport and road investment planning are not yet in place. One of the main problems, in this respect, is the lack of access control along major roads. In order to alleviate this problem, the following strategies are proposed:

- develop, disseminate and implement guidance papers on land-use planning, with respect to transport and road investment planning (including matters of road safety), both for new development and rehabilitation of existing developed areas. The guidance papers should focus on the need to:
  - reduce transport demand;
  - attain an optimum balance between the different transport policy objectives (e.g. accessibility versus safety);
  - attain an optimum balance between the different transport modes (e.g. public transport versus the private car);
  - avoid conflicts between the different transport modes;
  - restrict land-use development and enhance access control along roads;
  - take the safety of all road users into account;
- develop and implement strong legislation, and apply adequate enforcement and sanctions, in order to eliminate illegal and unsuitable land-use along roads.

Road Planning

In Lebanon, systematic road safety considerations when planning new roads, road rehabilitation, maintenance and operation are not yet in place. In order to alleviate this problem, the following strategies are proposed:

- develop and implement methods to integrate the accident statistics with respect to existing roads into the analysis of their deficiencies and needs, and select roadway sections for reconstruction or improvement;
- improve knowledge on 'normal' accident numbers and accident risks for different types of roads, as well as accident 'reduction factors' for different safety measures, and implement the findings into the appraisals. This could be done by analyzing experience gained internationally, and compiling and analyzing statistical data (eg. accidents, casualties, traffic flows and road characteristics);
- develop and implement up-to-date monetary values for evaluating accident reduction. This could be done by analyzing experience gained internationally, compiling and analyzing statistical data (national statistics, and statistics from the Traffic Police, the Lebanese Red Cross, hospitals, private accident investigators and insurance companies);
- improve knowledge on the safety effects of different types of rehabilitation, maintenance and operational actions, and implement the findings into the planning and decision models for road maintenance management.

Road Design and Equipment

In Lebanon, comprehensive guidelines for road design and equipment are not yet in place. In order to alleviate this problem, the following strategies are proposed:

- develop and implement guidelines for roadsides (including safety zones) with respect to front and back slopes, as well as to minimum distances to hazardous objects;
- develop and implement guidelines for at-grade junctions with respect to crossing angles, junction radii, paved areas and islands;
- develop and implement guidelines for guardrails at high and steep slopes, in medians and at bridges, ends of guardrails, as well as with respect to the position and lengths of guardrails in relation to hazardous objects;
- analyze the suitability of adopting European norms for road equipment with respect to: guardrails, road markings, vertical signs, traffic signals and roadway lighting;

- develop and implement guidelines for:
  - roads passing through agglomerations; for instance, by using the concept of 'environment and safety prioritized' thoroughfares, in order to reduce operating speeds and improve conditions for vulnerable road users;
  - the design and use of facilities for vulnerable road users on semi-rural roads (e.g. separate tracks/lanes for pedestrians, bicyclists, moped riders, animal-drawn carts, etc.);
  - the design and use of speed reducing devices and facilities, in order to increase the alertness of drivers (eg. humps and rumble strips);
  - access control along roads (eg. for small roadside establishments);
  - the quality of stone aggregates, texture depth and skid resistance/friction of new road surfaces (stricter technical specifications).

Speed Limits

Speeding is a big problem in Lebanon, probably because of the following reasons:

- prevailing speed limits are often unsuitable and not always sufficiently shown by signs;
- lack of adequate traffic law enforcement;
- irresponsible driver behavior.

In order to alleviate this problem, the following strategies are proposed:

- develop and implement national guidelines for determining appropriate speed limits on all types of roads, ie. establish criteria for setting speed limits, depending on the prevailing road and traffic conditions. Among other things, the guidelines could be based on accident rates, road geometry (cross-section, alignment, sight distances, etc.), traffic flows and weather conditions;
- revise the principles with respect to speed limit signage, and position the signs more frequently and visibly;
- develop and implement a program for the introduction, implementation and enforcement of the new speed limit guidelines. This program should be a combined effort between all agencies involved in road matters;
- inform road users, especially drivers, about the dangers of speeding by means of continuous information campaigns.

Black Spot Management

In Lebanon, adequate black spot management is not yet in place. In order to alleviate this problem, the following strategies are proposed:

- develop and implement:
  - improved methods for identifying black spots; for instance, by looking at the indicator 'accident/casualty risk';
  - methods for diagnosing and determining suitable countermeasures; for instance, by looking at accident types and patterns, and contributing factors, using so-called 'accident diagrams';
  - a 'system' for estimating the safety effects of a number of countermeasures;
  - methods for prioritizing black spot remedy projects;
  - monetary values for evaluating accident reduction;
  - follow-ups and evaluation methods for black spot countermeasures;
  - special earmarked funding for black spot management.

Safety Audit

In Lebanon, safety audits are not yet in place. In order to alleviate this problem, the following strategies are proposed:

- develop and implement:
  - methods for auditing the safety of existing roads, using comprehensive checklists;
  - long-term plans for auditing the safety of existing international and primary roads;
  - methods for auditing the safety of new roadway projects, using comprehensive checklists at different stages (mainly during the preliminary and the detailed design stages);
  - mandatory audits of newly built international and primary roads;
  - an authority (embracing a team of independent and impartial experts) to audit both existing and newly-built roads;
  - guidelines to audit deficiencies and applied countermeasures;
  - special earmarked funding for the execution of proposals resulting from the safety audits.

Road Maintenance and Operation

In Lebanon, road surface maintenance is often poor; skid resistance/friction is often insufficient. Also, road equipment, especially road markings and guardrails, is poorly maintained. Further, there are often dangerous sight obstructions and hazardous objects close to the carriageway. In order to alleviate these problems, the following strategies are proposed:

- develop and implement guidelines/standards for:
  - the maintenance of roadway surfaces, especially with respect to skid resistance/friction and unevenness (eg. texture, quality of used stone aggregates, etc.);
  - the maintenance and operation of road equipment (signs, road markings, guardrails, lighting, etc.);
  - the removal of dangerous sight obstructions (eg. trees, bushes and signs);
  - the removal of hazardous objects that are close to the carriageway (e.g. lighting columns, utility poles and trees).

Organization and Co-operation

In Lebanon, there is a road safety unit associated with the Ministry of Public Works & Transport. However, it is not functioning efficiently as it is under-funded. Further, there is no co-operation between provincial and municipal authorities on road safety issues. In order to alleviate this problem, the following strategies are proposed:

- develop and implement:
  - an improved and powerful road safety organization under the auspices of the Ministry;
  - co-operation between the provincial and municipal agencies involved in road safety issues;
- establish internal, 'horizontal', working groups at the Ministry to address common and imminent road safety issues.

Staff Competence

Within the Ministry of Public Works & Transport, there is not enough road safety competence amongst staff, and there is also very little information material available on this subject. In order to alleviate this problem, the following strategies are proposed:

- develop and implement improved higher education programs on road safety issues at the universities in Lebanon;
- develop and implement special road safety courses for staff of the Ministry, for instance, concerning:
  - road safety analysis;
  - black spot elimination;
  - road safety auditing;
  - road signs and markings,
  - signaling at road work zones;
- provide the staff at the head office and the provincial offices of the Ministry with up-to-date versions of accident databases for follow-ups.

CONCLUSIONS

As this paper has shown, the road safety situation on non-urban roads in Lebanon is not good and can, for instance, be characterized by the following:

- the road design is not always safe;
- he road equipment is not always designed, used and maintained in a proper manner;
- transport and road investment planning are not sufficiently well-coordinated and integrated into the land-use planning process;
- there is a lack of safety considerations when planning, rehabilitating, maintaining and operating newly built roads;
- comprehensive guidelines for road design and equipment are lacking and, also, existing standards are not always adhered to in practice;
- there is not enough funding for black spot management;
- no safety audits of existing and newly-built roads are performed;
- maintenance of roads and road equipment is poor;
- the existing unit for road safety at the Ministry of Public Works & Transport is under-funded and can, therefore, not work efficiently;
- within the Ministry of Public Works & Transport, there is not enough road safety competence amongst staff, and there is also very little information material available on this subject.

In order to alleviate these problems and, thus, improve the safety on non-urban roads in Lebanon, several strategies have been proposed in this paper. If no drastic actions are undertaken, the number of injury accidents and their consequences will see no improvement.

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Appendix 1

Old Form	
Time:	date, hour
Vehicles involved:	type, number, color, year of production, and license type
Drivers:	name, date of birth, nationality, possession of a driver's license (yes, no)
Information and dead and injured:	name, type of injury, hospital to which the injured was transported and consequences (death...)
Accident Type:	multiple collision, collision with rigid object, collision with pedestrian, overturn
Accident cause:	speeding, inattention, mechanical failure, skidding, other
Weather condition:	

New Form	
Time:	date, hour, day of the week, location (town, distance ...)
Accident type:	multiple collision, collision with a rigid object, collision with pedestrian
Road type:	one-way each direction, one way, two-way each direction, three-way direction

Weather condition:	foggy, cloudy, unstable, snowy, sunny, rainy, unspecified
Road Geometry:	straight, intersection, bridge, curve, tunnel, turn, crest, roundabout, narrow, downhill, rail-road intersection, other
Accident causes:	unlawful pedestrian action, speeding, overtaking, changing direction, overloading, stopping, inefficient lighting, failure to use directional lights, inattention, driving against the flow of traffic, road works, mechanical failure, skidding, use of cellular phone, defective lights, tire failure, weather conditions, alcohol or drug use, malicious act.
Type of vehicles involved & Year of production	Vehicle type and make, year of production, malfunctions before the accident, registration year
Driver's information:	sex, date of birth, nationality, driver license (date, number, private, public), type of injuries (light, heavy), death, health status before the accident, name of hospital to which he/she was transported, unknown
Accident victims other than drivers:	sex, date of birth, age, nationality, type of injuries (light, heavy), death, health status before the accident, name of hospital to which he/she was transported
Map of the accident	
Map showing the collision type (front, sideswipe, back...) And the damages to the vehicles involved	

"Skip's Corner"

Personal Protective Equipment On Construction Sites

Because any number of potentially hazardous situations can exist on construction sites, minimum Personal Protective Equipment (PPE) requirements should be established for personnel entering, working, or traveling within the confines of a demarcated construction area. The minimum PPE should be: Hardhat, Industrial Strength Safety Glasses with Side Shields, and appropriate safety footwear. Other PPE (i.e., flag vests, hand protection, hearing protection, respiratory protection, etc.) Should be required and mandated as dictated by the work being performed and hazards present. This position is in accordance with 29 CFR 1926 - Subpart E standards, related to Occupational Safety and Health (OSHA) interpretations and recommendations, and common "best practices" of the construction industry.

Clear demarcation and posting of the construction site is critical to ensure these PPE requirements are clearly communicated to Site personnel and visitors. If possible administrative and break areas should be kept out of the "construction site" to minimize potential non-compliance. Mixed on common work or material/equipment staging areas within the site would be considered to meet the requirements for wearing this PPE, regardless of whether or not a direct head/eye/foot hazard exists. It should be normal to assume that this PPE is to be worn in all areas located within the demarcated construction site boundary. Only under limited exception (i.e., isolated administrative or break areas, inside project office trailers, etc.) And when clearly posted, shall this PPE not be required.

Construction is "generally" defined as: ***"Any combination of erection, installation, assembly, demolition, or fabrication activities involved to create a new facility or to alter, add to, rehabilitate, dismantle, or remove an existing facility. It also includes alteration and repair (including dredging, excavating, and painting) of buildings, structures, or other real property, as well as demolition and excavation activities conducted as part of environmental restoration or remediation efforts".*** Please note that construction areas are also defined by work activities being performed. Questions concerning exceptions should be referred to your Construction Project Safety Manager.

Asbestos: The Hidden Menace in Home Modifications

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Abstract

Despite the prohibition of import and manufacture of asbestos products, the prevalence of asbestos in existing buildings can remain a considerable threat to home renovators and workers who are modifying these buildings. This article describes the health effects from exposure to asbestos, which may be severe, have a delayed presentation, and are generally not treatable. Due to the severity of the health effects and the lack of treatment, this article documents the primary emphasis for workplace safety as being the need to focus on prevention of exposure.

Introduction

Finnegan (1998) indicates that, by 1964, asbestos had become a material of choice, because of its fireproofing properties, density and adaptability for use in a variety of ways. Other benefits of asbestos identified by Lavelle (2004) also include durability, strength, waterproofing and insulating properties. However asbestos related diseases have been documented since the beginning of the 20th century. The first reported incidence occurred in 1900, when Dr H. Montague Murray discovered asbestos fibres in the lungs of a thirty three year old man, who died of severe pulmonary fibrosis after working in an asbestos textile factory. Other incidences that were documented during the early 1900's include lung scarring of asbestos factory workers noted by Dr Henry K. Pancoast in 1917, the recognition by Dr W. E. Cooke of the first case of asbestosis in 1924, the discovery of unusually early deaths of asbestos workers by an insurance statistician in 1918, and the first workers compensation claim being made for asbestosis in 1927 (EWG Action Fund, 2004a). The EWG Action Fund (2004a) also notes that, by the 1930's, asbestos manufacturers and insurance companies were aware that "... asbestos was killing workers at alarming rates" (Early Knowledge that Asbestos Was Deadly section, ¶ 4).

Despite this long history suggesting awareness of health effects of asbestos over many decades, there has recently been a surge in media coverage on these; for example regarding the law suits of James Hardies Industries by "60 minutes" (Overton, 2004) and "The 7:30 Report" (Peacock, 2004). This, combined with the complete ban of asbestos products in Australia at the beginning of January 2004 (WorkSafe Victoria, nd) has implications for the building industry. Lavelle (2004) states that people working in the home building industry now account for the highest percentage of new mesothelioma cases. Wagner (1997) warns that limiting exposure to asbestos during original installation has been addressed, however workers need to consider that maintenance, repair and removal can also release high numbers of respirable fibres.

The hidden menace in home modifications

Recent warnings by the media to raise awareness in home renovators regarding the prevalence of asbestos products in houses, and the significant health risks that arise when renovating the home, include "ABC news" (Skinner 2004 and "Fibro Linked" 2003), "Catalyst" ABC (Phillips, 2004), "Today Tonight" (Wenn, 2004), and The New Zealand Herald (Johnston, 2000). For example, the interview by Phillips (2004) describes home renovation as "... a looming tidal wave of asbestos cancer" (4th Narration section, ¶1.), and he starts his interview by stating ....

> We all know renovating a home can give you grief, but you don't expect it to kill you. Yet that is happening because of a danger lurking in most homes built before the 1980s...asbestos. Home renovators are the new sufferers of asbestos cancer. (1st Narration section, ¶1)

Another media article by Johnston (2000) even suggests that asbestos related conditions will continue to occur, with "... an ongoing 'tail' of post-epidemic cases resulting from the asbestos already installed in offices, factories and homes "which" will exceed the pre-epidemic background rate" (¶7). As a result of recent media coverage and changes in legislation, occupational therapists responsible for designing home modifications for people with a disability expressed concerns regarding the safety of the trades' people who are contracted to complete these modifications. These concerns were posted on a nation-wide e-mail based home modifications list serve throughout late July and early August 2004. Following a permanent disability, people may need to have their home modified to enable them to continue to manage at home while using a walking aid or wheelchair, ranging from installation of handrails to complete bathroom or kitchen renovations. Unlike private home renovators, who may only need to arrange an assessment to detect the potential for asbestos in one home, workers completing these modifications will often need to attend several different homes of varying ages and construction types every day. Therefore assessment in each instance and each house is not always practicable or feasible.

The potential risk for workers in one major organisation that has a primary role in completing this style of home modification for people following a disability was reviewed. This organisation, like many similar organisations in other states, employs people who have basic generalist skills in home maintenance to install handrails, banister rails, general ramps, platform steps and shower hoses, as well as contracting work to qualified tradesmen to complete major renovations, such as bath removal, wall removal, door widening, and major ramp constructions. When concerns as raised on the home modifications list serve were discussed, it was indicated that incidence of houses containing asbestos is small, that these homes would be easy to identify, and where asbestos is identified, handrails could be constructed as a freestanding

banister style arrangement and bolted onto the floor, rather than bolted into the walls. The purpose of this study, then, was to determine whether potential health effects would be sufficient to warrant a review of the organisation's practices, as well as to determine potential level of risk to exposure at the low levels encountered particularly with the minor home modifications such as installation of handrails.

It is very difficult to determine immediate health effects of asbestos exposure, due to the long latency period between exposure and presentation of initial symptoms. In addition, health effects are often asymptomatic until the latter stages of the disease process. As noted by Cravens (1998), the effects of breathing asbestos are not immediately apparent, and the worker would not be aware of any effect until symptoms develop, potentially 15-40 years later, perhaps many years after the worker has ceased working with asbestos materials. However the EWG Action Fund (2004c) states that injury to the body still occurs with that initial inhalation of asbestos fibres, although X-rays will not detect lung damage until approximately 30% of lung capacity has been lost. Baker & Landrigan (2002) state that the latency period between exposure and symptoms can also result in mis-identification of the aetiology of the disease, and state that the worker "... may well have retired. In such a case, it is unlikely that the worker will be diagnosed as having a disease of occupational origin" (p.1640).

It was noted by the US Environmental Protection Agency (nd) that asbestos breaks down into microscopic fibres that are approximately 1200 times thinner than human hair, which easily penetrate body tissue, and can remain in the body for many years. Cravens (1998) reports that large fibres are trapped in nose hairs and mucous, however smaller fibres progress into the lungs. Lavelle (2004) also suggests that these minute fibres often lodge in the alveoli (air sacs), affecting oxygen exchange into the blood. According to Kim Stewart, quoted by Finnegan (1998), fibres longer than 5 microns are not expelled by the body. Besson, Lalanne, Wang & Guyot (1999) indicate that 70% of chrysotile fibres are shorter than this (and therefore able to be expelled), whereas only 55% of amosite fibres are shorter than 5 microns. This may in part account for the observation by Mossman and Gee (1990, cited by Minter, 1993) that the chrysotile fibres, which amount for 95% total asbestos production, pose less of a health threat than the amphibole fibres. Churg (1993) and Corbridge & Kamp (2004) also note that the behaviour of the fibres in the body depends on the type of asbestos fibres, with chrysotile fibres being rapidly removed, and amphibole (amosite and crocidolite) fibres tending to remain in the lungs. Besson, Lalanne, Wang & Guyot (1999) also suggest that fibre size affects carcinogenicity with risk increasing as fibre length increases and diameter decreases.

The latency period between exposure to asbestos and symptoms or evidence of an asbestos-related health disorder appears to be variable. US Environmental Protection Agency (nd) suggests 10-30 years, while Cravens (1998) suggests 15-40 years, Lavelle (2004) suggests 30-40 years, and EWG Action Fund (2004a) suggests 20-50 years. In relation to asbestos associated cancers, the latency period can be as long as 30-40 years (Luo, Liu, Mu, Tsai & Wen, 2003). In regards to radio-graphical evidence, Wagner (1997) suggests it is rare for the fibrotic changes of asbestosis to be noted earlier than 15-20 years. The latency period for pleural effusion ranges between 5-20 years, pleural plaques 20-40 years, asbestosis 20-30 years, and mesothelioma 20-40 years (Corbridge & Kamp, 2004). Yeung, Rogers & Johnson (1999) discovered that the mean latency period for mesothelioma between 1979 and 1985 in Australia was 37.4 years, and between 1985 and 1995 was 41.7 years, with latency periods being shorter in primary asbestos industries where exposure is higher, which may suggest that, with the organisation's workers only having a relatively lower exposure to asbestos, the latency periods between exposure and detection of health effects may take comparatively longer.

Potential health effects due to asbestos exposure

It is difficult to accurately ascertain projected long-term health outcomes for the organisation due to the difficulties in determining probability and extent of exposure for the workers employed directly as well as the private contractors utilised for major modifications. Many studies support the notion that exposure time and amount has a significant impact on the degree of potential for development of serious health effects. This therefore would be influenced by how often the homes that are being modified actually contain asbestos, time spent working in these houses, and how many fibres are released during low-level activity (such as drilling to install handrails and fix ramps), as well as the major renovations by contractors.

Potential long-term health effects due to asbestos exposure, which may affect staff and contractors completing home modifications, include:

a) **Asbestosis**

Definite links appear to have been made regarding the clinical presentation of asbestosis with exposure to asbestos (Occupational Safety and Health Administration 1994 and World Health Organisation 1989 both cited in EWG Action Fund 2004b, Bolton, Richards & Ebden 2002, Cravens 1998, Corbridge & Kamp 2004, Commission on Life Sciences 1984, Lavelle 2004, and Baker & Landrigan 2002). Asbestosis is scarring of the lung tissue that impedes normal respiratory function, and can potentially result in death due to complications of heart failure, respiratory infection, or lung cancer (Cravens, 1998).

Asbestosis has an insidious onset with gradual progression of dyspnoea (shortness of breath), initially only noted with exertion, and possibly a cough (Wagner, 1997). Corbridge & Kamp (2004) add that, in some instances, clubbing of the digits may also be present and, in advanced disease, there may be signs of right-sided heart failure. Commission on Life Sciences (1984) identifies breathing difficulties may be attributed to the impaired oxygen exchange leading to hypoxaemia (inadequate oxygenation of the blood), restricted

breathing and lung volume, and increased resistance of the small airways. There is no treatment available, although progression of the disease will vary amongst individuals, with some remaining relatively stable with minimal progression over years, and others deteriorating rapidly (Corbridge & Kamp, 2004).

b) **Mesothelioma**

Based on information from National Institute for Occupational Safety and Health (NIOSH) 1996, Baker & Landrigan (2002) indicate that nearly 100% of mesotheliomas in the general population are related to occupational exposures. Many studies and articles, including Luo, Liu, Mu, Tsai & Wen (2003), Wagner (1997), Bolton, Richards & Ebden (2002), Cravens (1998), Corbridge & Kamp (2004), Commission on Life Sciences (1984), Occupational Safety and Health Administration (1994) and World Health Organisation (1989) cited by EWG Action Fund (2004a), Lavelle (2004), and Baker & Landrigan (2002) have reported the association between asbestos exposure and mesothelioma.

Mesothelioma is a tumour, often malignant, of the lining of the chest or abdominal cavities (Cravens, 1998 and Corbridge & Kamp, 2004). Symptoms include an insidious onset of chest pain that may radiate to abdomen or shoulder, weight loss, cough, dyspnoea, and low-grade fever. It may also have associated pleural effusion and pleural plaques, as well as occasional destruction of the adjacent ribs (Corbridge & Kamp, 2004). Craighead et al (1982) cited by Commission on Life Sciences (1984) note that it causes few symptoms in the early stages, so that by the time it is recognised and diagnosed, it is rapidly fatal, with most deaths occurring in less than 2 years. Lavelle (2004) also notes that peritoneal mesothelioma (in the abdomen) has a prognosis of death within approximately 8 months. Both Corbridge & Kamp (2004) and Commission on Life Sciences (1984) suggest surgery may assist if the disease process is limited, however otherwise chemotherapy and radiotherapy appear ineffective. Commission on Life Sciences (1984) and Lavelle (2004), however, indicate that these interventions will potentially delay death or improve quality of life for a few months. Prognosis is generally palliative (Corbridge & Kamp, 2004).

c) **Pleural Disease**

Exposure to asbestos has been found to increase the risk of pleural diseases (Dement et al. 2003, Corbridge & Kamp 2004, and Commission on Life Sciences 1984), as does other hazardous occupational exposures such as silica and welding (Dement et al., 2003). Luo, Liu, Mu, Tsai & Wen (2003) suggest that there is an irritative and inflammatory process that occurs at the pleura of the lung with exposure. Bolton, Richards & Ebden (2002) also note the link between benign pleural disease, including pleural plaques, with asbestos.

Wagner (1997) reports that benign pleural effusion tends to occur within the first 15 years of exposure. Corbridge & Kamp (2004) report that pleural effusions may even develop as early as 5 years after exposure, and symptoms may include chest pain and dyspnoea, although individuals may at times be asymptomatic. Commission on Life Sciences (1984) indicates that symptoms are likely to occur when there is extensive pleural involvement, and describes these as similar to those of restrictive pulmonary disease. Commission on Life Sciences (1984) also states that complaints of pain are rare. Pleural effusions may become chronic, or may resolve spontaneously, and in some cases, progresses to parenchyma fibrosis (Corbridge & Kamp, 2004). Corbridge & Kamp (2004) report there is no effective treatment for this.

Corbridge & Kamp (2004) state that pleural plaques occur after 20-40 years, and may be collections of fibrous or calcified tissue, normally located mid-chest and along the diaphragm. Isolated plaques are asymptomatic, however diffuse plaques may reduce lung volume and cause dyspnoea. There is no effective treatment for this.

d) **Lung Cancer**

Wagner (1997), Bolton, Richards & Ebden (2002), Cravens (1998), Corbridge & Kamp (2004), Commission on Life Sciences (1984), Occupational Safety and Health Administration (1994) and World Health Organisation (1989) cited by EWG Action Fund (2004a), Lavelle (2004), and Baker & Landrigan (2002) all report there is a link between asbestos and lung cancer. Corbridge & Kamp (2004) also state that lung cancer results in a higher mortality rate than mesothelioma. Commission on Life Sciences (1984) notes research has indicated that asbestos-related lung cancer is distinctive, as it tends to arise more often from the lower and peripheral parts of the lungs compared to non-asbestos related cancers. They also note invasion from the cancer may cause obstructions to the airways, resulting in symptoms such as breathing difficulties, infection behind the obstruction, and haemorrhage if blood vessels are affected by the spread. Treatment is the same as per non-asbestos related lung cancer (Corbridge & Kamp, 2004), and may include surgical removal of the primary tumour, radiotherapy and chemotherapy with varying levels of success (Commission on Life Sciences, 1984). Lavelle (2004) indicates that early diagnosis and surgical intervention increases likelihood of a cure or good outcome from treatment.

e) **Cancer of Other Sites**

Luo, Liu, Mu, Tsai & Wen (2003) indicate that cancers from other sites such as the larynx, oesophagus, colon and large intestine had been reported in previous studies completed by Selikoff, Hammond and Seidman (1979), Morgan, Foliant and Wong (1985) and Hodgson and Jones (1986) (all cited by Luo, Liu, Mu, Tsai & Wen 2003). Wagner (1997) and EWG Action Fund (2004b), quoting the

Occupational Health and Safety Administration (1994) and World Health Organisation (1989), report an increase in risk of cancers particularly in the gastrointestinal tract, and Finnegan (1998) quotes Selikoff (1967-1986), who lists other sites as including gastrointestinal tract, larynx, pharynx, kidneys, pancreas, gallbladder and bile duct.

An area of uncertainty exists regarding the connection between asbestos exposure and non-Hodgkin's Lymphoma or other types of haematolymphoid cancers. Weisenburger & Chiu (2002) refute results of previous case reports and epidemiological studies that had indicated a connection, due to their own animal studies and epidemiological research proving no significant increases in these disorders when exposed to asbestos.

f) **Effect on Airways**
A study by Ohar, Sterling, Bleecker & Donohue (2004) indicates that a higher proportion of individuals exposed to asbestos have obstructed airways rather than restrictions to the airways.

g) **Rounded Atelectasis**
Rounded atelectasis occurs at the periphery of the lung, and results from adhesions and fibrosis. It is benign, does not cause symptoms, and has no treatment (Corbridge & Kamp, 2004).

Hazard Management Strategies

For workers completing minor rail and ramp installations, as well as contractors completing the occasional major home modification, exact level of risk and exposure is ambiguous and therefore difficult to determine without formal testing at each site. This does not appear feasible or practicable, given the fact that several houses would be attended to each day, and therefore potentially hundreds of homes per year. Therefore it seems wisest to err on the side of caution due to the severity and incurability of the potential health effects, and the possibility that even minimal contact may result in cancer (Selikoff, cited in Finnegan, 1998). Wagner (1997) states that controlling current workplace exposure is essential to the prevention of the continuing occurrences of the debilitating asbestos-related diseases. He also reports that "too" often, employers fail to recognise and control the hazard, workers are unaware of the risk, and workplace inspectors fail to take samples and to enforce current exposure limits" (p.1311), and stresses prevention of disease via elimination of hazardous exposure conditions, which is essential due to the lack of effective treatment to reverse resultant illnesses. Dr. Selikoff (1990) suggested it is "...unethical to allow further exposure to asbestos" with current knowledge regarding the severe health effects of asbestos (cited in Minter, 1993, p.13).

One possible strategy could be to apply a principle of "universal precautions", similar to the principle applied to infection control, to all home modifications unless it can be definitely established that the house was built after 1989; that is, assume the building has asbestos rather than assume it does not, when dealing with even minor modifications. This principle allies with the notion that the majority of houses have asbestos (ArchiCentre Ltd., 2003).

Management strategies as part of "universal precautions" for minor modifications, particularly where asbestos is suspected, would include:

- Education to identify when presence of asbestos in a building product can conclusively be eliminated prior to commencement of work (and application of universal procedures whenever this cannot be identified)
- Workers to wear protective clothing for any modifications using power equipment (such as a drill) or where dust may be created. This includes disposable overalls and goggles (Skinner, 2004), respirators and gloves (Mlynarek, Corn & Blake, 1996). Wagner (1997) also indicates that, where exposure is intermittent, as it would be for these particular workers, respiratory protection by personal respirators may be useful in conjunction with safe work practices. Dement et al. (2003) reinforces the need to ensure workers are adequately protected during work including maintenance and repairs, not just renovation and demolition. As noted by Mlynarek, Corn & Blake (1996), these measures will not reduce dispersion of fibres, however offers protection to the workers themselves.
- Ensure the work area is secured (Mlynarek, Corn & Blake, 1996), probably to minimise air movement from traffic as well as reduce the number of people exposed to the dust. This includes pets (Dawson, 2004).
- Ensure windows are closed, and air conditioning/heating/fans are turned off to minimise circulation of dust throughout the room (Mlynarek, Corn & Blake, 1996)
- Plastic sheeting is recommended to cover floors and equipment (Mlynarek, Corn & Blake, 1996)
- Use of hand tools rather than power tools for cutting (ArchiCentre Ltd 2003, and realestate.com.au Ltd. nd). This may also assist for drilling.
- If working with fibro or any other materials suspected of containing asbestos, wet it down thoroughly before drilling or cutting to prevent release of asbestos fibres (Skinner 2004, ArchiCentre Ltd 2003, and realestate.com.au Ltd. nd). This causes the fibres to adhere better, thereby reducing the amounts released into the atmosphere (Mlynarek, Corn & Blake, 1996). Mlynarek, Corn & Blake (1996) also suggest water spraying and wet wiping of equipment and plastic sheeting, and Dawson (2004) indicates that plastic sheeting should not be disturbed until the job is fully completed. Naturally care would need to be taken when wetting surfaces regarding proximity of electrical equipment and wiring.
- Wet-wipe (or vacuum if a high efficiency particulate air (HEPA) vacuum is available) the surrounding area including floor once finished (Mlynarek, Corn & Blake, 1996). The ArchiCentre Ltd (2003) and realestate.com.au Ltd. (nd) also suggest wetting residue prior to sweeping. Moir, of the University of Massachusetts (quoted in Sarkis, 2000) stresses the need to pre-plan for

dust management prior to commencing tasks.

- Note that ordinary vacuum cleaners are not intended for use with asbestos or suspected asbestos, and may even contribute to fibres being spread. Instead, specific vacuums with HEPA filters are required (Skinner, 2004). Training and cost of the equipment was noted to be too expensive for the average homeowner, although it may be worth the larger organisation investigating the viability of this if workers suspect asbestos in the homes potentially occurs quite frequently. Otherwise, professional asbestos removalists would need to be utilised (Skinner, 2004).
- Skinner (2004) recommends a spray-coat of penetrating or bridging encapsulant on sprayed-on asbestos-containing-materials on walls and ceilings if they have never been painted before. In the case of the organisation's workers, however, it would simply be better to leave these walls alone and not install the rails, as the material should not be disturbed in any way. Other strategies using independent living aids (eg. toilet frame) may need to be employed instead.
- All asbestos waste, or suspected asbestos waste, including clothing, filters, equipment and building materials, must be disposed of as asbestos waste (in double 6mm transparent plastic bags, labelled, and transported to approved landfill).
- Where asbestos is detected, work must immediately cease, the area sealed off, and professional called. It is essential that any removal work be left to the professionals. (US EPA, nd)

Baker & Landrigan (2002) outline the hierarchy of strategies for primary prevention of occupational disease. The mechanisms for secondary and tertiary prevention do not appear feasible due to the difficulties of early detection and screening for asbestos-related disease, and the long latency periods between asbestos exposure and the first clinical signs. The methods for primary prevention, however, could be applied as noted by this hierarchy, which includes (in order of priority):

1. Elimination or substitution – this is not practical unless complete renovations are being completed; ie. removal of a wall. It is now a requirement by law that any asbestos removed must be replaced by non-asbestos containing products (WorkSafe Victoria, nd)
2. Engineering controls – this would include use of hand rather than power tools for sawing and cutting, use of a high efficiency particulate air (HEPA) vacuum (if available), and turning off any air conditioners/heaters/fans. However ability to engineer the environment is extremely limited as the work is conducted inside private residences, over which the organisation has very little control
3. Work practices – this would include application of the engineering controls as noted above in all homes older than 20 years, care with housekeeping, diligence with disposal of plastic sheeting and protective clothing, wetting potential asbestos-containing walls prior to drilling and cutting, wetting dust prior to sweeping, and informing the client to keep pets and themselves clear of the area until work is completed
4. Administrative controls – this would include completing hazard alert paperwork when asbestos is discovered in the person's home, to be entered on the client database to flag the need for extra precautions if any home modifications are completed in the future. It may also include training of staff on the hazards and management of asbestos, as well as indicators to assist in the identification of potential asbestos-containing products.
5. Personal hygiene – this would include washing of hands prior to eating, ensuring bags for disposal of protective garments and sheeting are kept sealed and away from foodstuffs, and taking extra care when removing protective garments that dust does not fall onto clothing or shoes.
6. Personal protective equipment – includes goggles, gloves, respirators, disposable overalls, and shoe coverings, as well as procedures to damp-wipe these down after each job, and correct disposal methods.

Joseph Durst of the Carpenters' Union, as quoted by Minter (1993), voiced concerns regarding exposure to workers in the building trade to asbestos daily during renovations and remodelling, and the fact that samples are often not taken to determine presence of asbestos, or protection provided for the workers. Lavelle (2004) suggests that it is essential to identify if there is any asbestos containing products in the home prior to starting any renovations or demolition. He also indicates that it is difficult for a layperson to tell which products contain asbestos, and considers that potentially any type of board building material older than 20 years may contain asbestos. US EPA (nd) also suggests that it is not always possible to detect the presence of asbestos by visual examination, and recommends that workers "... treat material which could contain asbestos as if it does, until and unless reliable analysis proves otherwise" (Identifying Asbestos section, ¶1). Wagner (1997) stresses the importance of using specifically professionally trained workers for encapsulation or removal of asbestos, due to the high concentrations of fibres that may be generated.

It therefore would be highly recommended that, for the larger home modification projects involving disturbing walls, plumbing, ceiling and floor coverings, that appropriate sampling and testing by a qualified person be completed to eliminate the possibility of asbestos before proceeding with the modifications. Realestate.com.au Ltd. (nd) indicates that removal and disposal of asbestos cement sheeting by a licensed asbestos removal company may substantially increase the costs of the renovations. Additional cost would need to be calculated, and incorporated into the initial funding applications being made to complete the home modifications. Where the cost of assessment becomes prohibitive, particularly when completing the minor modifications such as the installation of

a handrail, it is further recommended that workers follow precautions to minimise personal exposure, regardless of whether or not they have knowledge of the existence of asbestos in the home, unless they can determine with full certainty that asbestos is definitely not present.

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Acoustic Shock & Call Centre Operators

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Abstract

The Call Centre Industry is one of the fastest growing industries in the world. An injury that is occurring to Call Centre Telephone Operators is Acoustic Shock. This article describes the origin of the problem, how this hazard is currently impacting on employees' health and suggests interventions that Safety Professionals and Employers may make to minimise or eliminate the causes and effects of acoustic shock for Call Centre Workers.

Introduction

The Call Centre Industry is designed with the intention of helping companies achieve economies of scale in service delivery and sales/marketing efforts. Centres typically consist of five to several hundred workers who conduct customer transactions by phone. The Call Centre Industry is estimated to employ approximately two percent of the national workforce in Australia and is growing at a rate of 25% a year (Australian Services Union, 2002). This means approximately 160,000 people are potentially being exposed to the risk of experiencing an injury of growing concern – acoustic shock.

Origins and Effects of Acoustic Shock on Call Centre Workers

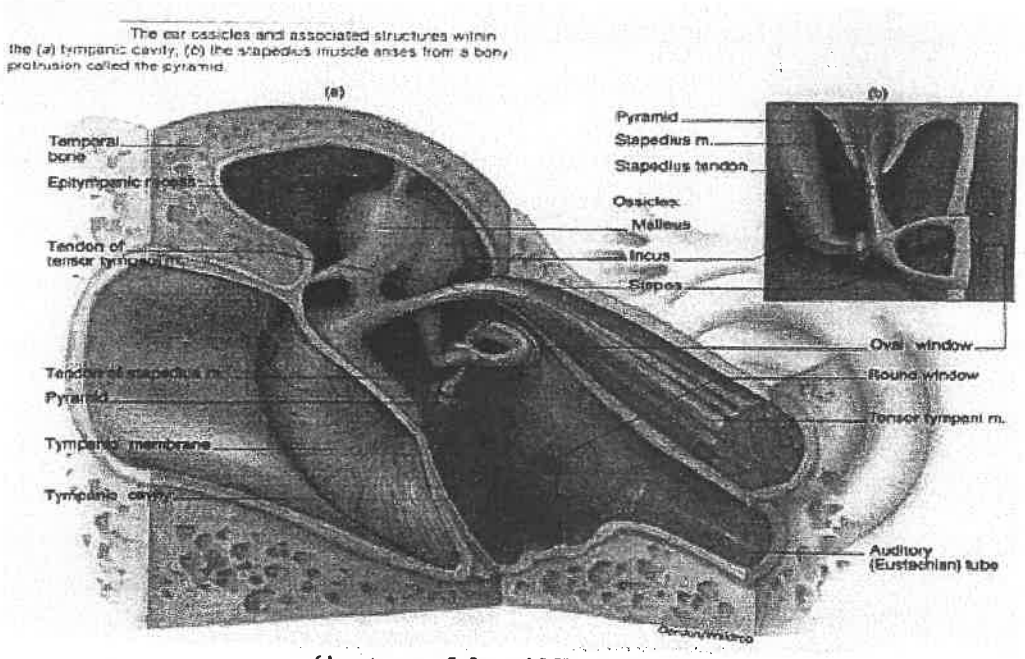
An acoustic shock injury can be described as any temporary or permanent disturbance of the functioning of the ear, or of the nervous system, which may be caused to the user of a telephone earphone by a sudden sharp rise in the acoustic pressure produced by noise. In Call Centres, the source of these sounds can include a misguided call to a fax machine; feedback in customer handsets; smoke alarms (in the case of emergency centres) or whistle (Patuzzi, 2002). The acoustic shock can also be due to the telephone network itself, which is described as audio spikes or shrieks. The exact source of an acoustic shock can sometimes remain unknown, however the resulting impact on the worker can have significant effects (Dillon, 2004).

It is acknowledged that an acoustic shock injury could occur to those not working within the Call Centre industry, such as when using a mobile phone, fax machine or cordless telephone at home. In the case of such events, people are able to move quickly away from the headset, thus limiting exposure to a minimal time. A Call Centre Operator, on the other hand, use a headset for listening to telephone conversations. This means longer exposure to the acoustic stimuli, sometimes for up to 2 seconds (Dillon, 2004). Therefore, due to the frequency and duration of exposure, acoustic shock injuries are a significant hazard in Call Centres.

When considering acoustic shock injury within Call Centres, the implication can be twofold. Firstly the incidence of acoustic shock is remaining relatively static, despite regulatory (Occupational Safety and Health Act of Western Australia, 1984) and workplace reforms aimed at reducing it. Secondly, the very "nature of acoustic shock injuries are difficult to control for many personal characteristics of the workers on a subconscious level have been attributable to the severity of a person's reaction to an acoustic shock incident" (Lynch, 2001, p. 3).

The mechanism by which an acoustic shock injury occurs is not yet fully understood (Dillon, 2004). It is thought "the sound exposure elicits an acoustic startle reflex. A person's response to the startle reflex action, together with the muscular contractions in the middle ear, account for the symptoms of acoustic shock" (Lynch, 2001, p. 3).

For an understanding of acoustic shock injuries it is important to understand how the ear functions when it hears a sound. There are two muscles within the middle ear that are of high importance – the tensor tympani and stapedius. "These muscles contract to distribute pressure, resonance and soundwaves into the inner ear" (Katz, 1994, p. 241). In the case of Call Centre workers, these "muscles are exercised in ways that can increase their mass and size – simply due to the repetitive contractions they perform throughout a working day" (Lynch, 2001, p. 3). Therefore the muscles, which are connected to small middle ear bones (ossicles) to transfer pulses into the inner ear, have the potential to cause damage to the sensitive component of the middle ear by contracting extremely hard in the case of loud noises. The muscles actually contract to 'dampen' the effect of a loud noise. When they contract too forcefully, a tear can occur, which can cause a loss of balance and feelings of giddiness.



(Anatomy of the middle ear, n.d.)

Initial symptoms following an acoustic shock injury have been reported to include tenderness, soreness and feeling of fullness in the ear, numbness, hearing loss, tinnitus and vertigo. In extreme cases, workers have been reported to drop to the ground in pain following the incident (Patuzzi, 2002). Often, secondary and tertiary symptoms can eventuate including jaw and neck pains, headache, fatigue, anxiety and feelings of vulnerability. In the case of tertiary symptoms, anger, hyper vigilance, hypersensitivity to sound, depression, substance abuse and anxiety regarding a return to work have been experienced (Patuzzi, 2002).

The startle reflex is an automatic response by the body to perceived dangers/threats in the environment (Keleman, 1988). The response consists of physical and physiological changes in the body, such as moving away from the offending stimuli, and exhibiting a heightened awareness. In the case of Call Centre workers, the unexpected loud shriek or spike leads to an acoustic startle reflex response. This response is automatic, and will include muscular contraction of upper limb, shoulder, neck, eye and ear structures (Dillon, 2004). In the case of the middle ear, the stapedius and tensor tympani muscles are activated to a heightened level. Depending on the person's reflex response to the acoustic stimuli, tinnitus, pain and vertigo can be experienced soon after. The person can also develop stiff neck and shoulder symptoms due to their automatic response.

It has been acknowledged that Call Centre workers have a much greater likelihood of being exposed to an acoustic shock injury through their headsets (Patuzzi, 2002). During the course of a working day, despite improvements in technology, they are still being exposed to shrills, spikes and other acoustic incidents. Some of these are put simply as "technical in origin" (Dillon, 2004) which would imply that more is needed to try and control this hazard.

Union bodies, both in Australia and Britain, have identified the Call Centre Industry as having a high turnover rate of workers, low satisfaction levels, and low morale (Lynch, 2001). The Australian Council of Trade Unions (2004) has highlighted increasing levels of stress and anxiety in the workplace due to unrealistic performance targets, limited breaks between call, excessive call monitoring for performance management, and inadequate support for workers. The Trade Union Congress (TUC) in Britain (2004) notes that over 400,000 people are employed in the call centre industry (more that coal, steel and manufacturing industries combined) with turnover rates as high as 40-60%. This high rate has been attributed to workers having long hours, low wages, increasing performance targets and fear of acoustic shock from telephone headsets.

The implication for both the personality and stress of a worker in the Call Centre was taken into consideration when analysing the emotional exhaustion of workers (Witt, Andrews & Carson 2003). It was found that those workers with a high conscientiousness level were more inclined to become emotionally exhausted under high performance target and high work demands.

The psychological pressures placed on Call Centre workers is important when considering the relation of increased stress level and emotional states in an individual's startle reflex threshold and reaction. It has been noted that a person can experience a heightened response to an acoustic shock incident whilst under psychological duress. It has been demonstrated in various studies (Goldsmith, 2002, Putzuzzi, Milhinch & Doyle 2000) that call centre workers are constantly having to meet demanding performance targets, undergo persistent monitoring, and have short duration for breaks between calls. Workers often work long hours and wear headsets for the duration of the day. Patuzzi (2002) noted that when an acoustic shock incident occurs with the above factors in mind, symptoms could render workers

unfit for extended periods. When a colleague is injured in the workplace, this too impacts on overall worker morale; increasing the reported levels of stress and dissatisfaction of workers (Jansz 2004).

The Australian Services Union (ASU) undertook a survey in 2001 of state and local government call centre workers. The survey report, *Can call centres be better places to work – ASU Survey Results,* revealed the following (as cited in Goldsmith, 2002):

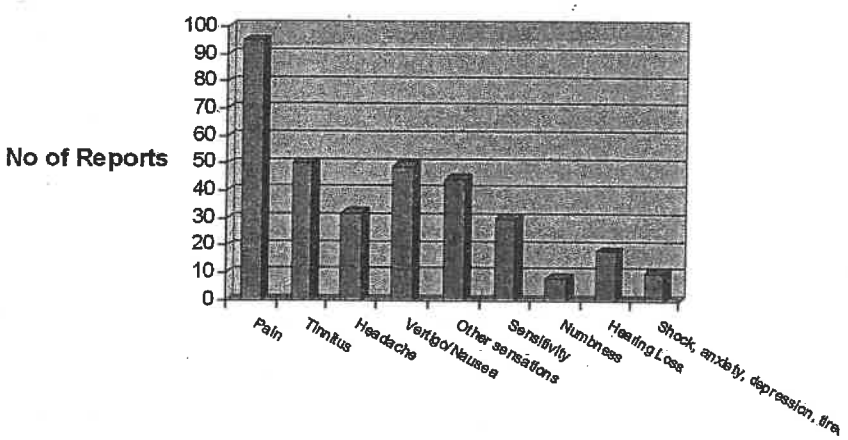
- 88% of respondents found their job and workplace stressful
- The main factors causing stress were rude customers (58.2%), call monitoring/recording (35.3%), equipment failure (34.8%), bad telephone and computer equipment (31.5%), unsupportive managers (31.5%)
- Almost one third took time off work due to stress, resulting in a median of five days off work
- Over one third reported insufficient communications and encouragement from managers
- Almost 40% suffered a workplace injury due to their stressful job and workplace
- Lost frequently mentioned injuries were headaches and eyesight followed by voice loss, earache, back injury and RSI
- 95.1% had their work monitored and measured and reported that this caused them stress

As the Call Centre industry is one of the fastest growing industries with its workers experiencing high stress levels and considering the increased time these employees spend on the phone, acoustic shock injuries can become more common. It can be inferred that acoustic shock and ear trauma can occur at lower levels of sound pressure (120dB SPL) than existing legislation provides for. Research has shown that acoustic shock in Call Centre workers results from a combination of a high incidence of work related stress, increase in muscle strength (of the inner ear muscles) due to work intensification, a startle response and the loud and unexpected noise of 120dB SPL (Lynch, 2001).

How is Acoustic Shock Impacting on Call Centre Employees' Health?

It was identified by Patuzzi (2002) that acoustic shock injuries are a concern for the Call Centre industry. Through a greater understanding of the mechanisms by which such injuries occur, and the possible underlying factors that have been identified as affecting the severity of injury, Occupational Health and Safety Advisors need to be proactive when it comes to controlling the hazard and assessing employees who sustain such injuries.

Milhinch (2002) attempted in her study to determine whether the stressful nature of acoustic incidents is responsible for acoustic shock injury and to examine evidence of significant injury as a consequence of exposure of acoustic incidents. It was explained that of the total number of symptoms reported pain was the most common, followed by tinnitus, loss of balance and hypersensitivity to sound (as shown below):



In cases of moderate to severe acoustic shocks, operators typically described the acoustic incident as "like being hit over the head" or "stabbed in the ear". In a significant number of cases, pain and unusual sensations consistently recurred when the individual experienced any moderately loud sound, similar in pitch to the acoustic incident itself. Psychological symptoms included anxiety and depression, anger, feelings of vulnerability and persistent hypervigilence (Milhinch, 2002). The results suggest that a new understanding of the mechanism of injury following severe acoustic incidents is required. Thus the term "acoustic shock" has been used to differentiate the injury from the more commonly understood "acoustic trauma" which "describes damage to the hair cells in the inner ear, as a consequence of exposure to excessive noise over a prolonged period of time, or to an extremely high intensity stimulus" (Milhinch, 2002, p. 4). The evidence obtained in this study shows that acoustic shock injury presents as an atypical cluster of symptoms.

A study by Halford & Cohen (2002) was undertaken to examine the incidence of musculoskeletal injuries in Call Centre Workers. It highlighted the importance of psychosocial and organisational factors in the welfare of workers, and that further emphasis needed to be placed on certain individual psychosocial factors, as they

were emerging to have an influence on the type of injury / symptoms reported. This study does not discount the physical ergonomic considerations required for the workplace, however it does tend to highlight individual considerations of the workers.

Individuals become emotionally exhausted when they do not have enough resources to meet work demands. Such "resources may include various types of social support, participation in decision making and control" (Cordes & Dougherty, 1993, p. 625). It was suggested that whilst some managers in Call Centres felt those who were considered more conscientious could cope with a higher work demand, this could in fact lead to greater burnout rate, and turnover of staff. Also, by increasing work demands, stress levels were seen to rise. The Call Centre workplace was defined as extremely competitive, where some workers were able to increase their wage by meeting demanding performance targets. In doing so, stress levels in the workplace during these periods would be seen to increase significantly.

Optimism and stress of Call Centre Workers was also reviewed by Tuten & Neidermeyer (2002). In general, those considered as optimistic, reported lower levels of job related stress and lower work / non work conflict. They note that pessimists had higher levels of stress, however this did not necessarily directly relate to work dissatisfaction, or decreased work performance. It was acknowledged high level stress would lead to decreased worker performance and satisfaction over time.

The above examples of the psychological pressures placed on call centre workers is important when considering the relation of increased stress levels an emotional stated in an individuals' startle reflex threshold, and reaction. It has been noted that a person can experience a heightened response to an acoustic shock incident under psychological duress. It has been demonstrated in various studies (Goldsmith 2002, Grillon, Ameli, Foot & Davis, 1993, Halford & Cohen 2002, Putzuzzi, Milhinch & Doyle 2000) that call centre workers are seemingly constantly having to meet demanding performance targets, undergo persistent monitoring, and have short duration for breaks between calls. Workers often work long hours, and wear headsets for the duration of the day. Patuzzi (2002) noted that when an acoustic shock incident occurs with the above factors in mind, symptoms could render workers unfit for extended periods of time. When a colleague is injured in the workplace, this too impacts on overall worker morale; increasing the reported levels of stress and dissatisfaction of workers.

Interventions that may be implemented to limit the occurrence and the effects of Acoustic Shock.

It has now been identified that acoustic shock injuries are a concern for the call centre industry (Patuzzi, 2002). Through a greater understanding of the mechanisms by which such injuries occur, and the possible underlying factors that have been identified as affecting the severity of injury. Occupational Safety Advisors and workplace Managers need to be proactive when it comes to controlling the hazard, and assisting employees who sustain such injuries.

Given that statistics are showing that the incidences of acoustic shock have been on the rise over the last few years (David, 2004), many organisations have taken the attitude to be proactive rather than reactive in reducing the likelihood of possible acoustic shock incidents within the workplace. The fact that acoustic shock is a compensable injury has also given rise to such pro activity.

Taking initiatives such as providing technical support through limiters and acoustic shock prevention devices can reduce the incidence of reported acoustic shock. These controls are able to filter electronic signals, and dampen noise levels in the headset. Acoustic design of the Call Centre will also assist to filter background noise levels. If these noises are at a minimum, a worker will be more able to reduce the noise levels of their headset. It is understood that for purposes of "clarity through the headsets, a minimum of approximately 48 dB is required" (Patel & Broughton, 2002, p. 660). Consequently sound shield devices such as those manufactured by Plantronics are being utilised on a rising level within call centres today (David 2004). Sound shields are programmed to limit incoming sound to 95dB and as such are believed to reduce the incidents of high pitched tone or frequency levels entering the headset.

It is imperative, however that Call Centre workers are provided with adequate training on sound shield devices. Training should consist of correct equipment utilisation, the purposes behind the implementation of such technology and a practical demonstration provided. Training needs to take place by an experienced technician and in optimum circumstances, be undertaken in small groups with adequate time allocated (David 2004). Providing employees with an audiometric evaluation prior to working (and at regular intervals thereafter) will ensure a headset will be suitable to the worker. Also, instruction and information as to how the headset is to be used and maintained is also desired. Headsets should also be assigned to each individual.

Much has been discussed regarding the relationship between a person's acoustic startle reflex, predisposing factors (such as stress and depressive emotions) and the working environment. There is "definite correlation between those individuals predisposed to anxious personality and those individuals who tend not to manage stress well" (David 2004). Research by David & Joffe is currently underway with regards to this hypothesis and it is envisaged as a consequence that when potential employees are recruited, indicators such as anxiety levels are obtained at the early stages prior to employment. This may reduce the likelihood of long term acoustic shock incidents (David 2004).

In Call Centres, the challenge is to create an environment where workers have a sense of job satisfaction, control and management performance targets. If these factors are not considered, the management for acoustic shock injuries will also be difficult.

Information regarding acoustic shock should be readily available to workers, so too should immediate support following

an incident. Literature, (Milhinch, 2002), is demonstrating that a comprehensive treatment regime is required, including intervention through audiological assessment (excluding loud stimuli), preliminary counselling, monitoring of progress and acknowledgement of the traumatic nature of the injury. Also, early detection of underlying psychological factors and a long term rehabilitation plan needs to be identified.

Ms. David, Psychologist and Injury Management Consultant to two of the largest call centres in Western Australia has commenced research into acoustic shock and workers predispositions to acoustic shock with Dr. Marc Joffe, Clinical Psychologist. Ms. David has advised that in general, many Human Resource and Occupational Safety personnel do not manage acoustic shock injuries well and "avoid" the issue where possible. Ms. David and Dr. Joffe are undertaking educational programs with Human Resource and Occupational Safety personnel at these Western Australian Call Centres to create an effective injury management program for employees.

David & Joffe (2004) stated that the main aspects to managing acoustic shock injuries include:

- Providing adequate training to all staff on sound shields and headsets and providing all new employees with education on acoustic shock and sound shields. This is to assist in decreasing the "stigma" of acoustic shock sufferers and also increase awareness and self management of incidences of acoustic shock.
- Provide immediate assistance and support to employees after experiencing acoustic shock, including talking with employee after the incident, explaining what symptoms they may experience and that these are "normal." The staff member doing this must understand and have knowledge regarding acoustic shock. It is recommended to provide the employee with an information sheet with basic information. It should be ensured that the information is not above the level of understanding of the employee and does not cause increased stress or anxiety about the injury.
- The employer needs to be supportive and be flexible in the next few days after the incident. As the work is stressful due to time limits and targets etc, it may be beneficial to change the employees shift the next day to a later shift (due to headaches that may cause difficulty with sleeping) or provide duties that reduce the stress and anxiety at work for a few days.
- Ensure regular follow-up of the employee for the next day and a few days later to provide the injured employee with support and understanding.
- If symptoms continue, the employer should have a preferred general practitioner who specialises in acoustic shock. Most Occupational Health Clinics (such as Delta Health) are able to provide these services. If a client is misdiagnosed or provided with unrelated treatment this may only increase symptoms and stress levels and elongate their claim. Providing the employee with correct treatment and diagnosis is essential to reducing claim costs. It may also be worthwhile arranging for the doctors to undertake a worksite visit of the Call Centre to ensure they understand completely the tasks and pressure staff are under. David (2004) recommended that to get a true understanding of the role of Call Centre employees, all people involved with the rehabilitation should perform the work to gain a better understanding.

Whilst the awareness of acoustic shock injuries is being highlighted by an increase occurrence to employees who work in the Call Centre industry, the sometimes debilitating range of symptoms are not understood by the employer. With further research into individual acoustic startle reflex mechanisms, and an increasing awareness of psychological factors, Occupational Safety Advisors, workers and treating health providers should be better able to coordinate effective rehabilitation programmes. Further research is needed into the technological advances with headset and telephone lines. Similarly research is required for individual (psychological) differences in acoustic startle reflex. Recent studies (Dillon 2004, Folmer, Griest & Martin 2002, Halford & Cohen 2002, Putzuzzi, Milhinch & Doyle 2000) have demonstrated causal relationships, however the strength of these needs further enquiry.

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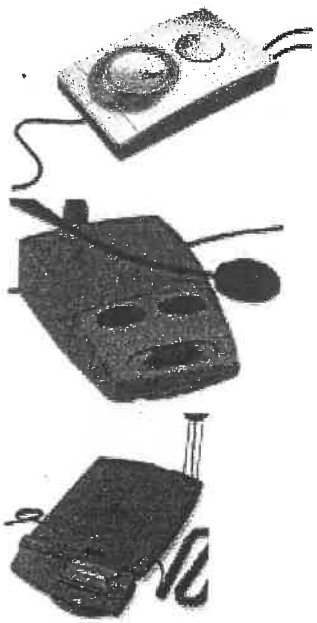
Appendix 1

Soundshield is a digital *Acoustic Shock Protection Device* designed & manufactured in Australia using the latest DSP (Digital Signal Processing) technology. SoundShield prevents acoustic shrieks or high pitched tones from reaching the ear of a headset user, by detecting and instantly rejecting these shrieks within 16-32 milliseconds. Acoustic shrieks can potentially cause injury known as acoustic shock syndrome.



GN8210 acoustic limiter amplifier. Uses state of the art digital processing technology, setting new standards for headset sound quality. Incoming background noise and interference are reduced, ensuring crystal clear communication at all times. The GN8210 digital amplifier also filters out overly loud sounds and noise spikes, protecting your hearing.

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Information retrieved April, 23, 2004 from http://www.ergolink.com.au/acoustic.html

The Cost Effectiveness of Accident Prevention Systems

by: Dr. Milos Nedved, Associate Professor, Edith Cowan University, Western Australia. Fellow, Safety Institute of Australia. Assistant Director, World Safety Organization International Office for Australia.

Abstract

Very frequently, the management sees the cost of the prevention of accidents at work as an unproductive financial burden, and the safety professional's arguments, based on humanitarian reasons, are being quite frequently either ignored, or rejected outright. It is therefore, of crucial importance for all safety practitioners, to be able to argue not only on the basis of humanitarian reasons, but also on a very sound economic basis. If we manage to clearly demonstrate that occupational safety and health activities within the organisation represent a very good investment from the long-term point of view, such activity will get a much more serious commitment from management.

The Benefits of System Safety Approach

Certain resources, spent in the accident prevention activities in an organisation, can have a very varied impact on the final outcome of such activities. The use of system safety in general, and the use of some specific system safety techniques, is discussed to provide a focus for the management's decision.

The traditional moral arguments of safety can be clearly expressed in the terms of cost and schedule and performance, on the basis of a complete and integrated approach for reaching a management decision on any possible hazard within a system or within an organisation. The role of a safety professional is not only to manage safety and health at work, but to manage it in a cost effective manner.

Certain resources spent in the accident prevention activities in an organisation, can have a very varied impact on the final outcome of such activities. This article illustrates this fact, for better understanding in a graphic fashion.

FIGURE 1.

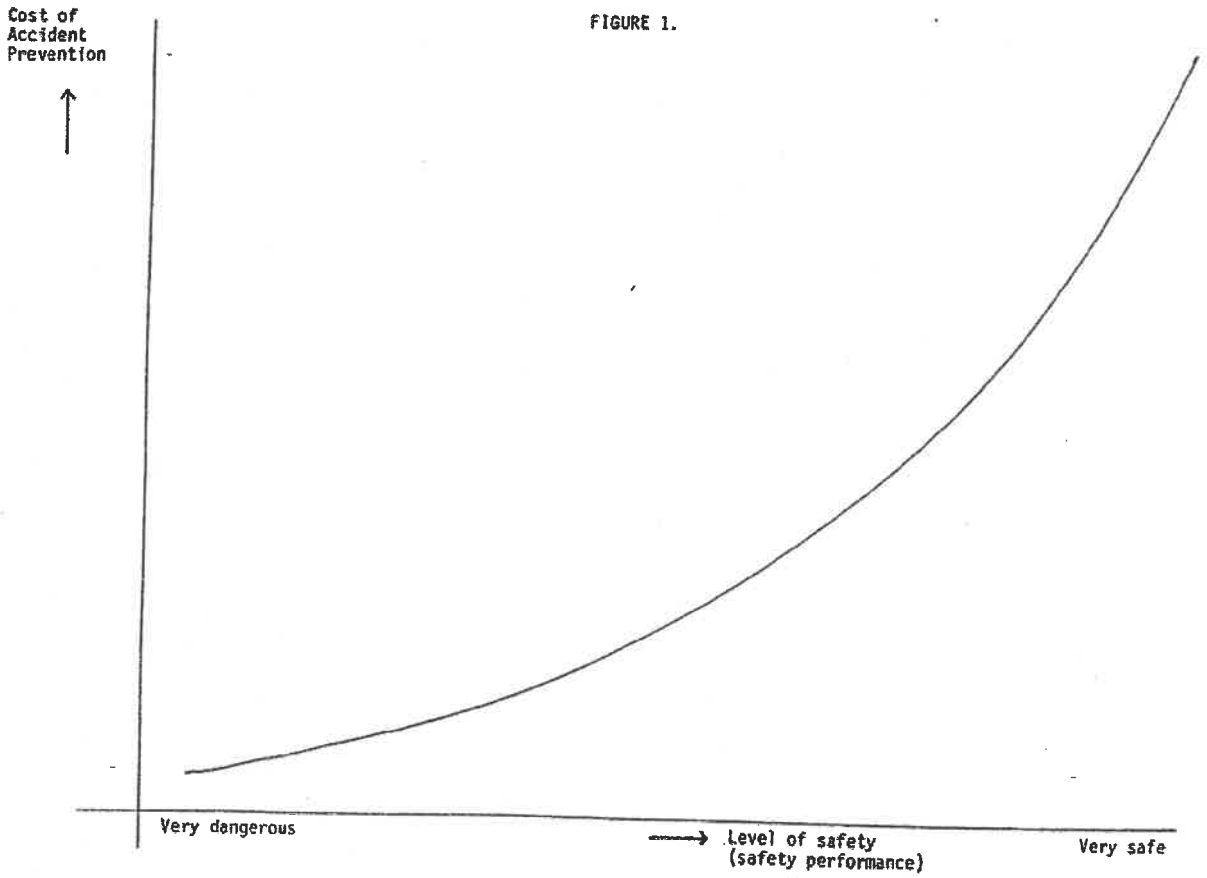
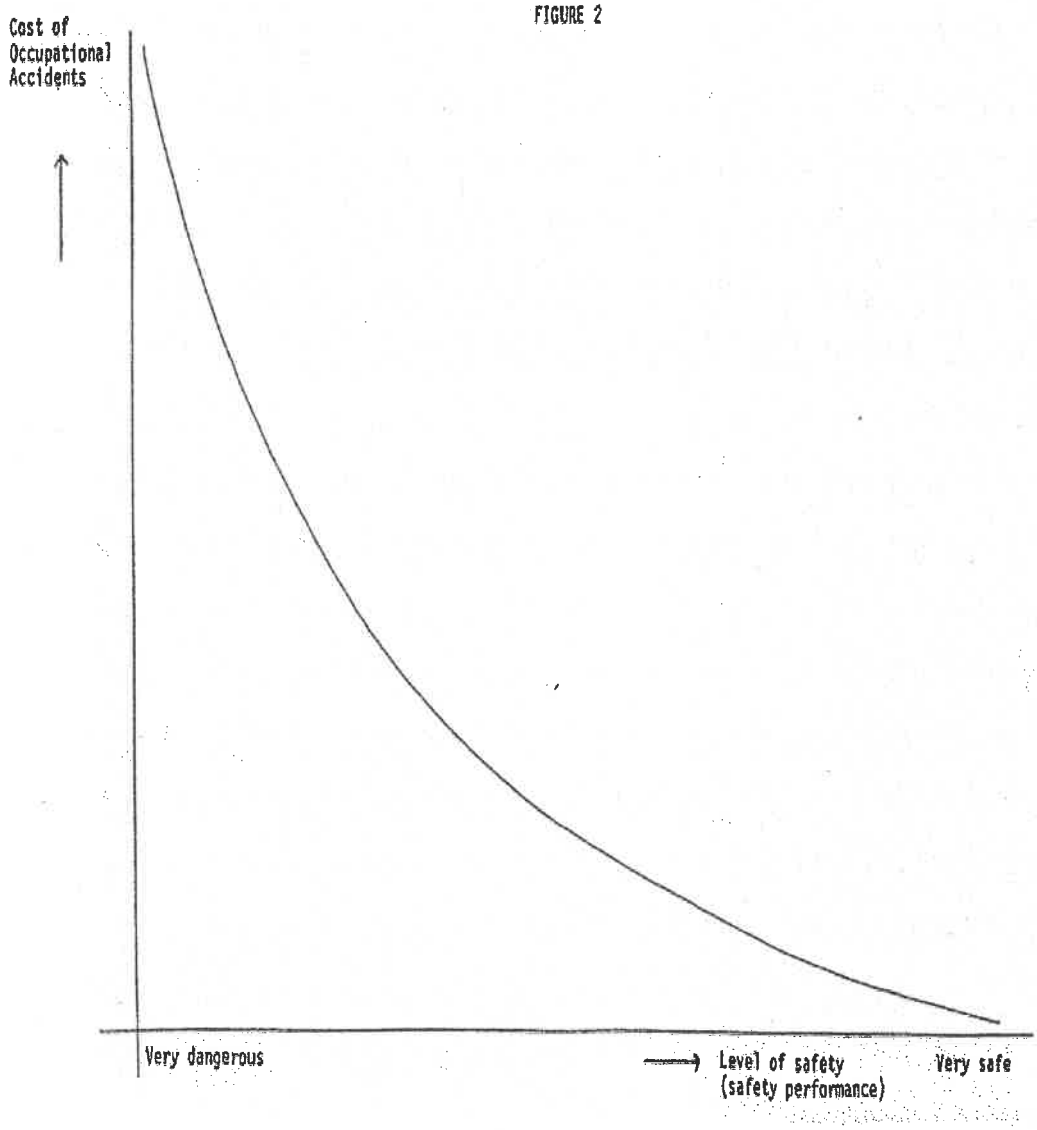


Figure 1 shows how the amount of resources spent in accident prevention influences the company's safety performance. The more resources are directed to the prevention of accidents and ill-health at work, the higher the level of safety (and the lower number of accidents) will be achieved.

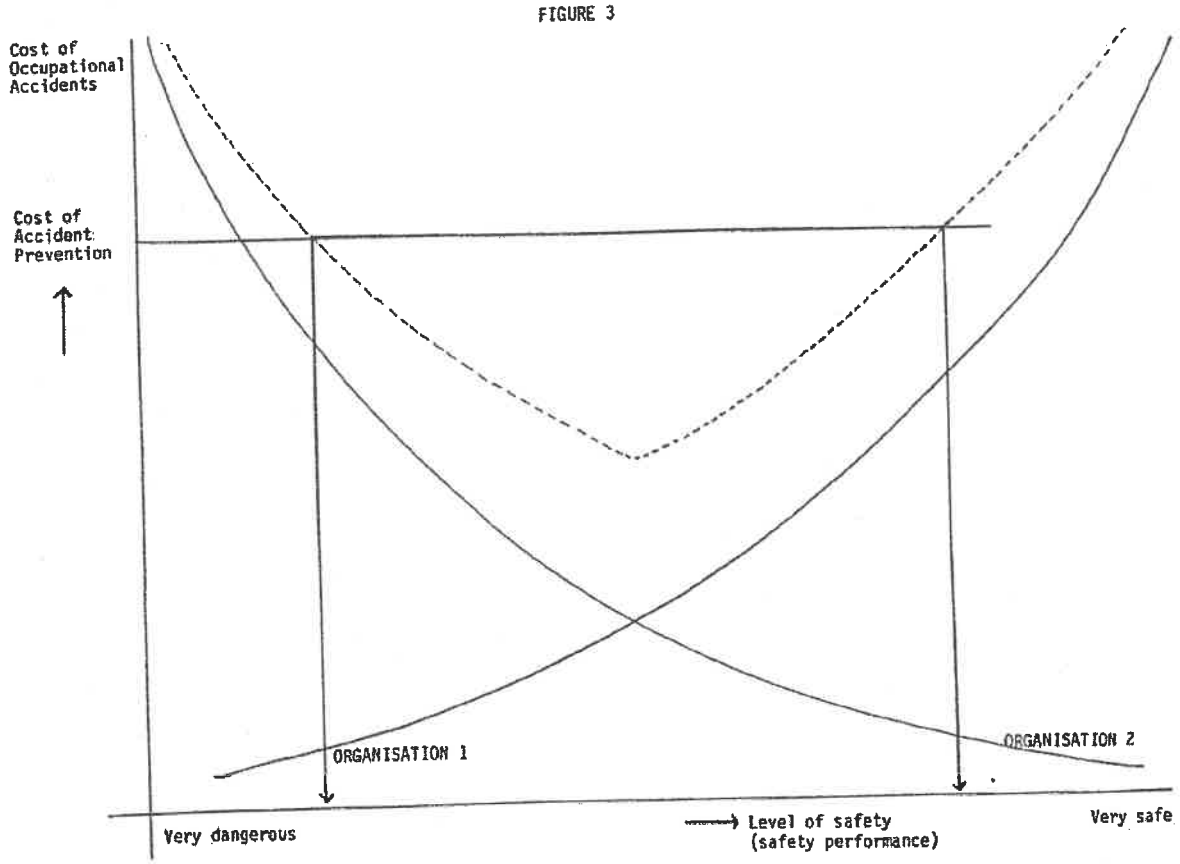
However, in an organisation where little attention and resources are directed at safety and health at work, the cost of occupational accidents would be very high. Figure 2 shows that the more hazardous the working environment, the higher would be the cost of occupational accidents. Improving the level of safety – by spending resources in accident prevention activities, reduces the cost of occupational accidents.

FIGURE 2



In Figure 3, the relationship between the cost of occupational accidents, the cost of accident prevention measures and the level of safety in the workplace is superimposed - on the vertical axis, the financial units (cost) have been used in both figure 1 and figure 2 cases; therefore, such superimposition is justified.

FIGURE 3



The dotted curve shows the overall cost of occupational accidents and the cost of accident prevention measures, as a function of the level of safety achieved in the workplace.

Using Figure 3 as the example, imagine that two different organisations are both experiencing the same overall cost of occupational accidents / accident prevention measures, as represented by the horizontal line in the graph – Figure 3. It can be seen most clearly from the graph, that the outcome can be very different between these two organisations. The safety level at the organisation one (1) is very low (close to very hazardous working environment). The safety level at the organisation two (2) is very hight (close to very safe working environment), in spite of the fact that both organisations are spending the same amount of resources to cover their cost of occupational accidents / cost of accident prevention measures.

This observation prompts consideration of what could be done to make sure that our organisation would be similar to the organisation two (2). In other words, how could we spend our resources in the most cost efficient manner.

System safety approach can help to achieve just that. On the basis of the philosophy of one of the system safety techniques, Fault Tree Hazard Analysis, a safety management technique has been developed, the Management Oversight Risk Tree technique. Since, according to the author's experience, the Management Oversight Risk Tree, or MORT, is the most powerful safety management tool, this paper gives some information on the technique.

System Safety Approach

W.G. Johnson, after his retirement from the American National Safety Council, with the help and assistance of thousands of people, completed what is regarded as the definitive guideline to safety excellence. His study aimed at achieving two goals. Significant reduction in accidents and risks, and a system acceptable to management with a high emphasis on excellence. Johnson looked at every idea, theory and development, and a number of criteria that passed his rigorous tests were integrated into his new programme.

He quickly realised that for this new development to be efficient and effective, it had to be investigative in its approach. Emphasis was placed on being able to prevent accidents, rather than merely preventing re-occurrences. The project started by analysing occupational accidents that had caused severe injuries and damage, and ended in developing methodology for investigating and solving safety problems.

Later, the companies with the best safety records were searched out; their policies and practices examined, and the safety programmes of the best safety performers were used. This combined knowledge gave Johnson an insight into the state of the art safety programmes of the day.

The next area that was integrated was the behavioural sciences, in order to understand where system failures occur that allow people to make mistakes. Error studies highlighted the close parallels

between errors and accidents. It was shown that when errors are investigated, much data becomes available for investigation. This may result in the introduction of improvements that can bring about error reductions. Several accident sequence models were examined to understand the errors/ accidents process. An important conclusion was reached. If an error is identified and system inadequacies are found (for example less-than-adequate training, equipment, supervision), then the system that allowed the error to develop is understood to have failed.

Human behaviour was studied to identify the fundamental concepts affecting safety performance. Motivation, along with other factors, has a major effect on work and safety. Therefore systems and processes were investigated which could produce an effective improvement in work attitudes, which results in better safety performance.

Management science was reviewed and utilised to provide evidence that safety and good management go hand-in-hand. Out of the dozens of management models and systems available, the best were chosen as they improved and stimulated safety effectiveness. Johnson concluded that good safety performance reflects good management practice. A Dupont company managing director has been quoted by Johnson for identifying safety as "the sharpest tool for the evaluation of supervisory performance."

Johnson (1980) then turned his attention to the area of risk assessment and established four main elements:

- "Determination – consisting of identification and estimation of risk.
- Alternatives – knowing the probability and consequences of risk.
- Evaluation – using the criteria to compare the risk.
- Choice – accept the risk or engage in risk reduction."

Among the last areas considered in the development of the technique were the concepts of energy release and energy transfer controls. Much of their concepts were based on Haddon's work, and his definition of an accident: "an unwanted transfer of energy, because of lack of barriers and/or controls, producing injury to persons, property, or process, preceded by sequences of planning and operational errors, which failed to adjust to changes in physical or human factors and produced unsafe conditions and/or unsafe acts, arising out of the risk in an activity, and interrupting or degrading the activity." (Johnson, 1980)

In producing the new systems which incorporated the core ideas of all of this research and information, Johnson included the fault tree logic. However, the MORT technique differs in that casual factors are traced back to management systems which have performed in a less than adequate manner. MORT can be used to analyse specific accidents, or to evaluate a safety programme by asking questions that may indicate "less-than-adequate" performance. It can also be used in designing a thorough, systematic accident prevention programme.

There are other system safety techniques in existence, such as Fault Tree Analysis, Failure Mode Analysis, Hazard Mode and Effect Analysis and others. They are all finding their use in the hands of an increasing number of safety professionals and also of some management specialisations.

System safety is defined as "the optimum degree of hazard elimination and/or control within the constraints of operational effectiveness, time and cost, attained through the specific application of management, scientific and engineering principles throughout all phases of a system life cycle."

A 'system' can be defined as "any complete entity consisting of hardware, software, personnel data, services and facilities, which transform known inputs into desired outputs." (Johnson, 1980). Typical characteristics features of systems approach are:

- The systems approach involves a specific method. The method consist of an orderly defined procedure or way of solving complex problems. All the steps involved in problem solving are arranged in a consistent and orderly manner.
- The systems approach is objective, which means that the steps in the problem solving method are free from personal bias. The results of each step in the problem solving process can be verified by someone other than the person who performed the task.
- Each element in the problem solving process results in a quantitative expression of significance.
- The systems approach employs a rational sub-division of the whole system into its constituent parts to find out the nature, function and inter-relationship of these parts as they contribute to system objectives.

Since analysis is the most significant part of system safety activity, and the ultimate purpose of such analysis is to aid the decision-making process, there are several requirements for system safety analysis:

- Knowledge of the system and its operation
- Knowledge of the system environment (natural environment such as temperature and pressure, corrosion problems, etc, political environment which is established both by the management and outside forces like the marketplace, economic environment such as production pressure resulting in forces on the system which can lead to hazardous operation)
- Knowledge of system hazards
- Methodology (which includes individual system safety techniques)

As a result of the above evaluation and assessment, three parameters of any and every hazard are simultaneously considered and then combined into an overall quantitative index. These parameters are:

- Severity, i.e. the consequential loss of this particular hazard
- Frequency, i.e. the probability of this hazard occurring
- The resources required to eliminate or control this hazard.

Management can be then presented with a list of hazards according to their hierarchy, or significance of individual hazards. Resolution of hazards, which follows, incorporates the decision whether to eliminate hazards or to make the systems tolerant to them.

Cost benefit analysis, which has found

more users in recent years, would form an element of comprehensive system safety approach. A pioneering paper in "Safety in Australia" (Benjamin, 1992) provides a very good introduction to this area.

Conclusion

System safety is better when compared with traditional industrial safety approach, in that it provides a complete and integrated approach for reaching a management decision on all possible hazards within a system.

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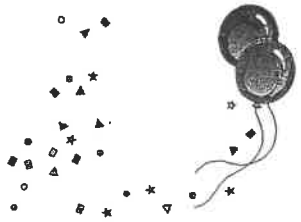

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Title: Conference on Occupational Respiratory Diseases
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Date: 19-22 April, 2005
Contact: Mr. Wang Mushi. Telephone: 86 10 68792527 Fax: 86 10 68792528 email: executive@icord2005.com
website: www.icord2005.com

Title: Joint South East Asia Ergonomic Society Conference & 15th Scientific Seminar of the Indonesial Physiology Society
Venue: Udayana University, Denpasar, Bali, Indonesia
Date: 23-25 May, 2005
Contact: Secretariat SEAES-IPS 2005, Department of Physiology; telephone / fax: (+62) 361 226 132
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National Institute for Occupational Safety & Health.

Title: Occupational & Environmental Exposure of Skin to Chemicals
Venue: Karolinska Insititet, Stockholm, Sweden
Date: 12th June, 2005
Contact: National Institute for Occupational Safety & Health
Website: www.cdc.gov/niosh/topics/skin/OEESC2/conference_info.html

Institute of Chemical Engineers

Title: 7th World Congress of Chemical Engineering
Venue: Scottish Exhibition & Conference Centre, Glasgow, Scotland
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