

WORK-RELATED NOISE INDUCED HEARING LOSS IN AUSTRALIA

APRIL 2006



Australian Government

Australian Safety and Compensation Council

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FOREWORD

The Australian Safety and Compensation Council (ASCC) leads and coordinates national efforts to prevent workplace death, injury and disease in Australia and aims to improve national workers' compensation arrangements and return to work of injured employees.

Through the quality and relevance of the information it provides, the ASCC seeks to influence the awareness and activities of every person and organisation with a role in improving Australia's occupational health and safety (OHS) performance.

The *National OHS Strategy 2002-2012*, (the National Strategy) which was endorsed by the Workplace Relations Ministers' Council on 24 May 2002, records a commitment by all Australian, State and Territory governments, the Australian Chamber of Commerce and Industry and the Australian Council of Trade Unions, to share the responsibility of ensuring that Australia's performance in work-related health and safety is continuously improved.

The National Strategy sets out five 'national priorities' to achieve short-term and long-term improvements.

The priorities are to:

- reduce high incidence and high severity risks
- improve the capacity of business operators and worker to manage OHS effectively
- prevent occupational disease more effectively
- eliminate hazards at the design stage, and
- strengthen the capacity of government to influence OHS outcomes.

In March 2004 it was agreed by the then National Occupational Health and Safety Commission (NOHSC) that, under the national priority to prevent occupational disease more effectively, eight disease categories would be considered for particular focus under any national action plan. These are work-related musculoskeletal disorders; mental disorders, noise-induced hearing loss; respiratory diseases; occupational cancers; contact dermatitis; infectious and parasitic diseases, and cardiovascular disease.

To assist the setting of national action priorities to prevent these diseases, reports were prepared for members on each disease category. The following report is an extract of the information provided to members on the causes and risk factors for cardiovascular disease, the available data on the magnitude and severity for the disease category within Australia, approaches to prevention and evidence for their effectiveness.

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EXECUTIVE SUMMARY

Occupational Noise Induced Hearing Loss - Overview

Noise exposure is the commonest preventable cause of occupational hearing loss. Whilst occupational noise induced hearing loss is entirely preventable, once acquired it is irreversible. Sound and pressure was the stated cause for over 96% of workers' compensation claims for hearing loss in 2001/2. Hearing losses from different causes are at least additive, and interactions can occur between noise exposure and ototoxic chemicals and drugs. Non-work factors also cause hearing loss, most commonly the ageing process. With older employees, the effects of work-related noise may be difficult to distinguish from age related hearing loss without access to previous audiograms.

Occupational hearing loss represents a very significant social and economic burden for Australia. Nationally, an estimated 1 million employees in Australia may be potentially exposed to hazardous levels of noise at work (in the absence of hearing protection). The number of deafness compensation claims (in CPM scope) was 4510 in 2001/2, representing 19% of all disease-related claims made and 3.2% of the total disease and injury related claims. Given an average direct cost of a noise induced deafness claim of \$6711, the direct cost of occupational noise induced hearing loss to Australia is just over \$30 million in 2001/2. However, it has been estimated that compensation costs are probably less than 10 percent of the total costs of noise.

Workers Compensation Claims for Deafness

In considering the workers compensation claim information it is noted that the criteria for making industrial deafness claims varies between jurisdictions, and that not all employees are eligible to make compensation claims. Thus, compensation statistics do not fully reflect the true incidence and cost of industrial deafness.

Over the period 1998/9 to 2001/2, the number of claims decreased each year, reducing from 5755 to 4510 overall. This is primarily due to a reduction in the number of claims (and also reduction in incidence rate) in the manufacturing industry sector. In 2001/2, males made 94% of all claims, and the highest number came from the 55-59 years age group. Over 99% of claims were for permanent hearing loss and 78% of all claims in Australia were made in NSW (3505/4510).

The three occupation groups with the highest number of claims in 2001/2 were: labourers and related workers; tradespersons and related workers; and intermediate production (plant or machine operators) and transport workers. These groups accounted for 88% of all claims.

The three industry sectors with the highest number of claims in 2001/2 were: manufacturing; construction; and transport and storage. However, when examining incidence rate of claims (per 100,000 employees), the highest were: mining; construction; and electricity, gas and water supply. Within manufacturing industries in 2001/2, metal product manufacturing had both the

highest number of claims and highest incidence rate. Within construction industries, non-building construction has the highest number and highest incidence rate. Within mining industries, coal mining had the highest number and highest incidence rate and within transport and storage in 2001/2, rail transport had the highest number and incidence rate.

Prevention Approaches

Programs of work are underway to help reduce work-related noise induced hearing loss in Australia. Jurisdictions are undertaking or planning a significant amount of work in inspections and auditing, targeting highest risk sectors.

Noise induced hearing loss is irreversible, therefore it is important to prevent exposure at the earliest possible opportunities. Focussing on schoolchildren and young people, plus promoting the need to manage hearing in the workplace from employees' induction onwards, and for apprentices could be effective. Awareness programs may also encourage more companies to introduce a noise policy, and a noise control and hearing loss prevention program.

Evidence of effective approaches illustrates that improvements can be made from work undertaken in all elements of a hearing loss prevention program. Each of the elements of the program have been shown to reduce exposures to occupational noise or manage employees' health better, though the chosen approach needs to be situation specific. However, perhaps here the focus lies in alerting companies to the possibilities of using the higher levels (elimination, substitution and engineering control), and encouraging them to think about opportunities.

Hearing protectors may be a topic to be considered for focus. Frequency of use is sometimes limited by concerns regarding hazard awareness when wearing them, and the ability to communicate and hear warning signals. However, opportunities lie in training in the use of hearing protectors (e.g. how to fit properly), choosing appropriately and in customising the fitting (e.g. by the use of custom-moulded devices). There is limited documented evidence (evaluations) of improvements from programs targeting the use of hearing protectors (eg case studies undertaken). Queensland are to examine the effectiveness in the abrasive blasting industry.

Studies further establishing the linkages between job activities, exposure and hearing loss will build up a national picture on the extent of occupational noise induced hearing loss. Gathering information from companies who have performed work exposures and measured employees' hearing loss and synthesising this information to provide a noise and hearing loss profile would lead to a better understanding of the noise induced hearing loss in Australia.

1. GENERAL OVERVIEW OF NOISE INDUCED HEARING LOSS

1.1 Overview and Context

The more effective prevention of occupational diseases is a priority area of the National Occupational Health and Safety Strategy 2002-2012 (National Strategy). Noise induced hearing loss (NIHL) has been identified as one of eight occupational diseases or disorders to be addressed over the life of the National Strategy. This report will focus on occupational noise induced hearing loss, its causes and mechanisms, magnitude of this problem in Australia, industries and occupations at risk and prevention approaches. This report is written to assist the National Occupational Health and Safety Commission and OHS jurisdictions in developing future programs and activities to reduce the incidence or NIHL, as part of the National OHS Strategy.

1.2 Occupational Noise Induced Hearing Loss

Occupational noise-induced hearing loss is defined in the NOHSC National Code of Practice (2004) as *hearing impairment arising from exposure to excessive noise at work*, and is also commonly known as industrial deafness. The extent of hearing loss increases with time of exposure, and also increases with increasing the intensity of sound levels to which an employee is exposed.

Noise exposure is the commonest preventable cause of sensorineural hearing loss (i.e. hearing loss related to the inner ear, and associated neurological structures) and while entirely preventable once acquired is irreversible.

The principal characteristics of occupational noise-induced hearing loss noted by the American College of Occupational and Environmental Medicine, ACOEM, (2002, Page 1-2) are that:

- It is always sensorineural, affecting hair cells in the inner ear.
- Since most noise exposures are symmetric, the hearing loss is usually bilateral¹.
- Symptoms may include gradual loss of hearing, hearing sensitivity and tinnitus.
- One of the first signs of hearing loss due to noise exposure is a “notching” of the audiogram at 3000, 4000, or 6000 Hz, with recovery at 8000 Hertz (Hz)².
- Noise exposure alone does not usually produce a loss greater than 75 dBHL at high frequencies, and 40 dBHL at lower frequencies. However, individuals with superimposed age-related losses may have hearing threshold levels in excess of these values.

¹ Asymmetric sources of noise such as sirens or gunshots can produce asymmetric loss, e.g. as a result of recreational shooting (Monley et al, 1996).

² Monley et al (1996) observed a notch at 6000Hz for workers with 0% Loss of Hearing, suggesting that may be the frequency most susceptible to noise damage, and would thus be the best frequency to use to test for early indications of hearing loss.

- The rate of hearing loss due to chronic noise exposure is greatest during the first 10-15 years of exposure³. This is in contrast to age-related loss, which accelerates over time.
- Most scientific evidence indicates that previously noise-exposed ears are not more sensitive to future noise exposure and that hearing loss due to noise does not progress (in excess of what would be expected from the addition of age-related threshold shifts) once the exposure to noise is discontinued.

1.3 Other effects of work-related noise on people's health

Whilst the scope of the paper is to cover NIHL, noise can also impact on workers' health in a number of other ways, and these effects are summarised briefly here.

Tinnitus (ringing in the ear) is frequently associated with NIHL. Monley (1995) reports that in WA workers with NIHL, the prevalence of tinnitus was 65%, around twice the prevalence in the general population.

Noise Control (NOHSC 1991, p2) notes that, "Although research on the effects of noise is not complete, it appears that noise can cause quickened pulse rate, increased blood pressure and a narrowing of blood vessels. Over a long period of time, these may place an added burden on the heart. Noise may also put stress on other parts of the body by causing abnormal secretion of hormones and tensing of muscles. Workers exposed to noise sometimes complain of nervousness, sleeplessness and fatigue. Excessive noise exposure can also reduce job performance and may cause high rates of absenteeism."

In *Management of Noise at Work* (NOHSC, 1991, p11) it is noted that noise is a safety hazard. It can distract attention and drown out the sound of a malfunctioning machine, an alarm signal or a warning shout. Noise also causes communication problems, annoyance and stress. Dineen (2001) reported on concerns of employees with regard to noise exposure. Noted concerns were: safety – impacting on ability to perceive hazards, and vigilance, resulting in more accidents; ability to communicate; effects on family life; tinnitus; pain – at high levels of intensity, employees reported being in pain from the exposure; and psychological effects – eg more likely to lead to disputes.

A detailed report has recently been published by the enHealth Council (2004) examining *The health effects of environmental noise – other than hearing loss*. Environmental noise or community noise is defined as noise emitted from all sources except noise at the industrial workplace. Effects due to environmental noise which have been observed are; annoyance, ischaemic heart disease, hypertension, psychiatric disorder and immune effects.

³ Behar et al (2000, p.37) and Johnson (1973) also show a decreasing rate of noise induced hearing loss with time.

2. CAUSES AND MECHANISMS OF HEARING LOSS

2.1 Noise exposure

The mechanisms of noise induced hearing loss are well accepted and documented, caused by excessive sound damaging the hair cells in the cochlea of the inner ear.

The relationship between hearing threshold levels and percentage hearing loss (PLH) is defined in the *Improved Procedure for Determining Percentage Loss of Hearing*, National Acoustic Laboratories (1988). The procedure for determining overall PLH is:

1. Establish hearing threshold levels at defined frequencies: 500Hz, 1000Hz, 1500Hz, 2000Hz, 3000Hz, 4000Hz, 6000Hz, 8000Hz;
2. Go to look up tables for each of the frequencies to determine percentage hearing loss (PLH) for each frequency (PLH₅₀₀, PLH₁₀₀₀.....);
3. Add up all the percentage hearing losses to give an overall figure, eg⁴:

$$\text{Total Hearing Loss, PLH} = (\text{PLH}_{500} + \text{PLH}_{1000} + \dots + \text{PLH}_{8000}).$$

This % hearing loss (PLH) thus determined is used for compensation claims.

2.2 Impact of various levels of noise

The US Department of Health and Human Services, NIOSH, (1998) in the publication *Occupational Noise Exposure (Chapter 3 - Basis for the Exposure Standard)*, has examined models that estimate the excess risk from occupational noise exposure. Excess risk is the difference between the percentage of the population that exceeds the fence (i.e. the maximum acceptable hearing loss) in an occupational noise exposed population and the percentage that exceeds it in an unexposed population. A summary of the modelling results over the range 80 dB(A) to 90 dB(A) is shown in Table 1. Further data relating risk of hearing loss with noise exposure levels are shown in Standards Australia AS/NZS 1269.4:1998 (Appendix F, pp37-42) and in work by Robinson (1988).

Regarding levels of sound, the NOHSC National Standard is generally consistent with international practice. It varies from the European Physical Agents (Noise) Directive, EU Directive 2003/10/EC (2003), in that:

- the EU Directive requires the provision of worker information and training, noise assessment, personal hearing protectors and audiometric health surveillance at an exposure level of 80dB(A) $L_{Ex,8h}$ ⁵ (the directive does not recommend reducing the maximum continuous exposure standard to 80dB(A)).

⁴ *Improved Procedure for Determining Percentage Loss of Hearing*, Appendix 7.

⁵ The European $L_{Ex,8h}$ is the equivalent of the $L_{Eq,8h}$ used in Australia.

- the EU Directive identifies an 87dB(A) continuous exposure limit and 137dB(C) peak exposure limit, whereas the NOHSC standard identifies a continuous exposure level of 85dB(A) $L_{Aeq,8h}$ and a maximum peak exposure level 140 dB(C) L_{Cpeak} .

There is some evidence to indicate a synergistic or cumulative effect of impulsive and continuous noise emissions (Noise Annual Situation Report 2003). To progress this issue and to recommend amendments to the National Standard, further scientific research is required to confirm a synergistically negative impact of the impulsive and continuous noise exposures.

Table 1. Comparison of models for estimating the excess risk of material hearing impairment at age 60 after a 40-year working lifetime exposure to occupational noise, by definition of material hearing impairment.

Average exposure level (dBA)	0.5-1-2-kHz definition					1-2-3kHz definition			1-2-3-4 kHz definition ⁶	
	1971 ISO	1972 NIOSH	1973 EPA	1990 ISO	1997 NIOSH	1972 NIOSH	1990 ISO	1997 NIOSH	1990 ISO	1997 NIOSH
90	21	29	22	3	23	29	14	32	17	25
85	10	15	12	1	10	16	4	14	6	8
80	0	3	5	0	4	3	0	5	1	1

Source: US Department of Health and Human Services, *Criteria for a Recommended Standard. Occupational Noise Exposure*, Revised Criteria, 1998. Basis for the Exposure Standard, Chapter 3.

⁶ As an example of the 1-2-3-4 kHz definition; NIOSH defines material hearing impairment as an average of the HTLs for both ears that exceeds 25 dB at 1000, 2000, 3000, and 4000 Hz. Based on this definition, the excess risk is 8% for workers exposed to an average daily noise level of 85 dBA over a 40-year working lifetime.

2.2.1 Acoustic Shock and Acoustic Trauma

Acoustic shock is described in the *Noise Advisory Standard* [Workplace Health & Safety Queensland (2004)]. "Acoustic shock is a term used to describe the physiological and psychological symptoms a person may experience after hearing a sudden, unexpected, loud sound (referred to as an acoustic incident), via a telephone headset or handset". Acoustic shock is of significant concern in work situations where operators spend a high percentage of time on the telephone, e.g. for employees of call centres. Acoustic shock does not usually result in hearing loss, and can be triggered by sounds with peak noise levels well below those in the National Standard.

Acoustic trauma, which is not the same as acoustic shock, occurs due to exposure to a very high sound level [greater than 140 dB(C)] for a short period of time, e.g. close to an explosion or gunfire. This hearing loss can be most severe in the ear closest to the sound.

2.3 Impact of infrasound and ultrasound on hearing in the audible range

The US National Institutes of Environmental Health Sciences reviewed scientific literature on the health effects of infrasound (2001). Infrasound is acoustic energy with frequencies up to 20Hz, and is seldom generated at high sound pressure levels (SPL) without accompanying audible sound. The American Conference of Governmental Industrial Hygienists (ACGIH) recommends that for infrasound the overall unweighted SPL should not exceed a SPL ceiling limit of 150dB. NASA criteria for noise exposure in space craft and space stations include a limit of 120dB for 24-hour exposure to 1 to 16 Hz sound. Five references from the review reported on studying the impact of infrasound on hearing in people, with 2 out of the 5 reporting an effect on the hearing threshold, the others reporting no effect.

Canadian information from the Environmental and Health Directorate (1991) identifies that ultrasound, at sound pressure levels below 120dB, has not been demonstrated to cause hearing loss. The review notes two reports of temporary hearing loss (for frequencies below 8kHz) due to ultrasound at pressure levels of 148 and 154dB, and notes that recovery from the losses was rapid and complete. Lawton (2001), in a contract research report for HSE, reports that 'very high frequency noise has not been observed to produce hearing impairment in the conventional audiometric frequencies up to 8kHz'. Where complaints due to ultrasound have been investigated in WA, usually a sub-harmonic in the audible range has been present.

2.4 Ototoxic substances

Ototoxins are discussed in the *Noise Advisory Standard* [Workplace Health & Safety Queensland (2004)]. " Exposure to certain chemical substances may result in hearing loss. These substances are called ototoxins. They may damage the cochlea in the inner ear and/or the auditory pathways. Hearing damage is more likely if exposure is to a combination of substances or to a combination of substances and noise. Ototoxins can be divided into two general classes: workplace chemicals and medication". Potential workplace

ototoxins include: butanol, carbon disulphide, ethyl benzene, heptane, n-hexane, perchloroethylene, solvent mixtures and fuels, styrene, toluene, trichloroethylene, white spirit (Stoddard solvent), xylene, arsenic, lead, manganese, mercury, organic tin, carbon monoxide, hydrogen cyanide, organophosphates and paraquat.

There is limited awareness in the occupational health community of the chemical hazards to hearing. Standard hearing conservation practices focus on noise and do not take into account the potential risk to hearing posed by chemical exposures.

The European Commission and the US (NIOSH) have commenced research to determine appropriate exposure standards for ototoxic substances. While for a given situation both noise levels and chemical exposure levels may be within the relevant exposure standards, synergistically there may be risk of hearing damage. The EU Directive 2003/10/EC (2003) requires that: *the employer shall give particular attention, when carrying out the risk assessment to, as far as technically achievable, any effects on workers' health and safety resulting from interactions between noise and work-related ototoxic substances*. NIOSH is developing guidelines on how to address the auditory risk.

The National Standard does not currently include references to ototoxic chemicals. As European and US research evolves it may become appropriate to include exposure standards for ototoxic substances. Consideration may be given to following the EU Directive (2003) in terms of noise risk assessments taking account of exposure to ototoxic substances, and including references to ototoxins in the Code of Practice.

It is planned to include an informative section on ototoxic substances as an Appendix in the revised edition of AS/NZS 1269, which is due to be completed early in 2005.

2.5 Compounding factors

Non-work factors also cause sensorineural hearing loss. Most commonly, hearing loss occurs with age, so that in older employees the effects of noise may be difficult to distinguish from age induced hearing loss without access to previous audiograms, Consensus Conference (1990). Other non-work factors may include congenital factors and noisy recreation activity eg listening to loud music.

However, while it is acknowledged that individual susceptibility to the auditory effects of noise varies widely, the role of cofactors (such as cardiovascular disease, diabetes, and neurodegenerative diseases) remains poorly understood (Ward, 1995).

2.6 Statistics of causes and mechanisms

A number of causes and mechanisms, which may lead to hearing loss, are described above. However, sound and pressure are the principle work-related causes/mechanisms of compensation claims due to loss of hearing (4340 out

of 4510 claims in 2001/2, from an examination of National Data Set information).

3. MAGNITUDE AND SEVERITY OF NOISE INDUCED HEARING LOSS

The National Data Set for Workers Compensation Claims (NDS) remains the most reliable source of data with regard to analysing the frequency of NIHL as a disease, but raw claims numbers understate the extent of occupational NIHL in the community.

3.1 Data examination

Figures are from the NDS for all persons 15 years and older, standardised for Comparative Performance Monitoring (CPM) scope (Appendix 2)⁷. Data were analysed in depth for the 2001/2 year, but also time dependent trends were examined over the period 1998/9 to 2001/2⁸.

The key variable examined is **claims due to deafness**.

Where incidence rate of claims is quoted this is the rate per 100,000 employees, defined as:

Incidence Rate = (number of claims/number of employees eligible to claim) * 100,000

3.2 Limitations of analysis based on NDS data

Compensation claims statistics do not completely reflect the true incidence and cost of industrial deafness. Whilst it is a positive sign, an improvement (reduction) in the number of claims being made does not necessarily correlate with an improvement in the prevention of NIHL. But they provide good indicators and useful trends for further examination.

3.3 Limitations include:

- Not all the working population make, or are eligible to make, compensable claims. Thus, the number of claims made will underestimate the number of employees who suffer occupational deafness.
- The industrial deafness threshold, i.e. the level at which compensation claims can be made, is not the same across all jurisdictions. In Appendix 1 the situation at October 2002 is presented, together with an estimate of the variation of claims number with threshold level.
- There is the need to establish that the disease is work-related.

⁷ Data has been presented in CPM scope, to be consistent with the NOSI database and other NDS results presented elsewhere. For deafness, as the claims are based on % hearing loss rather than time off work, technically, the use of unscoped data is more accurate. However, this does not make a large percentage difference overall - the number of unscoped claims for 2001/2 is 4632 compared with 4510 for the CPM scoped data.

⁸ It is noted that data for the years 1998/99 through to 2001/02 will be updated (as per normal practice) when 2002/03 data is published.

- Industries in which employees are known to be at high risk of NIHL are not all identified by the analysis of compensation claims, eg the music entertainment industry.
- The analysis focuses on industries with the largest number of claims. There may be smaller industries (not identified) with not many claims, but a very high rate of claims per employee.
- Employees move between jobs so the resulting hearing condition may be due to a combination of activities.
- Employees may feel under pressure not to claim eg if they think it may impact on their security of employment.

3.4 Time dependent analysis.

Drawing definite conclusions from changes in claims data with time with regard to improvement in noise management is not straightforward. Not least in that it can take many years for noise induced hearing loss to develop to a situation where a claim is made. Thus, a reduction in claims in one year may be the result of work done many years earlier. A changing labour market may have decreased the number of workers covered by workers compensation (eg if there are more self-insured, casual, contract hire and subcontracting workers), and thus have contributed to the decreasing number of NIHL claims in the national compensation statistics.

Over the period analysed (1998/99 to 2001/2), there has been no change in the thresholds for NSW, Queensland or South Australia, the three jurisdictions showing a significant decrease in number of claims for hearing loss (though there may have been some claims still to be processed from pre-threshold times).

An amendment was made to the WorkCover Queensland Act in 1999 (Section 153(3))⁹, but this would not have caused a reduction in claim numbers.

3.5 Results – claims for deafness (disease)

Details of results are shown in Appendix 4. Significant information can be obtained by examining both number of claims made and also the incidence rate per 100,000 employees. All results quoted are for the year 2001/2, unless otherwise stated, and are typical of the whole period 1998/9 to 2001/2.

In 2001/2 there were 4510 compensation claims due to deafness (in CPM Scope), representing 19% of all disease-related claims made, and 3.2% of the all injury plus disease related claims (Table 2 next page).

Over the period 1998/9 to 2001/2, the number of claims decreased each year, reducing from 5755 to 4510 overall (Table 2). This is primarily due to a reduction in the number of claims made in the manufacturing industry. From jurisdictions, the biggest reductions in claim numbers came in NSW,

⁹ Previously, a worker was entitled to a further lump sum payment if the worker had sustained a further diminution in hearing of more than 5% (on top of the 5% threshold loss). This was changed to an entitlement for a further payment with a further 1% loss in hearing.

Queensland and South Australia. In terms of cause of the claims, over 96% of the claims (4340/4510) were due to sound and pressure in 2001/2. Of these, only 30 claims were the result of single exposures, the main cause being prolonged exposure to noise.

Table 2. Number of claims for deafness

	1998/99	1999/2000	2000/01	2001/02
Claims for deafness	5755	5280	5185	4510
Percent of total disease claims	24	22	21	19
Percent of total disease & injury claims	3.8	3.5	3.5	3.2

Males accounted for 94% of all claims made in 2001/2, and the highest number came from the 55-59 years age group (Figure 1 below). Monley 1995 reported that from testing undertaken in the early 1990's, the mean age for workers with 10% or greater hearing loss in Western Australia was 52 years old and that noisy occupations are very much male dominated.

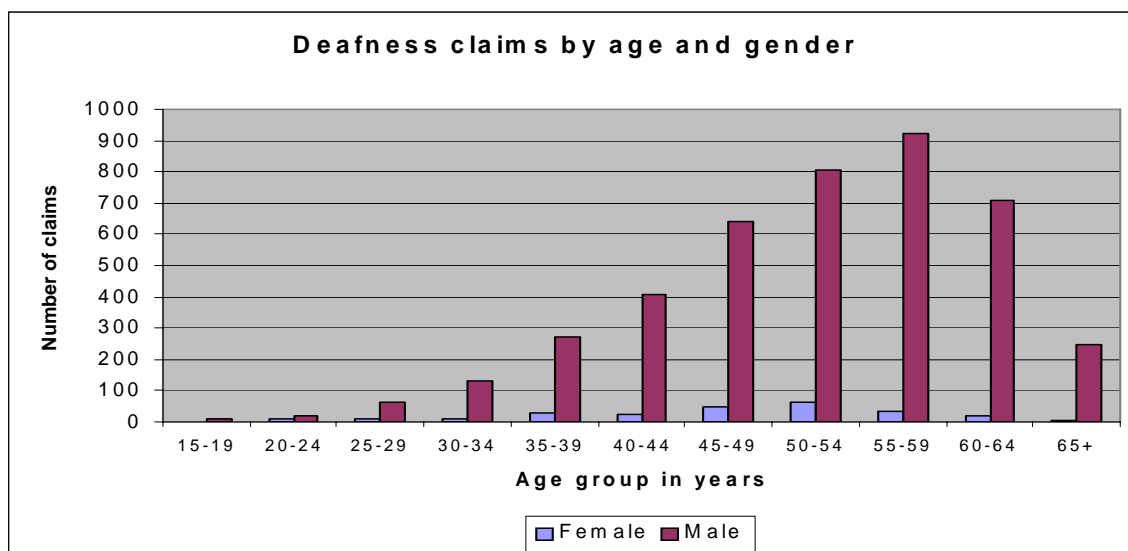


Figure 1. Incidence of deafness claims by age and gender (Workers' compensation 2001-02).

Over 99% of claims were for permanent hearing loss in 2001/2. Examining jurisdictions, 78% of all claims in 2001/2 were made in NSW (3505/4510), and the incidence rate was highest also.

3.5.1 Occupations

The occupations with the highest number of claims in 2001/2 were (in order, highest first) labourers and related workers, tradespersons and related

workers and intermediate production (plant or machine operators) and transport workers. These three groups accounted for 88% of all claims.

3.5.2 Industries

Industry sectors with the highest number of claims in 2001/2 were (in order, highest first) manufacturing, construction and transport and storage. The incidence rate (per 100,000 employees) over the years 1998/9 to 2001/2 is shown in Figure 2 (below), with mining having the highest incidence rate overall. These results are consistent with findings reported by Monley (1995), based on WA testing, and by HSE (based on 2000-02 figures for new cases applying for benefits).

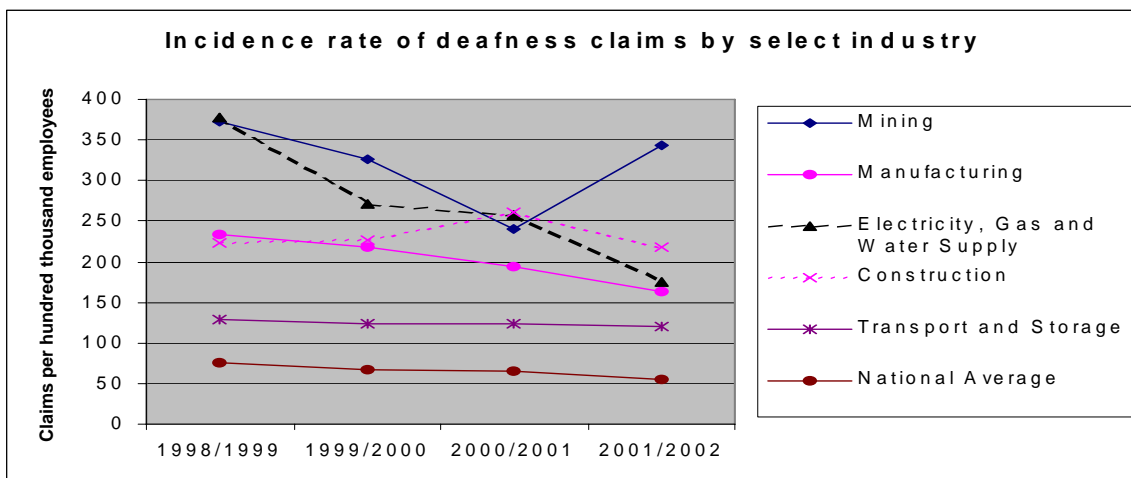


Figure 2. Incidence rate of selected industries (Workers' compensation 1998–99 to 2001–02).

3.5.3 Manufacturing

Within manufacturing in 2001/2, metal product manufacturing had both the highest number of claims (545) and the highest incidence rate (365/100,000), Figure 3 (next page).

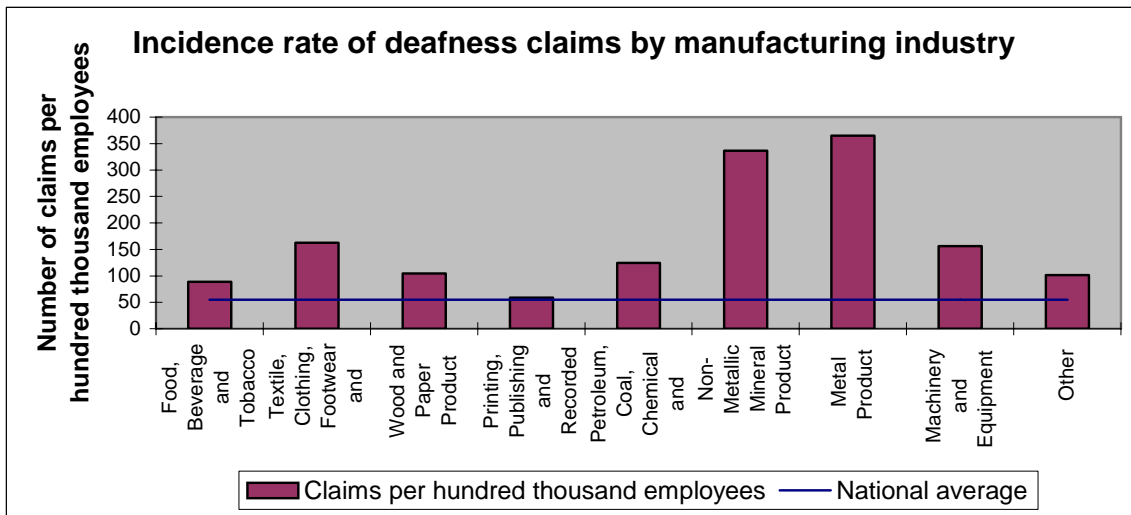


Figure 3. Incidence rate of deafness claims for the manufacturing industry (Workers' compensation 2001-02).

3.5.4 Construction

Within construction in 2001/2, non-building construction had the highest number (265) and incidence rate (579/100,000), Figure 4 (below).

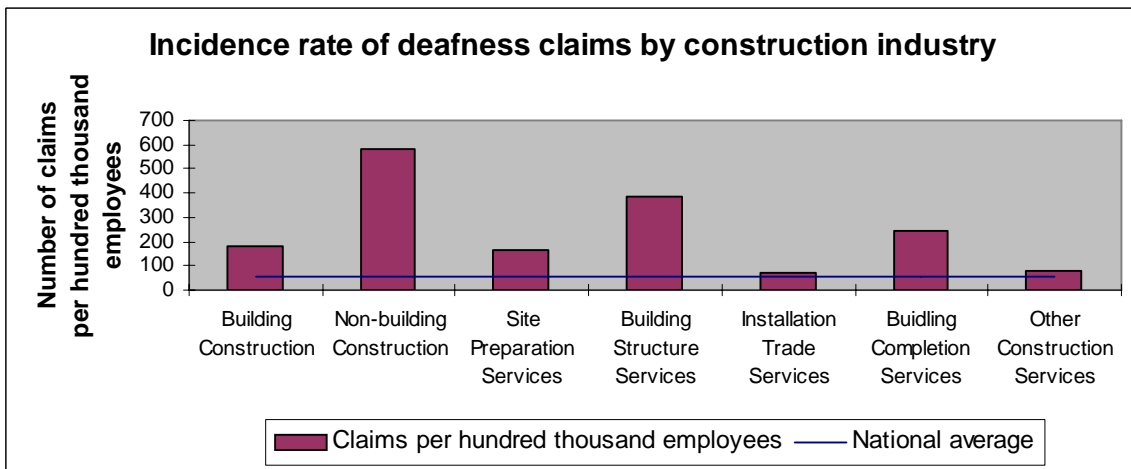


Figure 4. Incidence rate of deafness claims by construction industry (Workers' compensation 2001-02).

3.5.5 Mining

Within mining in 2001/2, coal mining had the highest number (145) and incidence rate (762/100,000), Figure 5 (next page).

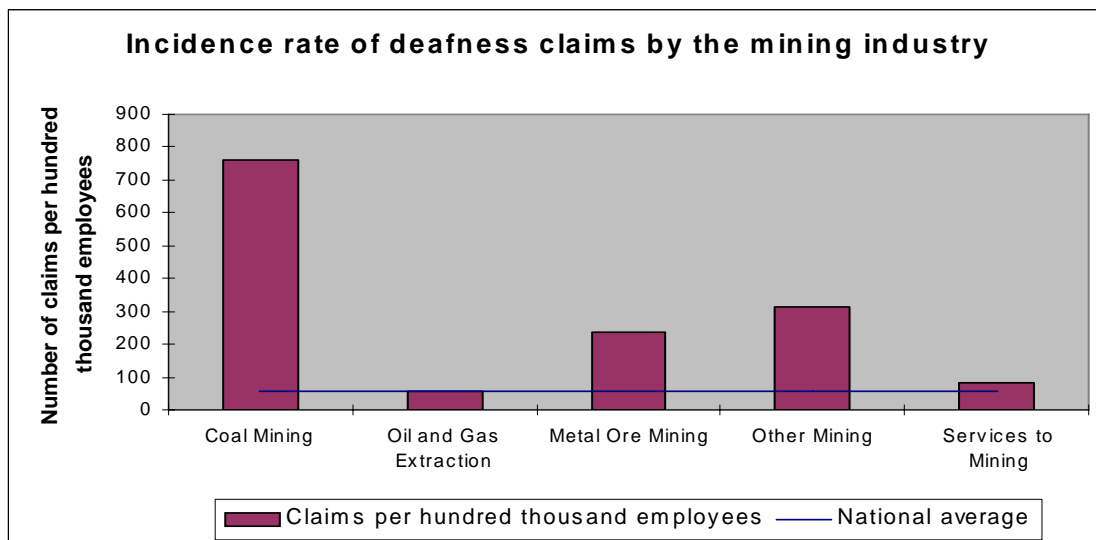


Figure 5. Incidence rate of deafness claims for the Mining industry (Workers' compensation 2001–02).

3.5.6 Transport and Storage

Within transport and storage in 2001/2, rail transport had the highest number (220) and incidence rate (662/100,000), Figure 6 (below).

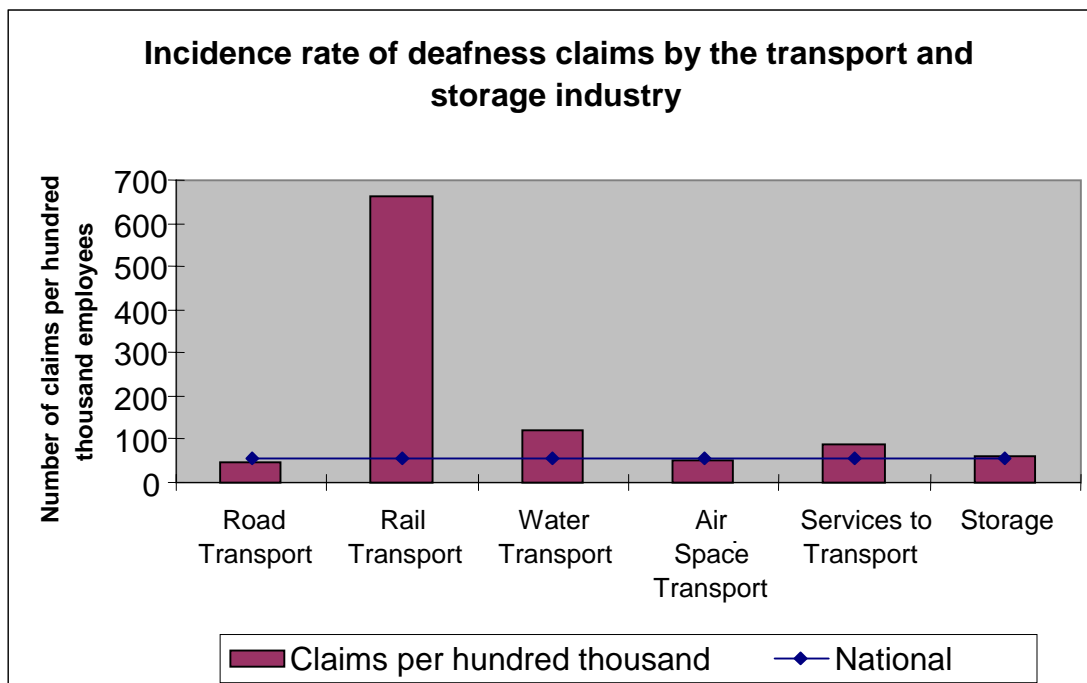


Figure 6. Incidence rate of deafness claims for the transport and storage industry (Workers' compensation 2001–02).

3.6 Examining the cost of deafness claims

The average cost of workers compensation claims for deafness in 2001/2 is calculated to be \$6711.

Therefore, for Australia, the direct cost of deafness claims for 2001/2 is calculated to be \$6711 x 4510 claims i.e. just over \$30 million.

In *Noise Management at Work*, Control Guide (NOHSC 1991), costs of noise and benefits of noise control are examined in module 6 (pp95-102). It is stated that "Compensation costs are probably less than 10 percent of the total costs of noise". This is based on combining the estimated costs of NIHL insurance premiums, absenteeism, staff turnover, employee quality, productivity and a personal protection program. It is also considered that this is a minimum estimate, and no financial cost has been placed on some factors, e.g. costs from noise-related accidents, and community health services costs.

3.7 Estimates of hearing loss

In their October 2003 position statement on preventing noise induced occupational hearing loss (Page 1), the American Academy of Audiologists state that estimates suggest that there are 5-30 million Americans occupationally exposed to noise levels greater than 85 dBA and that at present exposure limits one in four of these workers will develop a permanent hearing loss as a result of trying to earn a living.

In the Regulatory Impact Assessment of the Physical Agents (Noise) Directive (2003/10/EC), (HSE, 2003, Page 2), states that there are an estimated 170,000 people in the UK who suffer deafness, tinnitus or other ear conditions as a result of exposure to excessive noise at work.

From Sweden, the National Institute for Working Life (2002) reports that "Of all causes to work injuries in Sweden noise is the third most common. In 1997 9% of all reported work injuries were hearing impairments".

Within Australia, from the extensive WA testing program in the early 1990s, excluding medical hearing loss cases, results for 77,412 noise exposed workers were examined (Monley et al 1996). 7% of people examined were found to have noise related percentage loss of hearing (PLH) above 5%. A recent article in *Safety WA* (Industrial Foundation for Accident Prevention, June 2004, p5) reports that 11.5% of mining employees have measurable hearing loss compared with 7% of employees in non-mining sectors. From DOIR data for mining, it is further reported that the percentages of mining employees diagnosed with hearing loss more than 5% are, by group: management/supervisors (5.9%); underground workers (5.8%); surface operators (7.1%); ore treatment workers (7.0%); and non-mining industry employees (4.8%).

4. NUMBER OF PEOPLE POTENTIALLY EXPOSED

4.1 Modelling exposure

Two models for estimating the number of workers potentially exposed to hazardous noise at work (in the absence of hearing protection) are listed in Appendix 3. The first model involves extrapolation of the WA testing data from the early 1990's. The second model examines at risk groups, as identified from high rates of compensation claims.

From the models examined, an estimated 900,000 to 1,000,000 workers (i.e. around 12 % of the workforce) are potentially exposed to hazardous levels of noise at work.

A good correlation is to be expected between number of deafness claims and number of people exposed. For 2001/2, construction and manufacturing accounted for 2590/4510 (57%) of all deafness claims. These industries were examined in more detail for the highest risk industry sub-groups and occupations

4.1.1 Manufacturing

Closer examination at a greater level of detail for both industry and occupation for manufacturing shows that most of the claims occur in the following occupations and industries:

- Mechanical and fabrication engineering tradespersons: petroleum, coal, chemical and associated product manufacturing; metal product manufacturing and machinery and equipment manufacture
- Other tradespersons and related workers: printing, publishing and recorded media manufacturing
- Intermediate plant operators: petroleum, coal, chemical and associated product manufacturing; metal product manufacturing and machinery and equipment manufacturing
- Intermediate machine operator: textile, clothing, footwear and leather manufacturing; non-metallic mineral product manufacturing
- Other intermediate production workers: metal product manufacturing
- Factory labourers: food, beverage and tobacco manufacturing; petroleum, coal, chemical and associated product manufacturing; non-metallic mineral product manufacturing; metal product manufacturing and machinery and equipment manufacturing
- Other labourers and other related workers: food, beverage and tobacco manufacturing; non-metallic mineral product manufacturing; metal product manufacturing and machinery and equipment manufacturing

4.1.2 Construction

Closer examination of construction shows that most of the claims occur in the following occupations and industries:

- Construction tradespersons: general construction and construction trade services
- Intermediate plant operators: general construction
- Factory labourers: construction trade services
- Labourers and other related workers: general construction and construction trade services

4.2 Other estimates of exposure.

Waugh (1986) estimated that up to 500,000 people in Australia work in hazardous noise environments (defined as an average 8hr noise level of 85dB(A) or more), representing 12.23% of the total Australian workforce.

BHP Billiton (2003), a major mining and manufacturing company in Australia (and globally), conducted an extensive assessment of exposures in the workplace, and reported that 51% of employees are potentially exposed above the noise exposure limits (if no hearing protection is used).

For the United States, in their October 2003 position statement on preventing noise induced occupational hearing loss (Page 1), the American Academy of Audiologists state that estimates suggest that there are upwards of 5 million, perhaps as many as 30 million Americans occupationally exposed to noise levels greater than 85 dBA. With a working population of 138 million in 2003 (US Department of Labor, 2003), this represents an exposure range of 4%-22%.

In the Regulatory Impact Assessment of the Physical Agents (Noise) Directive (2003/10/EC), (HSE, 2003, Page 2), the number of workers potentially exposed to excessive noise in the UK is discussed. It is noted that that recent research estimates that over 1.1 million people are exposed to noise levels above the proposed upper action value, 85 dB(A). For an employment level of 25.6 million (UK National Statistics, 2001), this equates to an exposure rate of 4% or above.

Since 1997 the University of Washington [Department of Environmental and Occupational Health Sciences (2004)] has conducted almost 900 full-shift measurements of workers from 11 trades on construction sites. The average full-shift noise level is 81dB(A), for an average 8hr 26 minutes work shift. 34% of full-shift average levels are above 85dB(A) and 10% of full shift average levels are above 90dB(A). During the periods that workers were exposed above 85dB(A), it was found that hearing protection was worn for an average of 39% of the time.

From Sweden, the National Institute for Working Life (2002) reports that in the Swedish work force about 200 000 - 400 000 persons are exposed to harmful noise (i.e. an exposure rate of 5%-10%). More than 800.000 of the 3.9 million employees in Sweden are exposed to noise so loud that they can't communicate in a normal voice during at least 1/4 of their working hours. According to statistics, about 40% of all the workers in Sweden consider themselves as annoyed by noise at work.

5. EFFECTIVE PREVENTION AND MANAGEMENT APPROACHES

5.1 Introduction

Effective prevention and management approaches involves work in a number of fields:

- Effective research – to examine emerging issues;
- Effective national standard setting – by NOHSC & Standards Australia;
- Effective regulation and enforcement– by jurisdictions
- Effective provision of guidance – by jurisdictions, ACCI and ACTU;
- Effective implementation of programs - by industry;
- Effective support for employees and industry – by medical and audiometric services.

5.2 Noise Control and Hearing Loss Prevention Program

Since the impact of noise on hearing can take many years, health evidence will also appear after a number of years. Thus, the evidence of effectiveness of approaches is focused on looking at:

- (a) Actions to reduce noise exposure
- (b) Actions to monitor the health of employees

For a particular enterprise, depending on size and type, an effective noise control and hearing loss prevention program may involve a comprehensive effort in a number of areas.

5.2.1 Establishing a noise control policy and program

Once in place, a noise control policy and program will enable a systematic approach to hearing conservation in a company. Sydney Water reports a reduction in hearing loss claims from over 140 per year in 1998/99 to below 60 per year in 2002/03 (2003 Annual Report)¹⁰.

Establishing a purchasing or procurement policy, which examines (amongst other factors) equipment noise levels, is an effective strategy in reducing workplace noise exposure.

¹⁰ A decrease in employee numbers from 4500 to 3516 also occurred from 1999 to 2003.

5.2.2 A system of review and evaluation of the program

Evidence of effective external reviews was found in the literature, eg the review by Burgess and Lai (1999) into noise management in the building industry. However, no reports were found that document effective reviews and evaluations of programs undertaken by companies themselves.

5.2.3 Performing audits of the work environment and assessment of work exposures

Effective external auditing is reported commonly, for example the audit by WA WorkSafe of the music entertainment industry in 2000 showed lack of awareness of responsibilities, with 25 improvement notices issued. In 1998 and 2000, Queensland successfully prosecuted two music entertainment venue operators for failing to enforce the use of hearing protectors by staff. An example of internal auditing is the comprehensive workplace assessment program at BHP Billiton (reported in the BHP Health, Safety and Community Report, 2003).

Macpherson and Tickell (1996) developed a Noise Exposure Indicator (Index), a simple formula combining noise exposure level and number of employees, which has been found to be an effective tool in assisting strategy development. A Noise Assessment Report Proforma can be found as Appendix G in AS/NZS 1269.1:1998.

5.2.4 Managing exposure through effective use of the hierarchy of control;

The hierarchy of control covers a number of potential activities:

- Elimination
- Substitution
- Engineering controls - isolation, engineering control at source, engineering control in transmission
- Administrative Controls
- PPE - Hearing Protection

In line with other areas of OH&S management, effective use of the hierarchy of control is necessary to manage exposure to noise, with elimination being the best option. Numerous practical examples from within the hierarchy of control are demonstrated in the WA Noise Control Case Study series, the NOHSC OHS Practical Solutions Database, the SHARE program of the University of Ballarat, HSE *Sound Solutions*, the *Noise Reduction Ideas Bank* (Washington State Department of Labor and Industries) and elsewhere.

Elimination of excessive noise is possible. Examples demonstrated by Consolidated Constructions are; the use of heating and cooling to insert bearings instead of hammering them into place, and using glue for carpet grippers instead of using nails and hammering them. Substitution can also be

used effectively. Examples from Macmahon Contractors are changing saw type (5dB(A) improvement) and using a smaller angle grinder (6dB(A) improvement).

Many examples of engineering control at source are to be found. For example, work on the dust extractor system at Stegbar Building Products led to 18 dB(A) reduction in noise and modification of air gun nozzles for drying gave a 22 dB(A) improvement at Macmahon Contractors. Regarding engineering control in transmission, again this approach is frequently utilized in practice. For example, a 9 dB(A) reduction for electrical workers was achieved by partitioning the workshop at Williams Electrical Service, and a 24 dB(A) improvement for office work was achieved by effectively constructing an office inside a workshop at Stegbar Building Products.

Administrative arrangements can also be successful, for example during a hotel refurbishment by Consolidated Constructions, doing heavy demolition work at specific times reduced guest complaints and workers exposures.

Even after implementing measures at the higher end of the hierarchy of control, the effective use of hearing protection may still be required for effective noise exposure management in many situations. However, there are issues that may restrict their use in practice, thus the need to focus on higher up the hierarchy of control. For example, for employees with damaged hearing standard protectors are not suitable (specialist choice is necessary) and may not be used as they further reduce the already damaged hearing capability (Dineen, 2001). Hearing protectors are seen by some as hazardous, reducing hazard awareness impacting on communication and making it more difficult to hear warning signals, and if hearing protectors are not located in convenient spots they may not be used. However, benefits have been obtained from customizing the fitting of hearing protectors e.g. from the use of custom moulded hearing protectors. Over the last five years or so, a number of "flat attenuating" earmuffs and plugs have become available. These kinds of hearing protectors do not have the problem of most industrial type hearing protectors which have their highest attenuation at 2000 to 4000Hz frequencies (NIHL typically occurs at 4000Hz), but provide an almost flat attenuation over the whole frequency spectrum. They can therefore be beneficial to workers who already have a degree of NIHL.

There is much guidance material available on use of hearing protectors, for example, in the publication *Attenuation and the use of Hearing Protectors* (National Acoustic Laboratories, 1998). However, there appears to be little readily available, documented evidence, of benefits from industry programs focused on use of hearing protectors.

5.2.5 Actions to monitor the hearing health of employees.

This is very necessary, to ensure early detection of problems. Regarding new techniques, the successful use of otoacoustic emissions testing was demonstrated by Sydney Water (2003), detecting hearing loss that did not show up in standard testing.

5.2.6 Education & Training

Education and training have a significant role to play in preventing work related hearing loss. With rate of hearing loss greatest in the first 10 years of exposure, it is important to prevent exposure at the earliest possible opportunities. From the US, it has been reported (based on survey results) that that 5.2 million 6-19 year olds have hearing loss directly related to noise exposure (Dangerous Decibels™, 2004). Focussing on schoolchildren and young people is therefore good (e.g. Canadian programs), plus promoting the need to manage hearing in the workplace from employees' induction onwards, and for apprentices, and not leaving it until further down the track. WorkSafe *Smart Move* is a safety and health package for years 10, 11 and 12 high school students going on to work experience and work placements, and noise is a topic covered in the general module.

Training in the construction industry in the US, (Stephenson & Stephenson, 2001) led to less employees thinking they would not be able to hear warning signals when using hearing protectors, and also less employees thought wearing hearing protectors was annoying.

Case studies, clearly illustrating evidence of the effectiveness of approaches taken by companies themselves are a valuable resource. HSE (1995) has published a book of practical guidance, *Sound Solutions: Techniques to reduce noise at work*, having 60 case studies on how noise problems were tackled in a range of industries. Many describe engineering solutions, eg removing jet noise, and pneumatic impact press noise reduction. Work is currently underway to update the publication.

Summary

The analysis illustrates that improvements can be made from work undertaken in all elements of a noise control and hearing loss prevention program. Each of the elements of the program have been shown to reduce exposures to occupational noise or manage the worker's exposure better, though the chosen approach needs to be situation specific. Elimination of excessive noise is possible in many cases.

5.3 Ototoxic substances (ototoxins) and acoustic shock

In the *Noise Advisory Standard* [Workplace Health & Safety Queensland (2004)], strategies for managing ototoxins are recommended. These include audiometric testing for workers exposed to potential ototoxins, information on ototoxins to be included in training sessions, and implementing control measures to reduce exposure to ototoxins.

Measures for reducing the risk and severity of acoustic shock are described in both the *Noise Advisory Standard*, and the *Good Practice Guide for Occupational Health and Safety in Call Centres* [Australian Services Union – Victorian Private Sector Branch (2004), p17]. Current good practice includes: ensuring all employees and management are trained in the identification and symptoms of acoustic shock and what steps to follow in the event of an acoustic shock; and attaching acoustic shock devices which completely prevent

shrieks or loud sounds reaching the headset in call centres where loud sounds are assessed as a high risk.

6. PREVENTION ACTIVITY

Regulations and standards aimed at reducing NIHL have been introduced by OHS jurisdictions. In 2004, NOHSC has declared the National Code of Practice for Noise Management and Protection of Hearing at Work [NOHSC: 2009 (2004)]. Managing workplace hazards fact sheet on Noise is also available on the NOHSC website. Industries such as the Construction Industry, and the Music Industry have been identified as targets for prevention activities. Other institutions in Australia such as the National Acoustic Laboratories and FarmSafe Australia are also initiating activities to reduce the risk of noise injury in the workplace. For more information on prevention activities, readers are directed to the following websites.

- NSW WorkCover Authority
<http://www.workcover.nsw.gov.au/default.htm>
- Victorian WorkCover Authority
<http://www.workcover.vic.gov.au/dir090/vwa/home.nsf>
- WorkSafe Western Australia <http://www.safetyline.wa.gov.au/>
- South Australian WorkCover Authority <http://www.workcover.com/>
- Workplace Services South Australia <http://www.eric.sa.gov.au/home.jsp>
- Queensland Division of Workplace Health and Safety
<http://www.whs.qld.gov.au/>
- Workplace Standards Tasmania
<http://www.wst.tas.gov.au/node/WST.htm>
- Northern Territory WorkSafe <http://www.nt.gov.au/deet/worksafe/>
- ACT WorkCover <http://www.workcover.act.gov.au/>
- Comcare <http://www.comcare.gov.au/>
- The Australian Council of Trade Unions (ACTU) <http://www.actu.asn.au/>
- The Australian Chamber of Commerce and Industry (ACCI)
<http://www.acci.asn.au/>

REFERENCES

1. ACCI/ACTU (1998) *Joint OHS training resource*. Melbourne, ACCI/ACTU, 1998.
2. American Academy of Audiology (2003) *Preventing noise-induced occupational hearing loss*
3. Position Statement, October 2003
<http://www.audiology.org/professional/positions/niohlprevention.pdf>
4. American College of Occupational and Environmental Medicine (ACOEM), (2002). *Noise Induced Hearing Loss. Evidence-based Statement*. October 27, 2002. <http://www.acoem.org/guidelines/pdf/Noise-induced-Hearing-Loss-10-02.pdf>
5. Australian Services Union (2001) *Acoustic Shock and Call Centre workers*
http://asuservices.labor.net.au/asupeople/callcentres/20010705_accoustic.html
6. Australian Services Union – Victorian Private Sector Branch (2004) *Good Practice Guide for Occupational Health and Safety in Call Centres*
<http://www.asu.asn.au/media/ccgoodpracguide.pdf>
7. AWCBC Research Association of Workers' Compensation Boards of Canada
8. http://www.awcbc.org/research_search/
9. Ballarat University SHARE Program (Safety and Health Accumulated Research Program) www.ballarat.edu.au
10. Behar A., Chasin M. and Cheesman M (2000) *Noise Control – A Primer, Page 37*. San Diego (California), Singular Publishing Group, 2000
11. Better Hearing Australia <http://www.betterhearing.org.au/>
12. BHP Billiton (2003) Health, Safety, Environment and Community Report, 2003. Performance Summaries.
13. http://www.bhpbilliton.com/hsecReport/2003/performance/ps_health.html
14. Burgess M. and Lai J. (1999) *Noise Management for the Building Industry*. WorkCover NSW, October 1999.
15. Coal Services Health & Safety Trust (2004) Information Statement
http://www.coalservices.com.au/images/db_images/pages/infostat.pdf
16. Consensus conference (1990). *Noise and hearing loss*. Journal of the American Medical Association (JAMA); Volume 263, No. 23, pp3185-90, June 1990.
17. CRC for Cochlear Implant & Hearing Aid Innovation
<http://www.bionicear.org/crc/structure.html>
18. Dangerous Decibels™ (2004) From 3rd National Health and Nutrition Examination Survey, Niskar et al 2000
19. <http://www.dangerousdecibels.org/>

20. Department of Environmental and Occupational Health Sciences (2004) *Construction Industry Noise Exposures*. From Noise and Hearing Loss in Construction Study. Seattle WA, University of Washington, (2004)
21. Der Blaue Engel The Blue Angel http://www.blauer-engel.de/englisch/navigation/body_blauer_engel.htm
22. Dillon H. *Acoustic Shock*. National Acoustics Laboratories
23. http://www.nal.gov.au/Info%20for%20consumers/HD%20-%20acoustic_shock-%20main.htm
24. Dineen R. (2001) *Noise and Hearing in the Building and Construction Industry: A Study on Workers' Views on Noise and Risk*. Video. Causes and Prevention of Hearing Loss. Colloquium (NAL), 23 October 2001.
25. Electronic Library of Construction Health and Safety (2002) *Noise-Induced Hearing Loss in Construction*.
26. The Construction Chart Book, 3rd Edition, September 2002
<http://www.cdc.gov/elcosh/docs/d0100/d000038/sect43.html>
27. enHealth Council (2004) *The health effects of environmental noise – other than hearing loss*. Canberra, Department of Health and Ageing, May 2004.
28. Environmental Health Directorate (1991). *Guidelines for the safe use of Ultrasound: Part II – Industrial and Commercial Applications* Ottawa (Canada), Canadian Communication Group, 1991
29. http://www.hc-sc.gc.ca/hecs-sesc/ccrpb/publication/safety_code24/chapter2.htm#2.2
30. Franklin R.C., Challinor K., Depczynski .J, Fragar L.J. (2002) *Noise Exposure, Hearing Protection used and Noise Injury in Farmers aged 15-24 years* National Farm Industry Data Centre, Nov 2002
31. <http://www.acahs.med.usyd.edu.au/nfidc/Hearing%20Young%20Adults.htm>
32. Franks, J.R. and Morata, T.C. (1996). *Ototoxic Effects of Chemicals Alone or in Concert with Noise: A Review of Human Studies*. Scientific Basis of Noise-Induced Hearing Loss, A. Axelsson, H. M. Borchgrevink, R. P. Hamernik, P. A. Hellstrom, D. Henderson, and R. Salvi, Editors; pages 437-446. New York, Thieme, 1996.
33. Heads of Workers' Compensation Authorities Comparison of Workers Compensation Arrangements, Australia and New Zealand, October 2002.
<http://www.hwca.org.au/documents/Comparison2002.pdf>
34. Hearing Foundation of Canada Public Education, Advocacy and Position Statements
35. http://www.thfc.ca/advocacy_pos.html
36. Health and Safety Executive (UK) *Noise Induced Deafness*
37. <http://www.hse.gov.uk/statistics/causdis/noise.htm>, (July 2004)
38. Health and Safety Executive (UK) (1989) *Noise at Work Regulations* Norwich, HSE Books, ISBN 0110977904

39. Health and Safety Executive (UK), Noise – Live Issues. Regulatory Impact Assessment of the Physical Agents (Noise) Directive (2003/10/EC), 17th February 2003 <http://www.hse.gov.uk/noise/riafinaltext.pdf>
40. Health and Safety Executive (UK) (1995) *Sound Solutions: Techniques to reduce noise at work*. Norwich, HSE Books, 1995.
41. Industrial Foundation for Accident Prevention (2004). *New Evidence That Miners are Going Deaf*
42. Safety WA, (Western Australian Journal of Occupational Health & Safety) June 2004, p5. Editor: Dr David Leith.
43. Wiletton WA, Industrial Foundation for Accident Prevention (IFAP), June 2004
44. <http://members.iinet.net.au/~ifap/safetywajun04.pdf>
45. Johnson D.L. (1973) *Prediction of NIPTS due to Continuous Noise Exposure* US Aerospace Medical Research Laboratory, July 1973. Virginia (US), National Technical Information Service, 1973
46. Laborers' Health and Safety Fund of North America *Construction Noise Control Partnership*
47. <http://www.lhsfna.org/index.cfm?objectid=986BDA67-D56F-E6FA-92988E1148E3F539>
48. Lawton B.W. (2001) *Damage to human hearing by airborne sound of very high frequency of ultrasonic frequency*. HSE Contract research report no. 343/2001 Norwich, HSE Books
49. Lions Ear & Hearing Institute <http://www.lehi.com.au/>
50. Macpherson J. and Tickell C. (1996) *Development and Use of the Noise Exposure Index (NEI) in Occupational Noise Management* Australian Acoustical Society, 1996 Conference. "Making Ends Meet. Innovation and Legislation." 13-15 Nov, 1996, Brisbane.
51. Master Builders Association of Victoria Occupational Health & Safety Unit. Services to members, on-site safety services <http://www.mbav.com.au/members/ohs.html>
52. MINEHEALTH (2003) Department of Industry and Resources, Western Australian Government. <http://www.doir.wa.gov.au/aboutus/D93251CBE10441E583ACE7CF209A8C25.asp>
53. Monley P., West A., and Guzeleva D. (1994) *Hearing Loss and Industrial Groupings Western Australian Noise Exposed Workers* WorkCover WA, 1994.
54. Monley P. (1995) *Workcover Baseline Data – Where will future claims arise?* Deafness and Hearing Awareness Week Forum, 25th & 26th August, 1995
55. Monley P., West A., Guzeleva D., Dinh D.A. and Tzvetkova J. (1996) *Hearing Impairment in the Western Australian Noise Exposed Population*.

Australian Journal of Audiology, Volume 16, Number 2, November 1996, pp57-71.

56. National Acoustic Laboratories (1988). *Improved Procedure for Determining Percentage Loss of Hearing*
57. NAL Report No 118, January 1988. Canberra, Australian Government Publishing Service, 1988
58. National Acoustic Laboratories (1998). *Attenuation and the use of Hearing Protectors* (Eighth edition)
59. NAL, March 1998. Chatswood, Australian Hearing Services, 1998
60. National Acoustic Laboratories <http://www.nal.gov.au/>
61. National Institute for Occupational Health and Safety (NIOSH) Noise and Hearing Loss Prevention
62. <http://www.cdc.gov/niosh/topics/noise/>
63. National Institute for Working Life (2002) Programme for Technical Risk Factors. Noise.
64. <http://umetech.niwl.se/English/Action.Lasso?-Database=UITStaff.fp3&-Layout=Normal&-Response=Noise.html&-Op=cn&Team=Noise&-SortField=GrpChBuller&-SortOrder=descending&-SortField=Titel&-SortOrder=custom&-SortField=Enamnforst&-Search>
65. NOHSC (1991) *Management of Noise at Work*. Control Guide. Canberra, Commonwealth of Australia, 1991 ISBN: 0 644 12866 6
66. NOHSC (1991) *Noise Control*. Sydney, Worksafe Australia, November 1991
67. NOHSC (1995) *Core Training Elements for the National Standard for Occupational Noise*
68. Canberra, Australian Government Publishing Service, August 1995.
69. NOHSC (2000) *National Standard for Occupational Noise* [NOHSC: 1007(2000)], 2nd Edition
70. NOHSC (2003) Noise, Annual Situation Report, 2003
71. NOHSC OHS Practical Solutions Database
72. <http://www.nohsc.gov.au/OHSInformation/Databases/OHSSolutions/ohssolutions.htm>
73. NSW Health Research and Evaluation. Demonstration Research Grants Scheme: Current Grants.
74. Evaluation of the NSW Rural Hearing Conservation Program.
75. <http://www.health.nsw.gov.au/public-health/health-promotion/research/grants/current.html>
76. NT WorkSafe *Noise – occupational noise* (bulletin)
77. <http://www.nt.gov.au/deet/worksafe/corporate/bulletins/pdf/11-15/11.01.01.pdf>

78. Pilawska H et al (1977) *Effect of acoustic microclimate prevailing in shipyards on the health of workers.*
79. Med. Pr. 28, 441-447
80. Robinson D.W. (1988) *Tables for the Estimation of Hearing Impairment due to Noise for Otologically Normal Persons and for a Typical Unscreened Population, as a Function of Age and Duration of Exposure.*
81. HSE Contract Research Report No. 2/1988 UK Health & Safety Executive, April 1988.
82. Safe at Work Personal Hearing Protection Devices <http://www.safe-at-work.com/Reference/96-110/96-110l.htm>
83. Standards Australia (1998) AS/NZS 1269. *Occupational noise management Parts 0-4.*
84. Suter A. (2002) *Construction Noise: Exposure, Effects, and the Potential for Remediation; A Review and Analysis* AIHA Journal 63:768-789 (2002)
85. Standards Australia (1998) AS/NZS 1259.1. *Acoustics – Sound Level Meters, Part 1: Non-Integrating.*
86. Sydney, Standards Australia, 1998.
87. Stephenson C.M. and Stephenson M. (2001) *Noise Induced Hearing Loss in the Construction Industry*
88. OSHA's Advisory Committee for Construction Safety and Health (ACCSH). March 15, 2001, Washington, DC.
89. Sydney Water (2003) Annual report 2003. Environmental, Social and Economic Performance, Protecting Health and Safety. http://www.sydneywater.com.au/Publications/Reports/AnnualReport2003/embracing_responsibilities/protecting.html
90. UK National Statistics (2001) Census 2001. <http://www.statistics.gov.uk/census2001/profiles/uk.asp>
91. US Department of Health and Human Services, NIOSH, (1998) *Criteria for a Recommended Standard. Occupational Noise Exposure, Revised Criteria*, June 1998 <http://www.cdc.gov/niosh/98-126c.html>
92. U.S. Department of Health and Human Services, National Institutes of Environmental Health Sciences (NIEHS), (2002). *Infrasound – Brief Review of Toxicological Literature*,
93. http://ntp-server.niehs.nih.gov/htdocs/Chem_Background/ExSumPdf/Infrasound.pdf.
94. US Department of Labor, Bureau of Labor Statistics (2004) Labor Force Statistics from the Current Population Survey <http://www.bls.gov/cps/home.htm#overview>
95. Victorian WorkCover Authority Occupational Health and Safety (Noise) Regulations 2004
96. Ward WD. (1995). *Endogenous factors related to susceptibility to damage from noise.* Occupational Medicine; 10(3):561-575, 1995.

97. Washington State Department of Labor and Industries *Noise Reduction Ideas Bank*
98. <http://www.lni.wa.gov/safety/topics/ReduceHazards/NoiseBank/default.asp>
99. Waugh R. (1986) *A national strategy for the prevention of noise-induced hearing loss*. NAL Report No 113. Sydney, National Acoustic Laboratories
100. Waugh R. (1990) *Occupational Noise Exposure, Hearing Impairment, and Rehabilitation – An Overview of the Present Position in Australia*. Occupational Noise-induced Hearing Loss- Prevention and Rehabilitation. Worksafe Australia Seminar (1990), pp17-38. Sydney, NOHSC, 1991.
101. WorkCover Corporation, South Australia (2003) *Guidelines for Control of Workplace Noise*.
102. Adelaide, WorkCover Corporation of South Australia
103. WorkCover NSW (1997) *Code of Practice for Noise Management and Protection of Hearing at Work*
104. http://www.workcover.nsw.gov.au/NR/rdonlyres/8C0F94D6-CE53-4ACC-908B-126314675B5D/0/cop_noisemgt_150.pdf
105. Workcover Queensland Act Amendment No 17 (1999) Section 153(3). Further application for compensation for industrial deafness.
106. Workcover Tasmania How Loud? Safety Bulletin 8. <http://www.workcover.tas.gov.au/node/safetybull.htm>
107. Workplace Health and Safety, Queensland (2004) *Noise Advisory Standard (2004)* Queensland Government, Department of Industrial Relations. <http://www.whs.qld.gov.au/advisory/adv010v3.pdf>
108. Workplace Health and Safety, Queensland (2001) *Noise Safety Link. Noise in the Metal Fabrication Industry*.
109. Queensland Government, Department of Industrial Relations, November 2001.
110. <http://www.whs.qld.gov.au/safetylink/noise/noise03.pdf>
111. Worksafe Australia (1990) *Noise Management at Work: Control Guide*; Chapter 6, pp. 100-110
112. WorkSafe Victoria Occupational Health and Safety (Noise) Regulations 2004
113. WorkSafe WA *WorkSafe Smart Move* <http://www.safetyline.wa.gov.au/pagebin/edcnwssm0018.htm>
114. Worksafe WA (2000) *Noise Control in the Music Entertainment Industry*. Summary Report. July 2000.
115. <http://www1.safetyline.wa.gov.au/pagebin/pg000154.htm>
116. WorkSafe WA (2002) Code of Practice: *Managing Noise at Workplaces* (March 2002)
117. <http://www.safetyline.wa.gov.au/pagebin/codewswa0228.pdf>

118. WorkSafe WA (2003) Code of Practice: *Control of Noise in the Music Entertainment Industry* (March 2003)
119. <http://www.safetyline.wa.gov.au/pagebin/codewswa0230.pdf>
120. WorkSafe WA *Noise – Buying Quiet 1 – Noise at Work*
<http://www1.safetyline.wa.gov.au/pagebin/pg000155.htm>
121. WorkSafe WA Noise Control Case Study – Boulderstone Clough Joint Venture
122. <http://www.safetyline.wa.gov.au/pagebin/pg000166.htm>

APPENDIX 1: INDUSTRIAL DEAFNESS THRESHOLDS ACROSS AUSTRALIAN JURISDICTIONS

i.e. the level at which compensation claims can be made across (at October 2002).

Source: Heads of Workers' Compensation Authorities.

Comparison of Workers' Compensation Arrangements, Pages 14-15.

Jurisdiction	Industrial deafness threshold, i.e. when a claim can be made
Comcare	5%. Amendments to the SRC Act mean that for claims after the date of effect for the amendments, the threshold will be 5% binaural loss
Seacare	10%
Victoria	10%
NSW	6% binaural loss
South Australia	5%
WA	10% (Above baseline hearing loss previously assessed)
Queensland	5% A further application may be considered only if lodged more than 3 years after the previous application, and the claimant has sustained a further hearing diminution of more than 1%
Tasmania	5% binaural hearing impairment
NT	5% whole person impairment (percentage of loss of whole body)
ACT	A worker is not entitled to compensation if the total hearing loss is less than 6% S64(1)

Potential impact of differing deafness thresholds on the number of claims

From the extensive WA testing program in the early 1990s, excluding medical hearing loss cases, results for 77,412 noise exposed workers were examined (Monley et al 1996). Results were then adjusted for age, and Noise-Related Percentage Hearing loss calculated (Table 3 below).

Thus 7% of people examined have PLH above 5%, but only 2% have a PLH of 10%. Therefore, based on this data, for equal noise exposures, we might expect there to be 3.5 times as many claims in a jurisdiction with a 5% PLH limit compared with a jurisdiction one with a 10% PLH limit.

Table 3. Loss of hearing in WA workers tested. (Source: Monley et al, 1996)

% Loss of Hearing (PLH), corrected for age	% of workers (of 77,412)
0	42.29
0.1-1.0	33.09
1.1-2.0	8.87
2.1-3.0	4.33
3.1-4.0	2.66
4.1-5.0	1.84
5.1-6.0	1.40
6.1-7.0	1.19
7.1-8.0	0.95
8.1-9.0	0.74
9.1-10.0	0.58
10.1-20.0	1.98
>20.0	0.05

APPENDIX 2: STATISTICAL NOTES

Scope and coverage (CPM Scope)

The statistics presented in this report are compiled from claims made under the State, Territory and Australian Government Workers' Compensation Acts which resulted in a fatality, permanent disability or temporary disability with an absence from work of one working week or more. One working week is defined as being lost when the number of hours lost is greater than or equal to the number of hours usually worked per week. The data shown for 2001–02 refer to all new cases reported to 30 June 2002, for which liability was accepted as at 30 November 2002.

Within this publication, data for 2000–01 and 2001–02 are presented according to the NDS2 presentation scope.

Since 1993–94, Victorian data have been provided on the basis of cases involving more than 10 working days lost from work which is greater than the NDS2 scope of one working week. Hence, adjustments have been required so that Victorian data can be compared to the other jurisdictions.

The statistics in this report do not cover all cases of occupational injuries and diseases for the following reasons:

Occupational injuries and diseases occurring on a journey to or from work have not been included in the data.

While the majority of employees are covered for workers' compensation under general State, Territory and Australian Government workers' compensation legislation, some specific groups of workers are covered under separate legislation. Every effort has been made to compile data from all groups of employees, but it is known that currently, claims lodged by police in Western Australia and military personnel within the Defence Force are excluded.

Cases not claimed as workers' compensation or not acknowledged as being work-related are excluded.

Most occupational injuries and diseases to the self-employed are excluded because such workers generally are not covered for workers' compensation. The exclusion of self-employed persons is likely to result in an understatement of the number of occurrences for industries where self-employed persons are common, for example; agriculture, forestry and fishing; construction; transport and storage – road transport; and retail trade. Nevertheless, incidence rates are more reliable as the denominators used in the calculation of the rates have been adjusted to also exclude self-employed persons. Moreover, the type of occurrence data should be broadly representative of the industry experience as a whole.

APPENDIX 3: MODELLING EXPOSURES

1. Using WA Survey data

After introduction of the new workers compensation legislation in WA on 1/3/91, baseline hearing testing of 89,500 noise exposed workers was undertaken. Companies were required to test employees who were exposed to noise. In a paper by Monley et al, 1994, the number of people tested was discussed. This is shown in Table 4 (Column 1).

Can this information be used to as a predictor of exposures to noise, across Australia, over 10 years later? There are a significant number of assumptions involved; that the workers tested were in fact the noise-exposed employees in the industry, that the percentage of employees exposed now is the same as in the early 1990's; and that the distribution of employment and exposures in WA can be extrapolated for the whole country.

1.1 Factors that will tend to give an overestimated exposure

- Where a broad-brush approach to testing all employees on site occurred, this will have overestimated exposure.
- Some industries were more conservative in their testing, eg mining tested employees exposed to over 85 dB(A) - the exposure standard was 90dB(A) when this testing was undertaken.
- Improvements have been made in the management of noise since the early 1990's, eg in engineering controls, automation, new regulations and standards.

1.2 Factors that will tend to an underestimated exposure

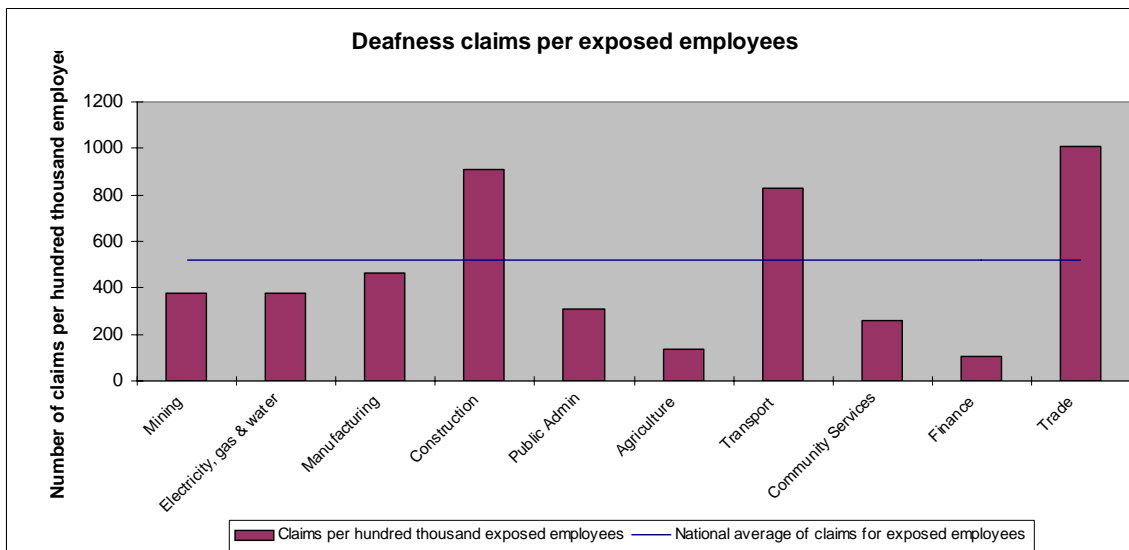
- Not all companies can be guaranteed to have undertaken the required assessments in the original WA program, eg if they did not consider the workplace to be noisy.
- Exposure standards have been reduced [to 85dB(A)], so more areas may be considered noisy.

Despite, these assumptions there is a reasonable correlation between national compensation claims data for 2001/2 and exposure rates from the WA testing in the early 1990s for industries with high exposure rates and claims incidence rates. This is illustrated in Figure 7. The ratio examined is:

Number of claims for the year (2001/2) per 100,000 exposed employees.

The estimated national average of 519 claims for 2001/2 per 100,000 exposed employees suggests 1 in 200 of exposed employees made a claim in the year.

Figure 7. Deafness claims for the year (Workers' compensation 2001–02) per exposed employee {from WA testing (exposure) rates}



Data for employment numbers across Australia were taken from the Australian Bureau of Statistics (ABS) 2001 Census. Industries from the census were allocated to appropriate groups in the WA listing. Allocations are shown in Table 4, Column 2.

By multiplying the industrial exposure rate by the number of employees in the industry, number of exposed employees is predicted, Table 4, Column 3. Adding together the total for each industry gives an estimated total exposure of around 900,000 employees.

Table 4. Modelling current levels of exposure to occupational noise.

INDUSTRY	% of workers tested in WA in early 1990s, assumed equal to number exposed (A)	Number of employees 2001 (ABS Census), (B)	Number of employees exposed in 2001/2, (A*B)/100
Agriculture	17.87	338,358	60,465
Mining	90.32	76,736	69,308
Manufacturing	35.32	1,033,970	365,198
Electricity, gas & water	46.53	62,099	28,895
Construction	23.80	571,807	136,090
Trade	1.59	1,687,235	26,827
Transport	14.43	364,349	52,576
Communication	0.15	151,937	228
Finance	1.88	1,261,921	23,724
Public Admin	18.57	378,683	70,321
Community Services	2.33	1,742,724	40,605
Recreation	0.57	627,621	3,577
Overall	12.14		
Column Total		8,297,440	877,814

2. By examining at risk groups, as identified from high numbers of compensation claims.

From the workers' compensation data the three high-risk occupations are: labourers and related workers (33% of all deafness claims); tradespersons (30% of all deafness claims); and intermediate production and transport workers (25% of all deafness claims). Together, these occupations account for 88% of all claims made in 2001/2.

Assuming then that all persons in these three occupations are working in high-risk areas the total exposed population across all industries from the ABS census data is 2.4 million, with approximately 1 million of these in manufacturing and construction (Table 5). This figure can be examined by analysing these two industries with high numbers of compensation claims more closely.

*Table 5. Working population for all industries – three high-risk occupations.
(ABS Census 2001).*

Industry	2001
Agriculture, Forestry, Fishing	112,097
Mining	43,448
Manufacturing	600,825
Electricity, Gas and Water Supply	23,577
Construction	394,686
Wholesale Trade	146,332
Retail Trade	323,579
Accommodation, Cafes and Restaurants	99,377
Transport and Storage	183,670
Communication Services	36,738
Finance and Insurance	3,582
Property and Business Services	138,318
Government and Defence	65,359
Education	25,112
Health and Community Services	64,872
Cultural and Recreation Services	34,024
Personal and Other Services	110,971
	2,407,567.5

2.1 Manufacturing

Closer examination at a greater level of detail for both industry and occupation for manufacturing shows that most of the claims occur in the following occupations and industries:

- Mechanical and fabrication engineering tradespersons: petroleum, coal, chemical and associated product manufacturing; metal product manufacturing and machinery and equipment manufacture
- Other tradespersons and related workers: printing, publishing and recorded media manufacturing
- Intermediate plant operators: petroleum, coal, chemical and associated product manufacturing; metal product manufacturing and machinery and equipment manufacturing
- Intermediate machine operator: textile, clothing, footwear and leather manufacturing; non-metallic mineral product manufacturing
- Other intermediate production workers: metal product manufacturing
- Factory labourers: food, beverage and tobacco manufacturing; petroleum, coal, chemical and associated product manufacturing; non-metallic mineral product manufacturing; metal product manufacturing and machinery and equipment manufacturing
- Other labourers and other related workers: food, beverage and tobacco manufacturing; non-metallic mineral product manufacturing; metal product manufacturing and machinery and equipment manufacturing

2.2 Construction

Closer examination of construction shows that most of the claims occur in the following occupations and industries:

- Construction tradespersons: general construction and construction trade services
- Intermediate plant operators: general construction
- Factory labourers: construction trade services
- Labourers and other related workers: general construction and construction trade services

Assuming that all persons in this cross section of industry and occupation are working in high-risk areas the exposed population for manufacturing and construction is approximately 0.5 million people (Table 6).

Table 6. Construction and Manufacturing industries by high-risk occupation at the two digit level. (ABS Census 2001).

Industry	2001
Manufacturing	263,712
Construction	252,027

2.3 Estimating Total Number of Exposed Workers

The key assumption now is that there is a one to one correlation between number of deafness claims and number of people exposed.

Key data

1. For 2001/2, construction and manufacturing accounted for 2590/4510 (57%) of all deafness claims.
2. Together, the three high risk occupations account for 88% of all claims made in 2001/2.
3. It is estimated that 0.5 million employees are exposed in the three high risk occupations in construction and manufacturing.

Population exposed over all industries in all occupations:

Estimated Exposure = 0.5 million * (1/0.57) * (1/0.88) = 1 million employees

APPENDIX 4: COMPENSATION CLAIMS FOR DEAFNESS (DISEASE)

Results are for the year 2001/2, unless otherwise stated

DATASET	NUMBER OF CLAIMS DUE TO DEAFNESS	INCIDENCE RATE OF CLAIMS DUE TO DEAFNESS, PER 100,000 EMPLOYEES. National Average = 55	COMMENTS
Magnitude of NIHL. NIHL as a factor in the overall number of claims made for disease	4510. 19% of all disease claims. 3.2% of total claims for injury and disease. There were just 60 injury claims for traumatic deafness.		In magnitude, NIHL ranks second in number of claims after musculoskeletal diseases. The number of claims is significant.
Variation in number of claims with time	Have decreased each year from 98/99 to 01/02. Reduced from 5755 to 4510 overall. Major decrease in manufacturing, from 2300 to 1625 claims. Decreases by jurisdictions: NSW, from 4250 to 3505 Queensland, from 525 to 105 South Australia, from 370 to 190.	Whilst manufacturing has shown a consistent improvement in incidence rate, not all sectors have.	Although the number of NIHL claims has been reduced, it does not mean that noise-induced deafness in Australia has been reduced. A recent study by MINEHEALTH (2003) has found that the proportion of mine workers with a hearing loss more than five per cent (adjusted for age) has increased by 4.3 per cent over the past 5-6 years, despite high levels of industry compliance with existing noise control regulations.
Diseases of the ear	Mainly deafness, 4510 compared with 115 for other diseases (including tinnitus)		
Causes of deafness claims	4340 out of 4510 were for sound and pressure. Only 30 out of 4340 were accounted for by exposure to single sound, the rest are due		Claims for deafness are primarily due to NIHL caused by long term exposure.

	to long term exposure		
DATASET	NUMBER OF CLAIMS DUE TO DEAFNESS	INCIDENCE RATE OF CLAIMS DUE TO DEAFNESS, PER 100,000 EMPLOYEES. National Average = 55	COMMENTS
Age	The highest number of claims comes from the 55-59 years age group for males, and the 50-54 years age group for females.		This is consistent with NIHL being caused by long term exposure.
Gender	Males account for 94% of all claims made.		Predominance of males employed in high risk situations, eg in manufacturing and construction.
Severity	Over 99% of claims are for permanent hearing loss.		Consistent with the understanding of the course of the disease.
Occupations	The highest number of claims are made in order: Labourers and related workers (1510), 33% Tradespersons and related workers (1320), 30% Intermediate production & transport workers* (1135), 25% (*plant or machine operators or transport drivers)		Labourers and related workers, tradespersons and related workers and intermediate production & transport workers account for 88% of claims by occupation.
Jurisdictions	The majority of claims are made in NSW, 3505 out of 4510 overall (78%).	NSW also has the highest incidence rate of claims (around 2.4 times the national average). Within a single industry sector (manufacturing) this pattern is also repeated. All other jurisdictions are	There are a number of possible reasons here eg: Differing thresholds - but not all are higher than NSW. Industry/exposure bias – but the jurisdiction pattern holds for manufacturing. Efficiency in identifying hearing loss, assigning causation, ease of making claims

		below the national average.	and having them accepted.
DATASET	NUMBER OF CLAIMS DUE TO DEAFNESS	INCIDENCE RATE OF CLAIMS DUE TO DEAFNESS, PER 100,000 EMPLOYEES. National Average = 55	COMMENTS
Industry Sectors	<i>In order:</i> Manufacturing (1625) Construction (965) Transport & Storage (420) Property & business services (270) Mining (260)	<i>In order:</i> Mining (343) Construction (217) Electricity, gas & water supply (176) Manufacturing (163) Transport & Storage (120)	Analysis of both claims and incidence rate of claims per employee gives two different pictures – both sets of analyses are relevant. Manufacturing, Construction and Transport & Storage account for 65% of the incidences of all deafness claims.
Manufacturing industry	<i>In order:</i> Metal product (545) Machinery & equipment (360) Food, beverage & tobacco (160) Petroleum, coal, chemical & associated product (135) Non-metallic mineral product (130)	<i>In order:</i> Metal product (365) Non-metallic mineral product (337) Textile, clothing, footwear & leather (163) Machinery & equipment (156) Petroleum, coal, chemical & associated product (125)	Again, number of claims and incidence rate portray slightly differing pictures. A marked decrease in claims for a number of the industries occurred from 98/99 to 01/02. Metal Product, Machinery & Equipment and Food, Beverage & Tobacco account for more than two thirds of all deafness claims in Manufacturing Industries. The incidence rate of claims for metal product industry is over 6 times the national average.
Construction	<i>In order:</i> Non-building construction (265) Building Construction (245) Building completion Services (155) Building structure services (145)	<i>In order:</i> Non-building construction (579) Building structure services (383) Building completion Services (244) Building Construction (183)	The incidence rate of claims for Non-building construction industry is over 10 times the national average.

	Installation trade services (80)	Site Preparation Services (168)	
DATASET	NUMBER OF CLAIMS DUE TO DEAFNESS	INCIDENCE RATE OF CLAIMS DUE TO DEAFNESS, PER 100,000 EMPLOYEES. National Average = 55	COMMENTS
Mining	<i>In order:</i> Coal mining (145) Metal ore mining (75) Other mining (25) Services to mining (10)	<i>In order:</i> Coal mining (762) Other mining (312) Metal ore mining (238) Services to mining (83)	Coal mining has the highest incidence rate of claims in all the industries examined – nearly 14 times the national average.
Transport and storage	<i>In order:</i> Rail transport (220) Road transport (75) Services to transport (60) Air and Space transport (25) Water transport (20)	<i>In order:</i> Rail transport (662) Water transport (118) Services to transport (87) Storage (62) Air and Space transport (51)	The incidence rate for rail transport is 12 times the national average.
Electricity, gas and water supply	<i>In order:</i> Electricity supply (85) Water supply, sewerage and drainage service (30) Gas supply (0)	<i>In order:</i> Electricity supply (197) Water supply, sewerage and drainage service (168)	For gas supply, the annual number of claims from 98/99 to 01/02 varied between 0 and 20. The number of employees covered in 2001/2 was 4263.