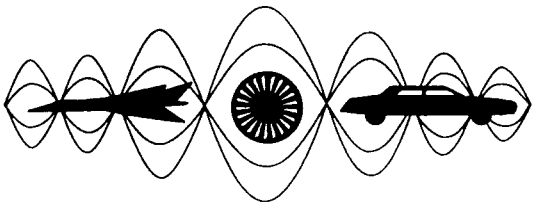

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THE DIFFICULTIES ASSOCIATED WITH DETERMINING INDUSTRIAL HEARING LOSS

David M Eager

Faculty of Engineering
University of Technology, Sydney, Australia

ABSTRACT

This paper reviews some of the difficulties associated with determining industrial hearing loss. The recently introduced legislation in the State of NSW, Australia now makes it illegal for employers to expose their employees to a noise levels that exceeds an 8-hour noise level equivalent of 85 dB(A) or a peak noise level more than 140 dB(lin). How will the Courts now handle employees that were exposed prior to this Legislation? When should employers have taken reasonable precautions to protect their employees from excessive exposure? How and to what extent should these precautions have been taken? Was there a phasing in period and if so what was it? This paper discusses these and other questions associated with the determination of industrial hearing loss.

INTRODUCTION

On the 31 May 1996 the State of NSW Gazetted the Occupational Health and Safety (Noise) Regulation 1996 (OH&S (Noise)) [1] which became law on 31 May 1997, earlier this year[1]. The object of the OH&S (Noise) Regulation is to adapt the provisions of Part 3 of the Occupational Health and Safety Act 1983 [2] which impose general obligations concerning the health and safety of persons at work **specifically in the area of exposure to**

[1] This regulation applies to all places of work in NSW other than mines within the meaning of the Coal Mines Regulation Act 1982 or the Mines Inspection Act 1901. It also provides for exemptions to be granted to individual workplaces. To obtain an exemption the employer must apply to the WorkCover Authority in writing after giving due notice of the proposed application to all persons employed at that particular workplace.

noise. The effect of the OH&S (Noise) Regulation is that a workplace is unsafe and a risk to health if any person is exposed there to noise levels that:

(a) exceed an 8-hour noise level equivalent of 85 dB(A); or

(b) peak at more than 140 dB(lin).

These are the levels that were previously established and contained in the National Standard for Occupational Noise (National Standard) back in 1993 [3,4]. The WorkCover Authority, the policing body within NSW, has also published a Code of Practice [5] which provides practical guidance on complying with the intent of OH&S (Noise) Regulation.

It is worth noting that Victoria passed legislation under their Occupational Health and Safety (Noise) Regulation 1992 that predates the National Standard. ACT, Northern Territory, Queensland and the Commonwealth have also adopted both the National Standard and the National Code of Practice for Noise Management and Protection of Hearing at Work [4]. The remaining Australian States are either considering, or processing, legislation in line with the National Standard. The exposure limits within the National Standard are in line with accepted world practice.

Prior to OH&S (Noise) Regulation employers in the State of NSW were required under the Occupational Health and Safety Act 1983 to provide a safe workplace. No exposure limits were specified within this Act so historically it has been difficult to quantify what exactly was an unsafe noise exposure. The National Standard published in 1993 went a long way to clarifying this issue. The OH&S (Noise) Regulation contains a stricter continuous noise exposure level than that embodied in the provisions of the Factories (Health and Safety - Hearing Conservation) Regulation 1979, in certain provisions of the Timber Industry (Health and Safety) Regulation 1992, and certain provisions of the Construction Safety Regulation 1950, the provisions of which are being repealed.

A question that needs to be answered is, *when would it have been reasonable to expect NSW employers to have provided a workplace that complied with the exposure limits contained in the OH&S (Noise) Regulation*? This is a complex and difficult question to answer. In many workplaces the engineering solutions are complex and expensive. Several workplaces still do not comply with the OH&S (Noise) Regulation and will need to apply for an exemption under the provisions contained within the OH&S (Noise) Regulation. More often than not, it is these workplaces that can least afford the costs associated with retro-fitting or replacing the old noisy equipment with modern quieter equipment. Notwithstanding, there are thousands of employees that were exposed to excessive noise prior to the introduction of this and previous legislation. How should the Courts handle these claims?

On the other hand, it can be argued that these industries were given ample warning of the impending limits contained within the OH&S (Noise) Regulation. It is a cold hard fact that employers have been encouraged over a number of years to replace noisy, old and obsolete equipment with quieter equipment. They have been advised that engineering control measures may include modifications to individual machines, components thereof, redesign of the actual process, or a combination of these elements. In a lot of cases industry has been non-responsive towards these suggestions and is only now starting to take heed as the teeth of the legislation start to bite. Industry is driven by the bottom line, their profit and loss statement. As the compensation claims increase and WorkCover imposes penalties, industries will become quieter places of work. The problem with this attitude is that hearing loss is an illness in which the effects can take years to become apparent and by this stage they

are irreversible. This is why is it vital to conduct regular audiometric tests and it is the reason that AS1269 specifically specifies the same.

HEARING DAMAGE RISK

Noise can affect the ears in three ways. It can deafen or damage ears instantaneously; it can severely reduce the ear's sensitivity to sounds at certain frequencies over a period of time; and it can numb the ear for a limited period of time with a return to near normal within a matter of minutes, weeks or months.

The first sort of damage, acoustic trauma, is usually the result of a very high-intensity impulse noise, for example from an explosion. For obvious reasons, it is not possible to determine by experimental means the level of the noise required to produce such damage. It is generally accepted that an impulse of over 150 dB would result in instantaneous damage. The eardrum would be ruptured beyond repair, and the ossicles broken or displaced. The cochlea, however, would probably survive, because the failure of the ossicles would prevent the full force of the noise being transmitted into the perilymph fluid.

Ear damage from very high-intensity impulse noise is not the main cause of hearing loss in the workplace. Far more prevalent are the effects of continuous periods of high-intensity noise[2]. This noise affects people in two ways, the first of which may not necessarily cause permanent damage. If you are exposed to a sound pressure level greater than say 85 dB in the middle- to higher-frequency range for upwards of a few minutes, you will afterwards suffer what is known as *temporary threshold shift* (TTS). The normal threshold of hearing is the lowest level at which you can hear a sound of a particular frequency, and after exposure to a loud noise this rises considerably. For example, if you were exposed to a band of noise in the 1,200-2,400 Hz range having a sound pressure level of 100 dB for 10 minutes, you would find immediately afterwards that your hearing sensitivity would have dropped. Whereas you could previously hear a 4,000 Hz tone at a level of 5 dB, after this exposure the noise tone would need to be increased to 20 dB before you could hear it. Your threshold of hearing at 4,000 Hz would have gone up from 5 dB to 20 dB. This loss would wear off after approximately 30 minutes. Any permanent threshold shift (PTS) which might have been associated with this exposure would be too small to measure. An audiogram of your hearing immediately after the exposure would have been characterised by the typical 4000 Hz notch or dip (even though the exposure was in the range 1,200-2,400 Hz).

As the exposure times get longer and the noise level higher, so the TTS and the recovery time increase. For example, if you were exposed to the 100 dB noise in this frequency range for 10 times as long, that is 100 minutes, you would have a TTS of approximately 30 dB, and it would take you approximately 36 hours to recover normal hearing. For the normal population[3], provided they are not exposed to these bursts regularly, the permanent effects will be so small as to be negligible. However, in countless workplaces throughout Australia, and the world, personnel are subjected to high noise levels day after day; the effects cease to be temporary, and over a period of time become severe and chronic.

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[2] Explosions are not the only source of impulse noise. If you strike a piece of steel with an impact press or drop-hammer, you will produce a sizeable impulse, but not at the level of an explosion. This lower-intensity impulse will still cause hearing damage, not to the middle ear, but to the inner ear in much the some way as continuous noise.

[3] Hearing loss is a statistical phenomenon with a gaussian distribution across the population. Hence, the same noise exposure will result in varying degrees of hearing loss among individuals.

It is a common occurrence for the noise victims to deny that there is anything wrong with their hearing. It is also common for factory workers, particularly male employees, to acknowledge that they are exposed to high noise levels, but to state that they have become used to it and their *tolerance* or *immunity* has increased. As we all know, this is absolute nonsense.

EMPLOYEE EXPOSED TO EXCESSIVE NOISE EXPOSURE

The employee commences work at a new workplace that has plant and machinery which exposures him to excessive noise levels. He may or may not be given ear protecting devices. Either way, research has shown that these are generally not worn, or if they are worn, then they are more often then not worn incorrectly. This is why both the Australian Standard for Hearing Conservation [10] and the National Code of Practise [4] are couched in wording that implies that the exposure is independent of whether or not an employee is wearing hearing protection and hearing protection should be viewed only as a temporary solution.

At the end of the first day he will have a large TTS, probably accompanied by tinnitus. If he is driving home, he will notice that the car engine is quieter and he will need to turn the radio up. When he arrives home and meets his spouse, her voice will sound just as loud, but as though she is speaking through a blanket. Unless he is subject to other hearing disorders, he may notice that high-frequency sounds seem unnaturally enhanced. This is because the loss of sensitivity around 4,000 Hz contrasts markedly with the negligible loss at higher frequencies. The noise will also have had a psychological effect on him and made him very tired and possibly irritable.

By the morning, his hearing will have partly recovered, the tinnitus will have stopped, and he will have slept off the tiredness. The second and subsequent days will not have nearly as much of an effect on him. He will go to work with a threshold shift, and consequently the noise in the workplace will not appear as loud. He will become accustomed to having a degree of hearing loss, and will probably have ceased to experience the tinnitus. Depending on the type and level of the noise he could be taken from this noisy workplace and moved to a quiet one, and after a few weeks or months, his hearing would return to within tolerable limits. However, there comes a point of no return, and eventually he will start to notice his own loss of hearing, and speech will become less intelligible to him. He will find that he can only hear the television if it is loud.

At this stage the hearing damage is permanent and irreversible. If he continues to be exposed to excessive levels of noise his audiogram tests will show that the dip at 4,000 Hz will be characterised by a deepening and widening as it drags down other frequencies. He will reach retirement as a very deaf person.

DIFFICULTIES WITH NEW LEGISLATION

The previous example was given to highlight what historically was common in the workplace. The question that should now be addressed is when would it have been reasonable to expect employers to have known about the effects of excessive noise exposure and taken reasonable precautions to protect their employees from this exposure.

The new OH&S(Noise) Regulation is explicitly clear, at first glance, about what is now considered an excessive and unsafe noise exposure within the workplace, but on closer inspection raises several difficult questions.

Over what period should the 8-hour noise level equivalent of 85 dB(A) measurements be taken? Is it a typical 8-hour a typical working day, as is implied in the legislation. This begs the question, what is a typical working day? Or should it be taken over an entire working week that would be a better indication of the hearing loss actually incurred? This can still be a problem as in a jobbing shop or construction site where the activities can vary from week to week. Or should the measurements be taken over an even longer period? It would appear that it almost impossible to be completely prescriptive and thus it will almost certainly be necessary to rely on the experience and skills of the specialist acoustician or well-trained OH&S officer.

It is worth recalling the legal case where Justice Maxwell in 1976 at the Supreme Court of NSW awarded substantial damages for an accident that occurred in 1968 to an employee of the steel works at Port Kembla. It was an unusual case because it involved a relatively short, once only, noise exposure. The plaintiff was exposed for approximately 5 hours with no hearing protection to the noise of an oil-air burner heating up a furnace. This once only exposure was enough to cause partial hearing loss and change the plaintiff's life dramatically and irreversibly.

How should exposure prior to the introduction of the new legislation be dealt with? The Workers Compensation Act 1987 (NSW) has the *relevant period* and the *percentage loss* provisions which define the compensation aspects, but make no attempt to address the technical aspects as to how this should be determined. The new OH&S(Noise) Regulation falls short in that it does not clearly define how hearing loss sustained prior to the enactment should be handled. Clearly, there has been adequate notice to employer groups and there should be some retrospectivity attached to the new legislation. The question is just how much? This is a complex issue and will vary from case to case. Notwithstanding this, it is my belief that the legislation should have also contained clear and coherent guidelines or parameters by which this could be judged.

The law has and will continue to be judge-made, by virtue of the precedence of previous cases within the Court system, particularly cases that have gone before an Appeals Court. It is, however, common for claims to be settled at the Court doors and these settlement sums are not disclosed nor recorded. In the case *Jack Vickery v. Commonwealth of Australia*, a claim for compensation was made in 1983 for hearing loss sustained from 1940 to 1942 while Mr Victery was employed as a drop forger at the Small Arms Factory, Lithgow. At the time of the claim the Mr Vickery was 70 years of age. Initially, Mr Victory was unsuccessful as his claim was made under the Commonwealth Employees Compensation Act 1930 that states that the claim shall be made within 6 months from the occurrence of the accident. When he submitted his claim it was some 39 years after he had sustained the hearing loss. Mr Vickery took his case to the Administrative Appeals Tribunal and they determined that his cause for failure to submit his claim within the allotted time was his total ignorance of his rights in the matter and this *justifiable ignorance* was regarded as *reasonable cause* and Mr Vickery was subsequently awarded damages.

There are enormous problems associated with retrospective compensation claims, particularly those for hearing loss. Typically, there is little if any detailed documentation of noise levels within the workplace over the time period of concern. Nor are there accurate audiometric records of the employee claiming exposure to excessive noise levels. There is also the problem of differentiating precisely where the hearing loss was sustained. In a recent Administrative Appeals Tribunal case *Dimitrios Mitsilias v. Australian Postal Corporation* (1995), the judgement handed down contained the statement 'It is no easy matter in

applications with respect to loss of hearing where there is an entitlement to a lump sum for pre-existing injuries ... to determine the amount of compensation that a person is entitled to receive ...'.

The Standards Association of Australia issued AS 1269 - SAA Hearing Conservation Code in 1976. This was amended in July 1977 and reprinted incorporating this amendment in 1977. It was revised in 1979 and again in 1983. The present Standard AS 1269 -1989 is currently under review. Although the scope has remained virtually unchanged the content has changed significantly from the original 1976 document. The present standard is also a far more complex document than the original document.

It is worthwhile noting that the Preface to all editions of the Australian Standard AS 1269 contains a common statement: *The detection at an early stage of noise-induced hearing loss is of critical importance. Persons highly susceptible to noise-induced hearing loss will show a hearing loss quite early in their exposure history which should be detected by audiometric testing.*

Early detection is of crucial importance. This is because it is extremely important to identify and quarantine members of the population that are highly susceptible to noise-induced hearing loss. Persons in the 95 percentile will show hearing loss quite early in their exposure history and this should be detected with regular audiometric testing.

QUANTIFYING THE HEARING DAMAGE RISK

In a population that has been exposed to excessive noise and has consequently suffered a measurable hearing loss, it is possible to conduct retrospective studies to determine quantitative relationships between noise exposure and a threshold shift.

Bies and Hansen [8] stated that there exists no physical hearing loss model to provide guidance on how the effects of age and noise should be combined. This is of importance as it is the relationship between hearing loss due to age and noise exposure that must be quantified to establish acceptable exposure levels. In particular, it is necessary to establish what constitutes exposure, as it is the exposure that must be quantified.

The Australian Standard AS 1269 - 1989: Acoustics - Hearing conservation [10] contains a table which shows the estimated prevalence of noise-induced hearing impairment in the noise-exposed population[4]. The table is based on the equations contained in the International standard ISO 1999, and is reproduced below in Figure 1. It shows the median, 5th and 95th percentile value of noise-induced PTS in deciles to be expected at 0.5, 1, 2, 3, 4, and 6 kHz from various combinations of exposure noise level and exposure duration. For example, if noise induced hearing impairment is not to exceed 10 dB over a working life for 95% of the noise exposed population at any of the frequencies, then exposure levels must be kept to an equivalent continuous level over an 8-hour working day of not less than 85 dB(A). Alternatively, if noise-induced hearing impairment is to be kept to not greater than 2 dB for 95% of the noise-exposed population at any of the frequencies, then exposure levels must be kept to not greater than 80 dB(A).

[4] It should be noted that this table does not give the total permanent threshold shift to be expected in noise-exposed population as the table does not contain data for threshold shift due to ageing or the threshold shift due to other conditions which have an adverse effect on hearing.

Exposure duration	Centile	Hearing impairment (permanent threshold shift), dB																											
		Frequency, kHz																											
		0.5					1					2					3					4					6				
		Exposure level ($L_{Aeq,8h}$), dB(A))																											
Years		75	80	85	90	95	75	80	85	90	95	75	80	85	90	95	75	80	85	90	95	75	80	85	90	95	75	80	85	90	95
5	95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	5	0	0	0	0	0
	50	0	0	0	0	0	0	0	0	0	1	0	0	0	2	4	0	0	2	6	12	0	1	4	8	15	0	0	2	5	10
	5	0	0	0	0	1	0	0	0	0	3	0	0	2	6	5	0	1	4	11	22	0	1	6	13	22	0	1	4	11	20
10	95	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	3	6	0	1	3	6	11	0	0	1	1	3
	50	0	0	0	0	0	0	0	0	0	2	0	0	1	2	5	0	0	3	8	16	0	1	5	11	20	0	0	3	7	14
	5	0	0	0	0	1	0	0	0	0	4	0	0	2	7	15	0	1	6	15	28	0	2	7	16	29	0	1	5	13	25
15	95	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	2	5	9	0	1	3	7	13	0	0	1	2	5
	50	0	0	0	0	0	0	0	0	0	2	0	0	1	3	7	0	0	4	9	18	0	1	5	12	22	0	0	3	8	15
	5	0	0	0	0	1	0	0	0	0	5	0	0	2	8	18	0	1	6	17	32	0	2	8	18	32	0	1	5	14	27
20	95	0	0	0	0	0	0	0	0	0	1	0	0	0	1	3	0	0	2	6	11	0	1	4	8	14	0	0	1	2	6
	50	0	0	0	0	0	0	0	0	0	3	0	0	1	4	9	0	1	4	10	20	0	1	6	13	23	0	1	3	8	16
	5	0	0	0	0	1	0	0	0	0	5	0	0	2	9	20	0	1	7	18	34	0	2	9	19	34	0	1	6	15	29
25	95	0	0	0	0	0	0	0	0	0	2	0	0	1	2	5	0	0	2	7	13	0	1	4	9	15	0	0	1	4	7
	50	0	0	0	0	0	0	0	0	0	3	0	0	1	5	11	0	1	4	11	21	0	1	6	13	24	0	0	3	9	17
	5	0	0	0	0	1	0	0	0	0	6	0	0	2	9	21	0	1	7	19	36	0	2	9	20	36	0	1	6	16	30
30	95	0	0	0	0	0	0	0	0	0	2	0	0	1	3	6	0	0	3	7	14	0	1	4	9	16	0	0	2	4	8
	50	0	0	0	0	1	0	0	0	0	3	0	0	1	5	12	0	1	4	11	22	0	1	6	14	25	0	0	3	9	18
	5	0	0	0	0	1	0	0	0	0	6	0	0	2	10	22	0	1	7	20	38	0	2	9	21	37	0	1	6	16	31
35	95	0	0	0	0	0	0	0	0	0	2	0	0	1	3	7	0	0	3	8	15	0	1	4	10	17	0	0	2	5	9
	50	0	0	0	0	1	0	0	0	0	3	0	0	1	6	13	0	1	4	12	22	0	2	6	14	25	0	1	4	9	18
	5	0	0	0	0	1	0	0	0	0	6	0	0	3	10	23	0	1	8	20	39	0	2	9	21	38	0	1	6	17	32
40	95	0	0	0	0	0	0	0	0	0	2	0	0	1	3	8	0	0	3	8	16	0	1	4	10	18	0	0	2	5	10
	50	0	0	0	0	1	0	0	0	0	3	0	0	2	6	14	0	1	5	12	23	0	2	7	15	26	0	1	4	10	19
	5	0	0	0	0	1	0	0	0	0	6	0	0	3	11	24	0	1	8	21	41	0	2	10	22	39	0	1	6	17	32
45	95	0	0	0	0	0	0	0	0	0	2	0	0	1	4	9	0	0	3	9	17	0	1	5	10	18	0	0	2	5	10
	50	0	0	0	0	1	0	0	0	0	3	0	0	2	6	14	0	1	5	12	24	0	2	7	15	27	0	1	4	10	19
	5	0	0	0	0	1	0	0	0	0	6	0	0	3	11	25	0	1	8	22	42	0	2	10	22	40	0	1	7	17	33

NOTE The values in this Table are population statistics and are not directly applicable to individuals

Figure 1: Estimated prevalence of noise-induced hearing impairment in noise-exposed populations [10]

CONCLUSIONS

Several questions have been raised associated with the difficulties in determining industrial hearing loss. Specific reference is made to the recently introduced OH&S (Noise) Regulation legislation in the State of NSW, Australia and the problems associated with the administering this legislation.

Several questions were raised and discussed, namely:

- When would it have been reasonable to expect NSW employers to have provided a workplace that complied with the exposure limits contained in the OH&S (Noise) Regulation?
- How should exposure prior to the introduction of the new legislation be dealt with? and
- Over what period should the 8-hour noise level equivalent of 85 dB(A) measurements be taken?

It is hoped that this paper stimulates collegial discussion within the Society and that the Society may play a part in assisting the relevant Authorities with the clarification and resolution of these and other issues arising from the administration of the new legislation in NSW.

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