G. BENKE

OCCUPATIONAL HEARING LOSS

conservation and compensation

OCCUPATIONAL HEARING LOSS

CONSERVATION AND COMPENSATION

PROCEEDINGS OF THE 1978 ANNUAL CONFERENCE
of the
AUSTRALIAN ACOUSTICAL SOCIETY

Edited by
R.L. Waugh and J.H. Macrae
National Acoustic Laboratories
Sydney, Australia.

ISSN 0156-6687

ISSN 0156-6687

Published by the Australian Acoustical Society, Science House, 35 Clarence Street, Sydney, NSW 2000, Australia.

December, 1978

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PREFACE

The papers collected in this volume were presented at a conference entitled "Occupational Hearing Loss - Conservation and Compensation" held at the University of Sydney on the 1st, 2nd and 3rd September, 1978. Edited transcripts of the discussions which followed most papers and of the two panel discussions are also included. The conference was organised by the New South Wales Division of the Australian Acoustical Society.

Several conferences on the topic of occupational hearing loss have been held in Australia in the last decade and these have provided valuable opportunities for public discussion of the hazards of occupational noise exposure and of the scientific and technological issues which arise when means of reducing these hazards are considered. The flow of ideas generated and sustained by these conferences has played a significant part in the development of advisory and regulatory policies; thus in the past five years we have seen the publication of the National Health and Medical Research Council's Model Regulations for Hearing Conservation (1973), the Standards Association of Australia's Code of Practice for Hearing Conservation (1976), and hearing conservation Regulations in South Australia (1976), Queensland (1977) and Victoria (1978). In addition, draft hearing conservation regulations have been prepared in Western Australia and New South Wales.

The publication of such codes and regulations signifies that the responsibility for the prevention of occupational hearing loss has shifted from the policy developers and lawmakers to the managements of organisations which employ people to work in hazardously noisy workplaces. In planning the topics of the invited papers and in selecting speakers to present them, we therefore sought to address this conference to issues of current concern to Australian industrial management.

The scientific, legal and economic ramifications of occupational noise exposure and hearing loss are so extensive that it is easy to lose sight of the human suffering and inconvenience in which the whole problem originates. We therefore asked Dr. Rosen to present the opening paper of the conference on the significance of occupational hearing loss to the individuals who have to endure it, in order to emphasise the point that this is fundamentally a health problem which

affects the quality of life of a very large number of people. The following papers discuss the legal responsibilities of managements regarding occupational noise and the management aspects of noise assessment, noise reduction and personal hearing protection programmes, thus following the order in which these topics are dealt with in standards and regulations and providing opportunities for more extensive discussions and explanations than occur in such documents.

There is at present great interest in industry, amongst both managements and unions, in the audiometric testing of noise-exposed workers. Consequently the following five papers constitute a segment on industrial audiometry. Two papers are concerned with the general issues of how to obtain a valid and reliable audiogram and how to interpret it and two papers provide practical feedback from organisations with considerable experience in the field of industrial audiometry. In the last paper in this segment, Dr. Noble presents a forceful critique of monitoring audiometry in which he argues that, whatever other purposes it may serve it contributes little, if anything, to the prevention of noise-induced hearing loss.

Trade unions are increasingly taking an interest in occupational health issues and the following paper presents a trade union viewpoint on industrial deafness, in the process developing a bridge between the conservation and compensation aspects of the conference theme. In the following paper, Mr. O'Keeffe reviews Australian workers' compensation law pertaining to occupational hearing loss and argues that the extraordinary diversity of approaches which have evolved in the various states - some of which, incidentally, effectively deny compensation for this condition - indicates the need for a more uniform approach.

The manner in which the complexities of the law complicate the audiological assessment of the compensation claimant, already a difficult enough task in itself, is well illustrated by Mr. Robinson in the next paper. The procedures necessary for an accurate assessment may surprise readers unfamiliar with this area. Audiologists have made a significant contribution to the development of equitable compensation assessment procedures in Australia and it is regrettable that their limited employment opportunities outside the clinical and special education spheres have made it difficult to apply equivalent energy to the preventive aspects of occupational hearing loss.

Despite their presumed interest to management, the insurance aspects of workers' compensation for hearing loss have received very

little public discussion in Australia and we were fortunate to secure Mr. Bennett's agreement to present an overview of the Australian situation.

During the conference a number of speakers and discussion participants mentioned the need for educational programmes about noise hazards and preventive measures and it was therefore appropriate for Dr. Simson and Dr. Rainsford to present the final paper of the conference on this issue. Given the existence of a national standard code of practice for hearing conservation and the enactment of regulations in several states, the development and execution of comprehensive educational programmes is possibly the most significant single action that can now be undertaken in relation to the mitigation of occupational hearing loss in Australia. The many constructive suggestions made by Dr. Simson and Dr. Rainsford thus conclude this selection of papers on a positive note.

I would like to take this opportunity to express my gratitude to my fellow committee members - Peter Kotulski, John Macrae (who is also co-editor of this volume), Terry Paterson and Geoff Pickford - for the many ideas and hours of work they so willingly contributed to organising and running the conference; to Professor Lawrence, Dr. Mather, Mr. Murphy and Mr. Weston for chairing the various sessions; to Mr. Ray Piesse, Director of the National Acoustic Laboratories, who consistently supported our efforts throughout the planning and running of the conference; and, of course, to the speakers and discussion participants whose contributions are the substance of these Proceedings.

R. Waugh

CONTENTS

OPENING ADDRESS

Mr. G.A.B. Riley
President
Australian Acoustical Society

Acoustics has always been regarded as the science of audible sound, so it is indeed appropriate that this conference should be concerned with the conservation of hearing, which is so important in our daily lives. However, there are now a number of branches of acoustics not directly concerned with audibility. They come under the general title either because the technological applications employ sound waves or because they are concerned with similar mechanical wave motions which happen to be outside the audible range.

Unlike the formal departments of human knowledge, acoustics has no place of its own in the traditional university. This may appear to be a serious omission when one considers the needs of the modern world, but those closely acquainted with this field of activity know that the subject could not reasonably be confined within any boundaries. The term "inter-disciplinary" may be applied to most branches of science but certainly to none more than this particular branch.

Over many centuries serious thought has been given to various aspects of acoustics. However it was not until the advent of Helmholtz in Germany and John William Strutt in England that a firm basis was laid. Helmholtz died in 1894, having been a Professor of Physiology for over twenty years, followed by a Professorship of Physics for a further twenty-three years. His investigations covered almost the whole field of science. When only 26 he presented a paper on the conservation of energy, which was to prove one of the epoch-making papers of the last century. However, his greatest contribution concerned the physics and physiology of both the eye and the ear. He explained accurately the transmission mechanisms of the outer and middles sections of the ear and discussed ways in which the cochlea might interpret the vibrations impressed upon it. His book The Sensations of Tone, published in 1863, has been described as the Principia of physiological acoustics.

In England only a few years later John William Strutt, whom perhaps we better know as Lord Rayleigh, was to publish The Theory of Sound, undoubtedly the greatest single contribution ever made to physical acoustics or, for that matter, to acoustics generally. Here again sound was only part of the broad scientific spectrum tackled by Rayleigh. His

appointment to succeed that matchless genius James Clark Maxwell as the second Cavendish Professor at Cambridge was not surprising as he continued the work on electromagnetic waves and combined this with the study of mechanical wave motions. Quite recently I was speaking to Sir James Lighthill, who is the present occupant of the Chair of Theoretical Physics and Applied Mathematics at Cambridge, and part of our conversation concerned the work of Maxwell and Rayleigh. Sir James Lighthill is taking a very intense interest in a number of acoustic problems and he remarked to me that the equations of Maxwell and Rayleigh have not been faulted by anyone.

Now another contribution that Rayleigh made, which perhaps doesn't concern us today but is indicative of the fact that up to date acoustics has formed one branch of science among many others and this emphasises the inter-disciplinary nature of the subject - Rayleigh concerned himself with the density of the known gases and the discovery of many rare gases and this proved to be a tremendous contribution to chemistry. Now when one considers the nature of the meagre instrumentation available at that time, one can only conclude that the men who made such contributions were of an intellectual stature difficult for us to comprehend. In the 1920's the electronic valve was introduced into measuring apparatus of various kinds and today virtually every instrument is a sophisticated electronic device, enabling armies of ordinary mortals to engage in research of an empirical nature. By piecing together the small bits of new information thus gained progress continues at quite a remarkable rate, particularly in the field of application, and this progress seems to continue with or without the presence of genius.

Diversification in the field of acoustics has become such that the Acoustical Society of America divides present day acoustics into about 18 major departments under titles like architectural, psychological, physiological, medical, speech, music, noise, mechanical vibration and shock, infrasonics, ultrasonics, surface waves - which were discovered incidentally by Rayleigh - underwater sound, atmospheric propagation, non-linear acoustics and linear acoustics. When one looks a little more closely into the classifications of the Acoustical Society of America, one finds that they have more than 200 headings, so you can be thankful that this three-day conference which I have the privilege of opening is confined to merely one segment of what has become a vast subject.

Acoustical Societies have been established in various countries, partly for the purpose of bringing a measure of cohesion to this inter-disciplinary science. You can imagine, if there were not some bodies trying to collect all this together, how difficult it would be to find out what was really going on in various departments of acoustics. The Australian Acoustical Society was established in 1964 and now has Divisions in four States - New South Wales, Victoria, South Australia, and Western Australia. We hope that it won't be very long before we are able to extend further.

A degree of international recognition has been achieved already and this is evident from the fact that the Tenth International Congress on Acoustics has been awarded to Australia and is to be held in Sydney in less than two years. Following the formation of the International Commission on Acoustics, which is the controlling body, international congresses have been held at three year intervals and up to date they have all been held in the Northern Hemisphere. They are now attracting much greater interest and although Australia is comparatively remote from the rest of the world we are planning for 1250 delegates plus accompanying persons. The subject matter will range over the whole field and although a number of world authorities will be presenting papers on a very high plane it is the policy to present the majority of papers on a level understandable to all. The Tenth ICA provides the Australian Society and Australian acoustics generally with a wonderful opportunity to become firmly established in international circles. We hope that you will take note and publicise the matter in your own spheres of influence because we need support from government, from business, from kindred societies, from our own members and from the community at large, so please register for the Tenth ICA when the time comes. In the meantime, those of you who are not already members of the Australian Acoustical Society, why not join it? Like many other learned societies there are several grades of membership and we can accommodate all who are interested.

I would now like to pay a tribute to the enterprise and enthusiasm displayed by members of the New South Wales Division of this Society. Through the years they have organised many successful conferences and invariably the subject matter has been interesting and of great practical value to the community. For portion of this conference we are being joined by the Audiological Society of Australia, which is having a conference of its own. We are pleased and grateful to have that

Society's assistance and wish its members every success in their own deliberations.

After looking through the programme and noting the credentials of the speakers there is no doubt in my mind that this conference will be a great success. How could it be otherwise, for the President of the Audiological Society of Australia is to be our first speaker. It is now my privilege to declare open this conference on Occupational Hearing Loss.

NOISE INDUCED HEARING LOSS AND THE DEFINITION OF HEARING DISABILITY, HEARING IMPAIRMENT, AND HEARING HANDICAP.

Dr. J. Rosen

Head, Audiology Department, The Hornsby and Ku-Ring-Gai Hospital, Sydney, New South Wales

The introduction of statutory regulations for noise control implies that it is in the best interests of both management and labor to co-operate in developing hearing conservation programs for the advantage of all concerned.

As a preliminary, it is essential that all parties gain some understanding of the nature of experienced hearing handicap resulting from noise induced hearing impairment. Thus, historical and demographic aspects of occupational hearing loss are reviewed and the importance of adequately specific definitions emphasized. Actual case studies are introduced as typical examples.

Introduction

Increasing mechanisation since the beginning of the industrial revolution has brought with it the unwanted by-product of increasing noise. The adverse effects of this noise have been well known since the early nineteenth century, with the first published report concerning noise induced hearing loss appearing in the British Journal 'Lancet' in 1802 (Glorig, 1977). However, it is not until the past 10-15 years that significant progress has been made both in understanding the many effects of noise on man, and in instituting reforms for noise control, with particular emphasis on noise in industry. This has led to increasing awareness of the problem throughout all levels of industry and it has become a matter of increasing concern both to management and to labor. Until this awareness has extended to government, however, 'concerned' management, faced with the monetary disadvantage of implementing non-compulsory hearing conservation programs, has tended to remain just that.

Once statutory regulations apply equally to all, this inequality no longer applies and it then falls to those involved at all levels to co-operate in developing the most advantageous programs for all concerned. Your presence here at this conference indicates

your interest in occupational hearing loss, and succeeding papers will be dealing in depth with many aspects of hearing conservation and compensation, from the pros and cons of presently advocated modes of industrial audiometry to details of noise surveying and noise reduction, and from actual legislation, to legal and other aspects of compensation and insurance. It is not my purpose to pre-empt any of these areas, nor to discuss in detail the anatomical "cause and effect" of industrial noise on hearing. Rather, as a practising clinical audiologist it will by my purpose to review some of the major aspects of industrial hearing loss as they affect the individual. The aim of this review, of course, will be to throw light on the very reason for this conference : First of all, why, in fact, there is increasing community concern about noise, and secondly, why its management, while complex, is so necessary.

A. Preliminary Considerations.

1. Historical Aspects.

Recognition of the syndrome of 'boilermakers' deafness' predated quantitative hearing assessment. Early quantitative investigators, however, disagreed about the actual effects of noise on human hearing. Disagreement lessened with increasingly more sophisticated technology and the introduction of noise spectrum analysis into experimental studies. Now, I think there would be little disagreement with the claim that, while not uninfluenced by the spectrum of the damaging noise, evidence of the response of human hearing to noise of damaging levels first manifests itself circa 4000 Hz, resulting typically in a 'notch' around this region (see Fig. 1), which, unchecked, not infrequently progresses over time to configurations such as these (see Figs. 2, 3 and 4). All of these audiograms are of actual cases which presented themselves as part of our routine clinical caseload at about the time I was preparing this paper. I think it is particularly worth mentioning here that although each of these subjects was well aware of longstanding hearing impairment, all were seeking help with communication difficulties at the time of their referral. None of the four had, to that point, any thought of seeking compensation for hearing impairment, and incidentally, although two of the four have subsequently purchased themselves hearing aids, and a third has organised a trial period with aids with the intention of buying them, as far as I know, none has subsequently made any moves towards seeking monetary compensation. However, all four have an industrial history which is clearly consistent with the configuration of their present hearing levels, a fact which was discussed with them at the time of

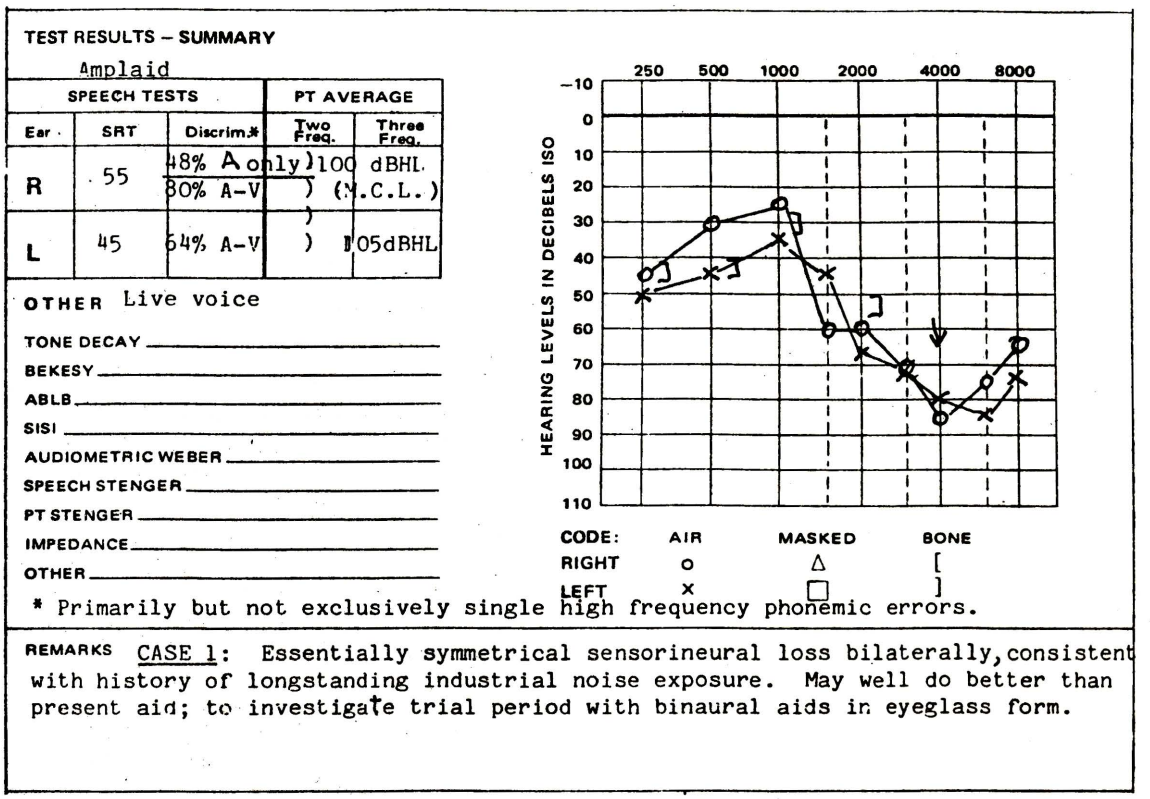


FIGURE 1. Summary of audiometric test results, Case 1.

their clinical assessment. I will be referring to these typical cases later in this discussion.

2. Epidemiology.

While not denying that harmful effects result from known levels of noise exposure it is obviously necessary that in order to be economically viable, any business enterprise must weigh benefits to be gained from noise prevention measures against the "costs" of refraining from employing such measures. In this regard, reliable prevalence figures for the total Australian population would be most useful. Unfortunately, the variability in effect on human hearing which results from time, intensity, and spectral considerations means that in general, incidence figures must be regarded as specific to each experimental report. However, in the United States in 1959-1962 a demographic health study of major dimensions included hearing evaluation in its health examination

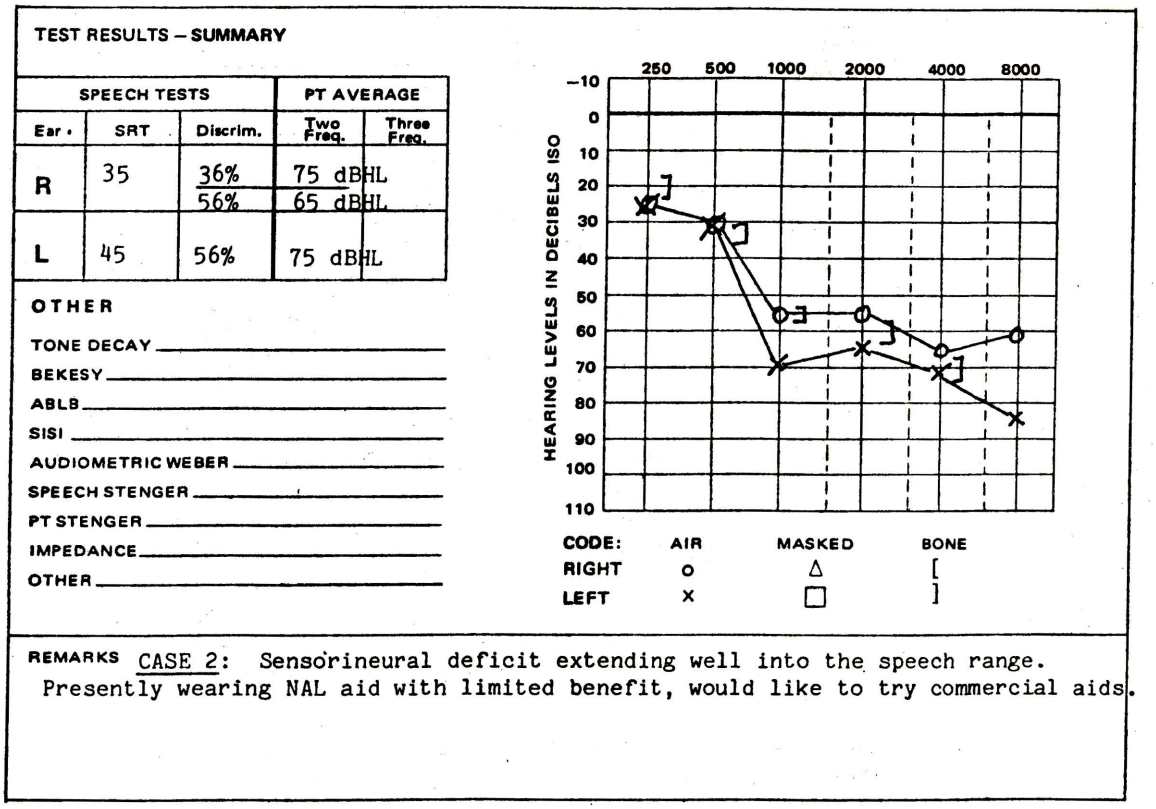


FIGURE 2. Summary of audiometric test results, Case 2.

of 6,672 adults aged between 18 and 79 years (NCHS, 1965). The subjects were selected to represent the 111 million adult civilian non-institutionalised population of the United States at that time. The results, converted to the ISO standard (ISO, 1964) and plotted as composite audiograms representing the medians (50th percentile) by sex and by age, clearly indicate a greater prevalence of impaired hearing in males which increases over time (see Fig. 5).

A little later, in 1969, a United States Department of Health, Education and Welfare (HEW) sub-committee investigating public health aspects of human communication considered the findings from the Health Examination Survey (above cit) together with all other evidence available to it. One of the HEW sub-committee's major conclusions as contained in its final report (NINDS, 1970, p.12) was that indeed, handicapping hearing impairments can be expected to be somewhat more prevalent at

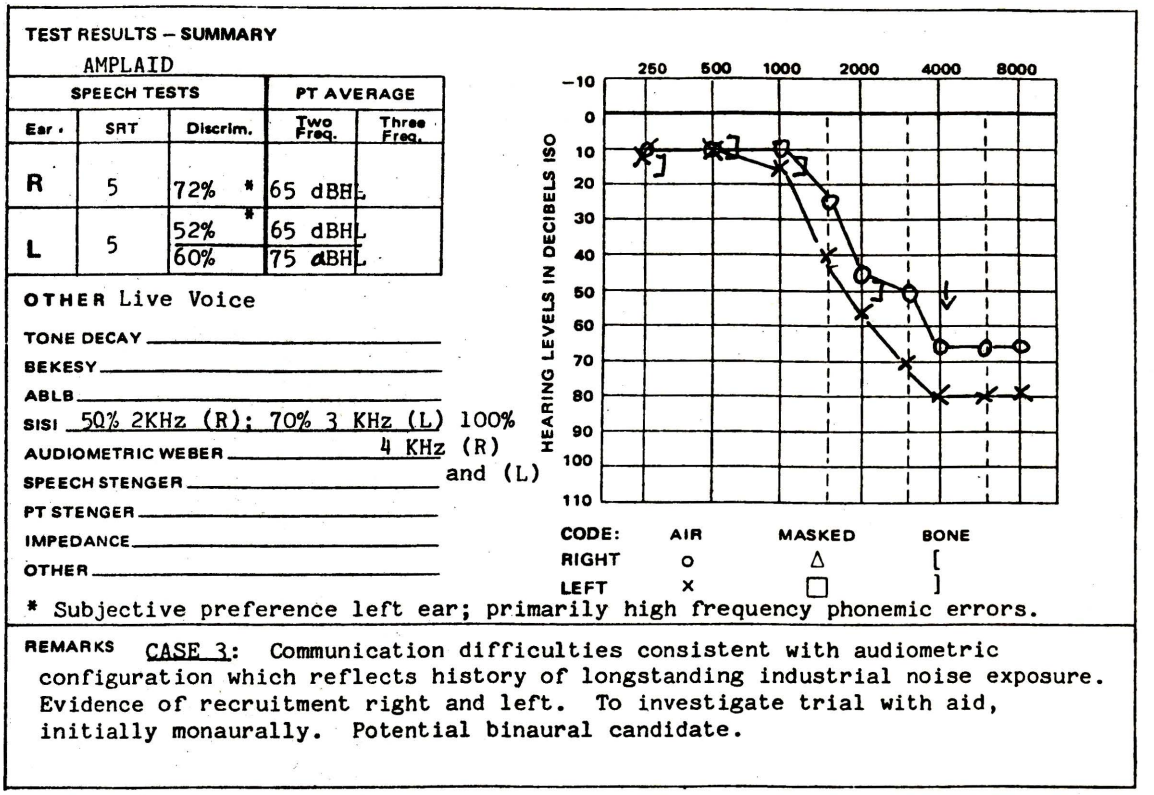
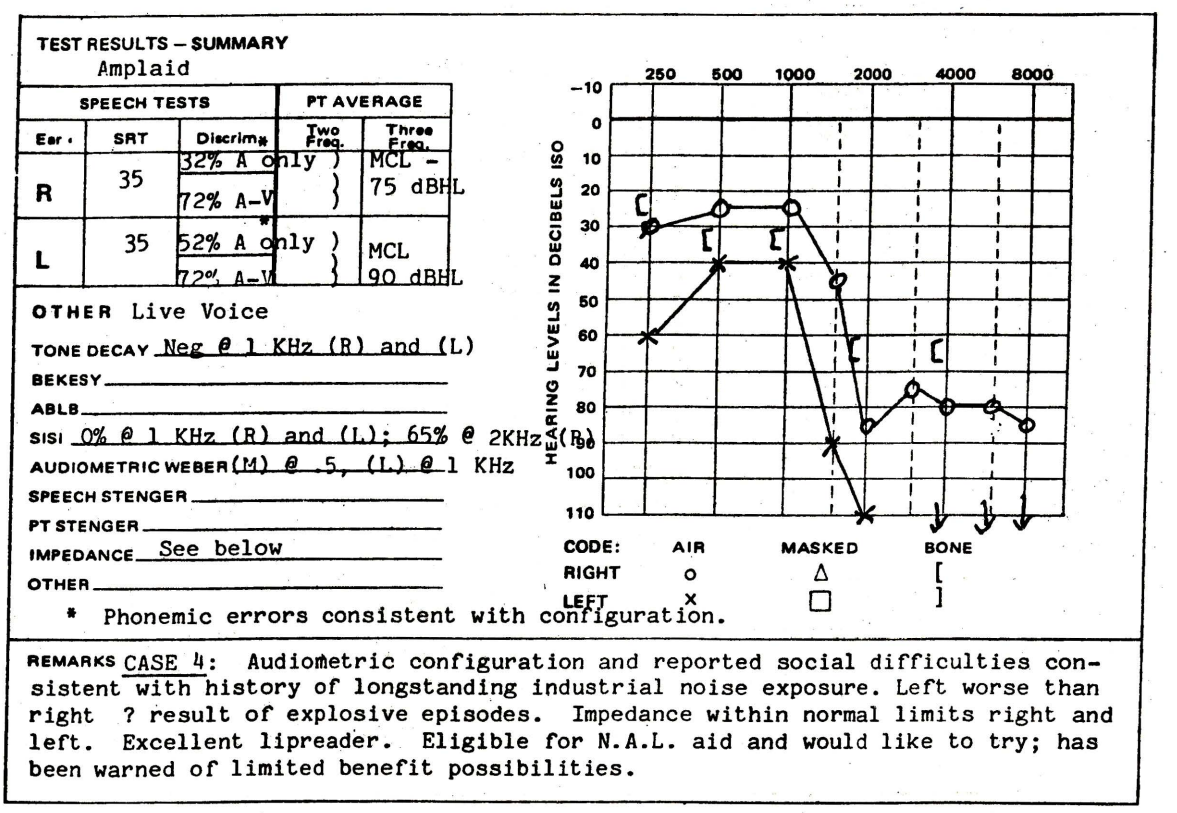


FIGURE 3. Summary of audiometric test results, Case 3.

all age levels among men than among women.

A few figures from a recent study of my own (Rosen, 1977) concerning aspects of acquired hearing impairment in a self-selected sample of hearing handicapped adults strongly suggests that Australian figures can be expected to reflect the American findings. The sample in this instance, consisting ultimately of 60 male and 60 female community volunteers, proved to match closely in all major respects with the projections of the HEW concerning distribution of handicapping hearing impairment in adults. When the pure tone threshold results of the Australian sample subjects were tabulated by commonly used site of lesion categorisations (see Table 1) it became clear that a major difference between the sexes was apparent when sensorineural losses falling into a so-called "ski-slope"[1] category were identified as a sub-group. The

[1] Bilateral purely sensorineural impairment with 15dB or greater inter-octave slope within the frequency range 250-3000 Hz.



TEST RESULTS – SUMMARY

Amplaid

SPEECH TESTS			PT AVERAGE	
Ear	SRT	Discrim*	Two Freq.	Three Freq.
R	35	32% A only 72% A-V		MCL – 75 dBHL
L	35	52% A only 72% A-V		MCL 90 dBHL

OTHER Live Voice

TONE DECAY Neg @ 1 KHz (R) and (L)

BEKESY

ABLB

SISI 0% @ 1 KHz (R) and (L); 65% @ 2KHz (R)

AUDIOMETRIC WEBER (M) @ .5, (L) @ 1 KHz

SPEECH STENGER

PT STENGER

IMPEDANCE See below

OTHER

* Phonemic errors consistent with configuration.

REMARKS CASE 4: Audiometric configuration and reported social difficulties consistent with history of longstanding industrial noise exposure. Left worse than right ? result of explosive episodes. Impedance within normal limits right and left. Excellent lipreader. Eligible for N.A.L. aid and would like to try; has been warned of limited benefit possibilities.

FIGURE 4. Summary of audiometric test results, Case 4.

occupations of these men and women were not specifically tabulated against their hearing impairment category, but overwhelmingly, this sub-group gave a typical history of exposure to industrial noise.

There has yet to be evidence demonstrating intrinsic hearing differences between males and females of any practical significance. However, it is well known that in general, a far greater proportion of males can expect to be exposed over a period of time to industrial noise at damaging levels. Actual prevalence figures for the total Australian population may as yet be unavailable, but the evidence that is -- and the inference -- can hardly be denied.

3. Current Definitions.

Classification tables for hearing deficit commonly base their divisions solely on the pure tone average of the three frequencies commonly regarded as the "speech frequencies" (500, 1000 and 2000 Hz)

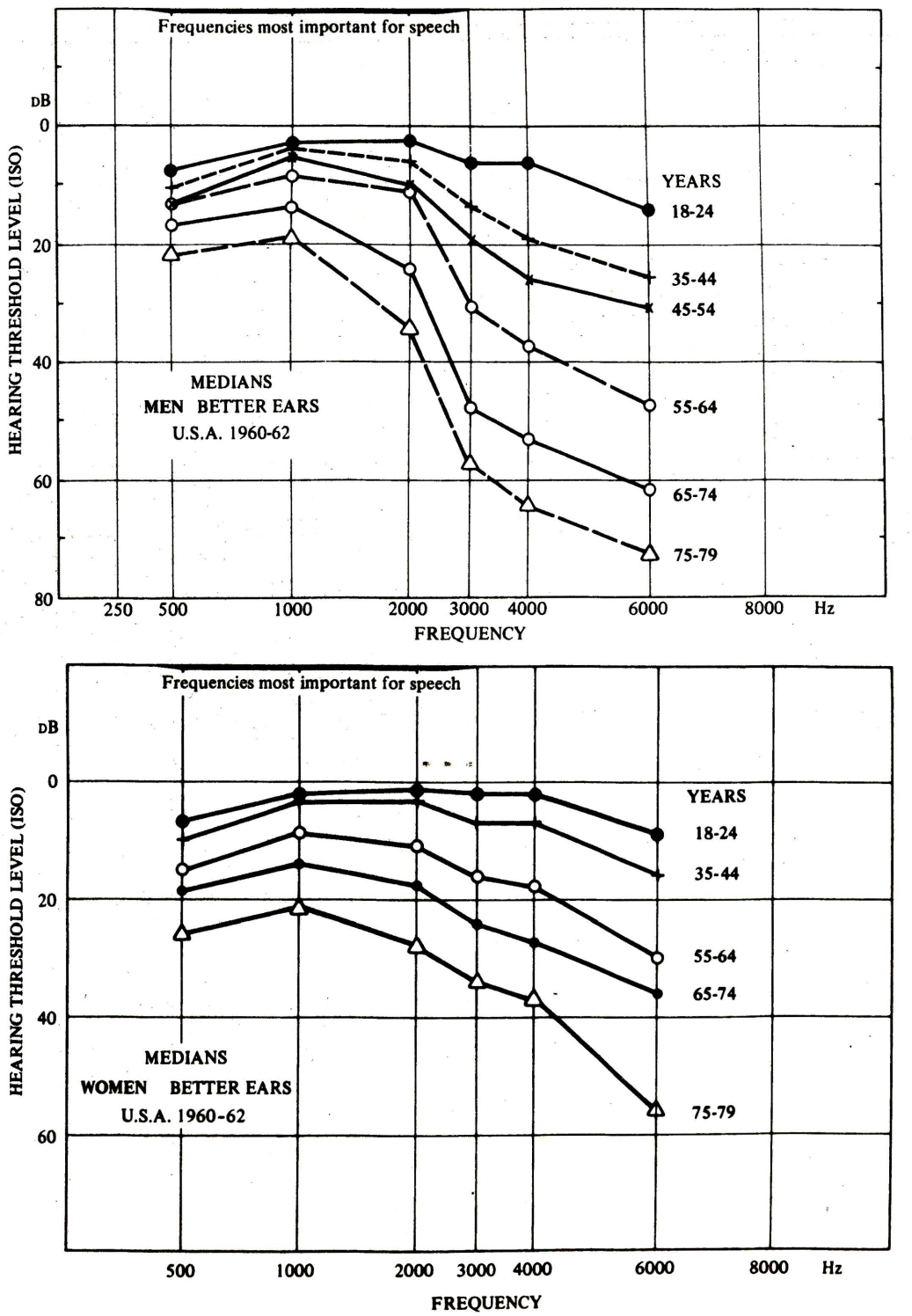


FIGURE 5. Composite audiograms for the better ear in men (A) and women (B) by age and by sex, plotted by median values. Data plotted is from the U.S. National Health Examination Survey 1960-1962. From Davis, 1970 b, p.111.

TABLE 1.

Sex Distribution of Experimental Sample by Pure Tone Hearing Threshold Level and by Site of Lesion.

Category	Classification	Experimental Subjects					
		Male		Female		Combined	
		No.	%	No.	%	No.	%
1.	Hearing within Normal Limits	8	13	19	32	27	22.5
2.	Unilateral Impairment	5	8.5	10	17	15	12.5
3.	Conductive Impairment						
4.	Mixed Impairment Sensorineural Impairment	5	8.5	9	15	14	11.5
5.	General	17	28	16	26	33	27.5
6.	Ski-slope	25	42	6	10	31	26
TOTAL:		60	100	60	100	120	100

of the better ear (see Table 2). As such tables are designed for group purposes, it is frequently considered that this information is sufficient, and that such individual characteristics as for example etiology of impairment are irrelevant. However, not only does this over-simplification ignore a basic pre-condition of any classification system for hearing impairment -- whether or not such impairment pre-dated the acquisition of language -- it brings additional limitations which are particularly relevant to industrial hearing loss but which are outside the scope of this paper.

It is relevant, however, that there is clear evidence that estimates of prevalence of hearing impairment in essentially similar populations can vary grossly in direct relationship to the definition of 'impaired hearing' which is used in each instance. For example, Hull et al (1971) reported 31 studies of defective hearing in the school age population of the United States where estimates of prevalence, dependent upon the standard used in each instance to define the presence or absence of a defect in hearing, varied between 2 per cent and 21 per cent.

In the audiological literature, there are three terms which are frequently used as if they were synonymous. These terms are disability, impairment, and handicap. As it is common knowledge that individual differences in experienced handicap frequently occur in the presence of apparently identical audiometric characteristics and audiological

TABLE 2.

Classes of Hearing Handicap. From Davis, 1970 a, p. 255.

Hearing Threshold Level dB (ISO)	Class	Degree of Handicap	Average Hearing Threshold Level for 500, 1000 and 2000 Hz in the Better Ear*		Ability to Understand Speech
			More Than	Not More Than	
	A	Not significant		25 dB (ISO)	No significant difficulty with faint speech
25					
	B	Slight handicap	25 dB (ISO)	40 dB	Difficulty only with faint speech
40					
	C	Mild handicap	40 dB	55 dB	Frequent difficulty with normal speech
55					
	D	Marked handicap	55 dB	70 dB	Frequent difficulty with loud speech
70					
	E	Severe handicap	70 dB	90 dB	Can understand only shouted or amplified speech
90					
	F	Extreme handicap	90 dB		Usually cannot understand even amplified speech

* Whenever the average for the poorer ear is 25 dB or more greater than that of the better ear in this frequency range, 5 dB are added to the average for the better ear. This adjusted average determines the degree and class of handicap. For example, if a person's average hearing-threshold level for 500, 1000, and 2000 Hz is 37 dB in one ear and 62 dB or more in the other his adjusted average hearing-threshold level is 42 dB and his handicap is Class C instead of Class B.

history, it should be clear that in order to avoid confusion, the differing implications of "impairment" and "handicap" should be considered. Add the medico-legal connotations which are an intrinsic part of occupational hearing loss, and we encounter the third term -- disability -- frequently used in legal interpretation of compensation laws. Particularly when we are examining aspects of occupational hearing loss, therefore, it is important that findings are not misinterpreted as a result of simple confusion of these three terms.

A major figure in audiology, Hallowell Davis, has suggested that with respect to general dictionary meaning, it is an easy matter to separate disability, impairment, and handicap when they are used to describe hearing (Davis, 1970a, p. 263). In general concord with Davis' proposed definitions, it is suggested that the following meanings should be clearly understood whenever the three terms are used with respect to hearing deficit:

a. Hearing disability. As disability is a term frequently encountered in compensation litigation, it is logical that use of the composite term hearing disability should be restricted to situations where it is clearly applicable in the legal context.

b. Hearing impairment. If attention is paid to common dictionary meaning, the term impair: 'to diminish in quantity, value, excellence or strength', [1] when used with respect to hearing capacity can readily be restricted to describing quantified deviation from a statistical norm, international physical standards for which have been established (ISO, 1964).

c. Hearing handicap. If handicap is defined as: 'a deficiency -- that prevents or restricts normal achievement', it may usefully be restricted with regard to hearing, to indicate the resultant effect of a quantified deviation, or impairment.

Subsequent papers at this conference will thus be dealing either with hearing disability, or with hearing impairment. Although at present the trend in occupational hearing loss in Australia seems to be towards a truly synonymous use of these two terms, they are and will remain, quite distinct from questions of experienced handicap secondary to acquired hearing impairment. The remainder of this paper will consider aspects of such hearing handicap as they affect individuals.

B. Handicap Secondary to Acquired Hearing Impairment.

Occupational hearing impairment and more particularly, its corollary -- hearing handicap -- a deficiency that prevents or restricts normal achievement -- may usefully be approached via three major directions:

[1] Webster's Seventh Collegiate

1. What and how it affects;
2. Who it affects, and how;
3. What can be done about it.

Question 1: What is occupational hearing loss and how does it occur?

The answer to this particular question is well understood by to-day's audience, and in any event will be dealt with in more depth by subsequent papers at this conference. Suffice it at this point to say that basically there are two types of occupational noise exposure which may occur separately or together, and which result in two types of occupational hearing loss : (a) acute acoustic trauma resulting from one definable episode of traumatic noise exposure and (b) chronic acoustic trauma which results from exposure to noise at damaging levels over a longer period of time. Effects and degree vary with individuals, and the two types differ in that the first -- acute acoustic trauma -- frequently results in an immediate post incident effect of virtually total deafness which may or may not partially recover over a period of time, while in the second, the permanent effect only becomes evident over time. However, both types are similar in two major ways :

a. Both affect the cochlea and effects essentially become permanent and irreversible.

b. Largely irrespective of the spectrum of the damaging noise, damage will typically be greatest in the region of 4000 Hz.

Thus, although the initial impetus of an acute onset is clearly defined, and although in cases of chronic noise exposure the 'acoustic trauma notch' can be expected to deepen and widen with time, the eventual audiometric configuration will follow essentially the same typical patterns.

Question 2: Who does it affect, and how will these people be affected?

This question would appear to be quite straightforward : 'Clearly, those who are exposed to damaging noise!'. However, looked at more closely, the question is not quite so simple. Where and when and for what do we use our hearing? Where is everywhere; when is all the time; and for what is not least for communication, on which our whole human societal structure is based. Thus, hearing impairment of any degree

has its effects firstly on the individual but it affects both him -- and those around him -- in every area of living.

a) Individual effects. Some theorists suggest that the harmful effects resulting from the absence of everyday noise can be observed in individuals as at three levels: the primitive level at which we react to the changing background sounds of the world around us without always being aware that we are hearing them, examples being the clock ticking on the kitchen wall, rain falling on the roof, the wind and the birds in the trees, and perhaps a trifle more prosaic, oneself or one's companion chewing happily on celery, or a carrot; the warning level, where sound warns us of approaching events such as the on-coming car, or the visitor arriving at the door; and the symbolic level in which, in the form of language, we use ordered sounds as symbols for things not immediately present, or for abstract concepts.

b) Constellation effects. Even if we restrict ourselves to the so-called 'highest' level, the 'symbol' or language level of hearing, it can readily be seen that hearing impairment will affect the individual in every area of living -- at work, in his family, in every social activity. It follows logically from this that it will of course therefore affect every individual in every one of those milieu with whom he comes in direct contact. As examples, let us look briefly at the four actual cases referred to earlier (Figs. 1-4) who are typical of the industrially affected subjects encountered in everyday clinical practice. The audiograms represent the actual test results but personal histories have been altered in minor detail in order to preserve the anonymity of the test subjects.

Case 1: A retired male in his early seventies, veteran of 30 years of employment in cement plants, he presently lives with the family of a married child. He consequently and quite understandably feels diffident about causing any unnecessary trouble and will prefer, for example, to endure such things as watching television at levels too low for him to understand, rather than risk discomfort to other members of the household by requesting louder levels.

At the time of his clinical evaluation, the strongly inferential relationship between his hearing levels and his employment history were discussed with him. However, although a life member of the appropriate union, and also on good terms with his previous employers, he was markedly reticent to take any steps towards investigating any possibility of compensation. Subsequently, although now on a very limited

income, he has proceeded to purchase binaural eyeglass aids for himself without seeking any help, even towards the not inconsiderable cost of that purchase.

Case 2: Another retired male with a history of gradually progressing hearing loss over a working lifetime of employment in steel mills. This man was eligible for, and first obtained, a National Acoustic Laboratories (NAL) free pensioner aid. However, he found that this aid gave him only limited benefit, and has subsequently purchased a hearing aid commercially. He recently wrote us to express his happiness with his new eyeglass hearing aid, and with permission I quote him:

> " I have worn it now for about three months and am thoroughly delighted. I am now able to follow serial programs on TV and be a sociable member of a group, something I was unable for about ten years to properly do because of working in my noisy factory."

Case 3: This man is a Master Cabinet Maker, in his early fifties, who left this employment because cabinet making machinery was making his ears ring continually. Despite this rather drastic move, his ears presently still both hurt and/or ring whenever he is exposed to loud noises. He is now employed as a hospital wardsman on night duty. In this particular job, of course, his disability is a constant irritation both to himself and to the nursing staff with whom he works, who in the middle of the night will quite naturally tend both to converse, and to give relevant orders, in whispers. In this case, it is not inconceivable that misinterpretation of poorly heard directions could even be dangerous.

Case 4: An active recently retired gentleman who gives a history of employment in heavy construction all his working life. He was in fact rejected from entering the Armed Services in World War II because of the hearing levels in his left ear at that time. As well as a constant high level of noise his work in heavy construction involved exposure to blasting noises, which is the most likely explanation for the comparatively greater loss in his left ear.

This man's major recreations at present include active involvement in lawn bowls competitions and in bridge groups. Although an excellent lipreader and very philosophic about his hearing limitation, it is nevertheless a constant everyday handicap to him.

These examples surely bring home the pervasive and handicapping results to the individual of a noise induced hearing impairment. All of these people will experience the everyday difficulties typical of any significant degree of hearing impairment: they will hear poorly when people speak softly, when they are in a group, when there is any background noise, when their wife speaks to them from another room, when anyone obscures their face or turns their head while speaking, when the light is behind the person to whom they are speaking. In turn, their poor communication ability will cause difficulty to each person with whom they are attempting to converse in any of these situations; which brings us to our third question.

Question 3: What can be done about it?

The answer to this question can essentially be represented as the two opposing sides of a coin. That is, do we a) compensate, or b) prevent.

a) Compensation. Compensation of itself has two elements:

(i) Financial. Pay anyone who can put forward valid evidence of industrially caused hearing impairment a sum of money, the amount to be determined in individual cases according to specified criteria. If we are economy-minded, perhaps we may anticipate that, as with all four of our clinical examples, a significant proportion of those eligible may never submit claims.

(ii) Rehabilitatory. Advise hearing disabled people to get themselves a hearing aid, and/or to seek re-training. Firstly, let us consider the hearing aid. What does a hearing aid do? Just what its name implies; it is a device which "aids hearing". However, it must not be forgotten that despite the marvels of modern technology, a hearing aid can only be added to a defective hearing mechanism; and depending on the characteristics of that defective hearing, particularly, for example, in cases such as our case number four (see Fig. 4) the sum total of 2+2 may well therefore be considerably less than 4. Next, the question of re-training. As witness our third example (see Fig.3), this also can be less simple than it sounds. Within to-day's competitive job market, it is not easy to start again with such a handicapping disadvantage as an inability to cope adequately with everyday communication.

Thence the other side of the coin:

b) Prevention. A major figure in hearing conservation in the United States, Aram Glorig, wrote recently: "I have often said, and have yet to be contradicted, that industrial noise causes hearing loss in more people than all other causes combined. Isn't it time something was done to stop this?" (Glorig, 1977).

Unfortunately, in matters of business viability it must undoubtedly be accepted that questions of cost cannot be ignored. Thus, perhaps this paper can most usefully conclude with a similar question with a somewhat different emphasis.

My question of you all then is this: If it can be demonstrated to you as representatives of industry that roughly equivalent costs may well accrue from adequately sound-treating the work environment and/or implementing a program of ear protection and hearing conservation as from paying large sums to cover the costs of workers' compensation for noise damaged hearing, can there be any justification for continuing with the latter course of action? That is, can there be any justification in failing to prevent an entirely preventable disease which has such widespread personal effects?

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Discussion

Mr. Mulcahey: I'd like to ask Dr. Rosen how successful does she think hearing aids are for people with industrial deafness?

Dr. Rosen: It will depend on the nature of the hearing loss and its extent, but if all of the loss can be prevented should we be looking at how successful hearing aids are? The whole problem of whether or not the hearing loss occurs in the first place is the question we should be addressing.

Mr. Mulcahey: It's always been my experience that they're not very successful at all.

Dr. Rosen: This is one of the things that bothers us as clinicians very much indeed. One of the characteristics of the noise-induced hearing loss is very frequently the steep configuration of the audiogram at the higher frequencies. Once it erodes back into the speech frequencies and the steeper it is, the less satisfactory a hearing aid is going to be. Although there is increasing awareness in the community at large of the fact that noise can damage hearing there are many areas still where people are not wearing hearing protection. They think that when their hearing loss gets bad enough they'll get a hearing aid but that's a very unfortunate attitude for people with noise-damaged hearing because they are amongst those who will find the least benefit from hearing aids.

Mr. Pickford: Have you calculated the percentage hearing loss for the four cases you presented - I'm told that Case 3 might not have any.

Dr. Rosen: Do you mean the NAL procedure?

Mr. Pickford: No, the American procedure.

Dr. Rosen: I didn't calculate that on those at all. On the American procedure, where you average hearing losses at .5, 1 and 2KHz, if there is good hearing at two of these frequencies very frequently they get no compensation anyway, although as you can see all four of them are most certainly seriously disadvantaged in their everyday lives.

Mr. Walsh: I'd like to follow up the question about hearing aids. For some of those examples where people exhibited fairly severe loss and they are issued with a hearing aid, is the amplification that is required going to help in rehabilitation or is it going to add more quickly to the problem?

Dr. Rosen: Well if the hearing aid is properly fitted to the loss and the person gains any benefit from it, it will be part of their rehabilitation. Again we must aleays remember that a hearing aid is no magic

answer to anybody's hearing deficit and there are many aspects to rehabilitation which must be considered. There are many aspects of course of hearing handicap which are quite independent of audition.

Mr. Walsh: The point I was really trying to make was the amplification that is required in the hearing aid - is it going to increase their hearing loss?

Dr. Rosen: No, especially if they are properly instructed in its use and they are not walking around the plant wearing it, and we can't guarantee that. I saw a man the other day who said to me "Oh, you know, I was told by the hearing aid dealer..." He will no longer be walking around the plant with his hearing aid turned on but he had been. And in that case he is amplifying the noise that he's in. But in any environment that has a hearing conservation scheme people surely shouldn't be walking around with their aids turned on.

Mr. Walsh: That has happened.

Dr. Rosen: Yes, but that's what we're all about - education.

Mr. Kimpton: That AAOO classification chart that shows the difficulty in understanding conversation for various levels of loss: would you know from your own experience whether the level of difficulty shown occurs under ideal conditions or under normal conditions?

Dr. Rosen: That's what I was saying about that particular graph. That graph is one that is frequently used as the basis for classification and as John Macrae has pointed out, if you use the AAOO procedure which is the basis of that particular graph, people are classified on their average hearing threshold levels at .5, 1 and 2KHz and this is grossly misleading and grossly unfair to people with noise-induced hearing loss. That was the reason for the new NAL scale which takes account of a much wider frequency range.

Mr. Kimpton: What I was getting at was that up to 40dB of hearing loss you would supposedly only have difficulty with faint speech. Now I would assume that this would be under laboratory conditions rather than under the normal working conditions of everyday life which would make communication more difficult.

Dr. Rosen: Yes, and in addition to that, if you are talking about average hearing levels, remember that the characteristic of the noise-induced hearing loss is that it will pitch off steeply - so an average hearing level of 40dB could be made up of more or less normal hearing at .5 and 1KHz but a very large loss at 2KHz and yet that person would very definitely be much more disadvantaged than would appear if you calculate it on an average basis. That was the reason for bringing those in - it is very important to look at the basis of the classification.

OCCUPATIONAL NOISE AND THE LAW

By Julian Disney
(Law Reform Commissioner, New South Wales) [1]

Within any particular Australian State or Territory, there is a considerable range of laws relevant to occupational noise. The difficulty of summarising these laws becomes even greater when one attempts a national coverage. Accordingly, this paper concerns itself only with the more important aspects of the law, and inevitably, it deals in broad generalities rather than precisely accurate detail. It should be treated as an introductory outline rather than as an authoritative and comprehensive description.

The paper concentrates primarily on the law relating to "occupational noise", by which I mean noise emitted in a workplace and affecting workers in that workplace. However, the paper deals also with some aspects of "community noise", which is noise affecting people outside the workplace, but which may have been emitted from a workplace. Controls on community noise may have considerable impact on occupational noise, and vice versa. References in this paper to a workplace include the property within which, say, the factory is located rather than merely the factory building itself.

The law relating to occupational noise has two primary aims, namely:

(a) prevention of unreasonable noise;

(b) compensation for people who suffer loss from unreasonable noise.

The following brief description of the five major areas of relevant law on occupational noise should cast light on the varying degrees to which these two aims are pursued, and achieved, in Australia.

A. THE COMMON LAW

The "common law" is law which is created and developed by the courts themselves, rather than being stated in legislation.

1. Negligence

A person who suffers damage from noise can sue the

noise-maker for negligence, provided that the damage was reasonably foreseeable and could have been prevented by the exercise of reasonable care on the part of the noise-maker. If the person succeeds, he or she will be awarded financial compensation ("damages") for the loss suffered. In the context of occupational noise, the loss could be caused by noise affecting an employee in the workplace or by the emission of noise from the premises so as to injure a passer-by or nearby resident. In the former case, an employee may sue the employer for negligence on the part of the employer himself, or on the part of another employee acting in the course of employment.

However, several problems confront persons suing for negligence in this area. Firstly, they must show that they suffered physical or financial injury. Usually it will not be sufficient to show that the noise causes irritation or annoyance. Secondly, if the person alleges noise-induced hearing loss, it may be very difficult to establish what caused the loss. For example, it may be difficult to prove whether, or how much of the deafness was caused by noise at one's workplace, rather than by advancing years, over-exposure to rock groups etc. If the employee has worked for several employers, it may be impossible to show how much deafness was caused by each. Thirdly, noise-makers may successfully escape liability by persuading the court that the measures necessary to reduce the noise would have been unreasonably expensive, or that it was not reasonable to expect them to foresee the likelihood of deafness being caused by the noise. Fourthly, the amount of damages may be reduced substantially if the court finds that the sufferer's own negligence, such as a failure to wear ear muffs, contributed to the loss. Finally, as with so many types of legal proceedings, the expenditure of time and money required to mount an action for negligence may prove a severe or insuperable barrier.

2. Private and Public Nuisance

In order to succeed in an action for private nuisance, a person must show that he or she suffered "substantial and unreasonable discomfort in the enjoyment of their premises".

Broadly speaking, an action for private nuisance can be brought only by a person who is affected in their enjoyment of property which they own or occupy.

Most actions for public nuisance can be brought only by the Attorney-General, and will succeed if "substantial and unreasonable discomfort" has been caused to a substantial section of the community. However, they may be brought by a particular person who, although not affected in his use of property, claims to have suffered more harm than other members of the public. [2]

"The nature of the locality..., the suitability and character of the activities carried on by the [noise-maker], and the character and duration and time of occurrence of the noise emitted and the harm occasioned are all relevant factors to take into consideration in deciding whether a nuisance has been committed". [3] If a nuisance has been committed the courts may award damages to the sufferer, and make an order (an "injunction") that the noise must cease or be reduced. Nuisance actions are unlikely to be of use to an employee suffering deafness from noise at work, though they may provide a remedy for residents living near a noisy factory. Unlike the action for negligence, it is sufficient to show that the noise is irritating or disturbing, even though no personal or financial injury has been suffered.

Problems with an action for nuisance arise out of the vagueness of criteria such as "substantial and unreasonable discomfort", and the fact that these cases are heard in the ordinary courts by ordinary judges and magistrates who have no expertise or significant experience in relation to noise control. As a result, there is a strong possibility of ill-informed decisions being made by the courts; on the other hand, if the courts allow expert evidence to be given, it may lead to a very expensive and slow hearing, and the expert information and opinion may not be digested properly by the court. An example of the dangers of inexpert adjudication arose recently in England where a court ordered that noise in a particular public house should not exceed 70 decibels, but it did not give any indication of how and

where the noise should be measured. [4]

However, during the last few years a significant number of private nuisance actions have been brought successfully by people living near noisy industries. In some cases the courts have placed very great reliance on noise-level readings, codes of "acceptable" noise levels in various types of locality, and expert opinion, in deciding whether a nuisance has been committed and, if so, to what level the noise should be reduced. [5]

3. Breach of Statutory Duty

If an employer fails to comply with the requirements of legislation concerning industrial health and safety, an employee who suffers injury as a result can sue the employer for breach of statutory duty. In this situation there is no need to prove that the employer was negligent; it is sufficient to prove that the statutory requirements were not observed. For example, generally speaking, this action would be available to an employee who suffers hearing loss because an employer exceeded noise levels prescribed by statute or did not comply with statutory requirements to provide hearing protection devices. However, although there will be no need to prove negligence, it may be difficult to prove that the breach caused the hearing loss. Also, unlike the action for negligence, an employee will not succeed in an action for breach of statutory duty if the breach was caused by a fellow employee rather than the employer himself.

In the past there have been very few relevant statutory duties upon which one could rely in an action arising from hearing loss. Part C. of this paper discusses the new statutory duties concerning noise control which are arising from new industrial health legislation around Australia. These new duties may lead to actions for breach of statutory duty becoming more common in relation to noise-induced hearing loss.

B. WORKERS' COMPENSATION LEGISLATION

1. Introduction

During this century workers' compensation legislation has been passed in each Australian State and Territory. In

addition there is a special Commonwealth Act in relation to employees of the Commonwealth Government.[6] Basically, each of these compensation systems provides financial compensation for employees who suffer physical harm arising out of, or in the course of, their employment. Compensation is paid regardless of whether the employer or employee was negligent, but, broadly speaking, it is not payable if the physical harm resulted from serious and wilful misconduct by the employee.

In New South Wales, Victoria, Queensland and Western Australia a special Workers' Compensation Board (in New South Wales it is a Commission) has been established to determine claims for workers' compensation. Appeals from this body go to the State Supreme Court. A broadly similar system applies under the Commonwealth and A.C.T. schemes. Under the other schemes, claims are determined by magistrates or courts, with an appeal to the Supreme Court.

Each system makes some use of medical boards and/or medical referees to assist in determining the cause, nature and extent of the harm for which compensation is sought. In some systems, particularly Queensland, these medical experts play a major role and their opinions are conclusive. Elsewhere, they are used less often and their opinions may be rejected by the bodies, referred to in the previous paragraph, which have general responsibility for determining compensation claims.

2. Compensation for Noise-Induced Hearing Loss

In relation to noise-induced hearing loss, the relevant types of compensation to which the employee may be entitled are:-

(a) Costs of medical and hospital treatment, including, in most compensation systems, the cost of hearing aids and rehabilitation;

(b) If the employee suffers a loss of earning power (i.e. his capacity to work is reduced)[7] - weekly sums at prescribed rates during the period of that loss of earning power;

(c) If the hearing loss is permanent - a prescribed lump sum payment.[8]

An employee may receive compensation under all three categories, provided he is eligible for each individually. However, except in New South Wales, Tasmania and Victoria, it is not possible to obtain the lump sum until weekly benefits have either ceased (i.e. the loss of earning power has ceased) or been terminated voluntarily by the employee. Under some schemes the combined total of all weekly benefits paid and the lump sum cannot exceed a prescribed figure. However, it is comparatively rare for claims for noise-induced hearing loss to allege a loss of earning power, and accordingly weekly benefits are rarely sought.

Because of the significant variations in the conditions concerning payment of compensation, it would be misleading to include here a comparative table of weekly benefits and lump sums under the various systems. However, "typical" figures at present are:[9]

Maximum weekly benefit for an employee without dependants:-

(a) For the first six months of loss of earning power:	Whatever is needed to boost his wages to their previous level.
(b) Thereafter:	$75-$80

Lump sum payment for permanent loss of hearing in -

(a) one ear:	$5,000
(b) both ears:	$15,000 - $20,000

Partial hearing loss is assessed pro rata; thus the loss of 20% of hearing in one ear gives an entitlement to 20% of the sum prescribed for total loss of hearing in that ear. Rather surprisingly, there is some confusion as to the amount payable when both ears are partially deaf. Some argue that the correct approach is to assess each ear separately, and calculate the compensation for each as being the respective percentages of the lump sum for total loss in one ear. The prevailing view now, supported by the National Acoustics Laboratory,[10] is to make a binaural assessment of hearing loss even when one ear is totally unaffected. The compensation is then a percentage of the lump sum prescribed for total loss in both ears.

In some systems a formula is prescribed so that the

levels of weekly benefits and lump sums keep pace with inflation, but in other systems increases are dependent on specific attention by Parliament. Nevertheless, by comparison with damages awarded in the common law actions mentioned earlier, workers' compensation is more likely to avoid unjust devaluation through inflation. On the other hand, particularly if a jury is involved, the courts in common law actions may take a more generous attitude than is taken by those responsible for prescribing statutory levels of workers' compensation.

Theoretically, temporary noise-induced hearing loss could give rise to a claim for weekly benefits. However, due to the brief period involved, little if any compensation would be due, and such claims are rare if not unknown. Therefore, this section on workers' compensation will concentrate on permanent noise-induced hearing loss.

3. Problems of Proof

In order to succeed in a claim for workers' compensation for a certain degree of noise-induced hearing loss, an employee must establish:

(i) that he suffered that degree of hearing loss
(ii) as a result of exposure to noise
(iii) arising out of, or in the course of, his employment
(iv) by a particular employer or employers.

In some cases, especially where the hearing loss resulted from a particular noise incident such as a loud explosion, no great difficulties may arise in establishing these four matters. However, in most cases where the loss has developed gradually through many years of exposure to industrial noise, severe difficulties arise. The following comments relate to gradual, rather than sudden traumatic, hearing loss. The overwhelming majority of claims concern the gradual type of loss.

(i) It may be relatively easy to establish that some hearing loss has occurred. In the absence of contrary audiometric data, it is assumed that the employee should have average hearing, and the hearing loss is calculated by reference to such average. However, there is still some debate as to whether the hearing loss is to be measured across the auditory range (20Hz-20kHz) rather than the speech frequency range (500Hz-4kHz).

(ii) It may be impossible to establish how much of the hearing loss was caused by noise, rather than by other causes such as advancing years ("presbycusis") or blows on the head. Some systems have specific rules aimed at overcoming this problem. In South Australia and Western Australia the legislation expressly states that if a hearing loss has been proved, and it has been established that the employee was exposed to noise at work at or immediately before the time when the claim for compensation was made, the onus is on the employer to prove that the loss was not noise-induced[11]. In Tasmania the legislation apparently places the onus on the employer even when there is no proof of exposure to noise at work[12]. However, both in these States and in the other places where the relevant statute says nothing on the point, the actual practice is broadly uniform, namely that provided the employee has worked for a significant period in an industry generally recognised as likely to produce noise-induced hearing loss, the employer will have to produce strong evidence that the loss was not entirely noise-induced[13].

One important qualification to this broad summary is that in some systems a reduction in the amount of hearing loss attributable to noise is required by statute to allow for presbycusis or other possible "extraneous" causes. In Tasmania 15% must be deducted from the measured hearing loss, while in South Australia and Western Australia one-half decibel must be deducted from the hearing loss for every year by which the employee exceeds 50 years of age. The employer can also try to establish justification for further deductions due to causes other than noise. In the other systems, where there is no statutory deduction, the employer must establish other causes in relation to the particular employee. He cannot rely, for example, on statistical evidence of average hearing losses in the community through presbycusis[14].

(iii) A closely related problem is to prove that the hearing loss resulted from exposure to noise <u>in the course of employment</u>. The New South Wales legislation, perhaps unintentionally, goes so far as to deem any employee's noise-induced hearing loss to have resulted from his employment. In South

Australia, Western Australia and perhaps Tasmania, the onus is on the employer to prove that the loss did not result from employment, although in South Australia and Western Australia the employee must first establish "exposure to noise" in his employment[15]. In practice, however, under each system, workers' compensation tribunals tend to regard the loss as arising in the course of employment unless there is substantial evidence to the contrary, provided the employee was employed for a significant period in an industry generally regarded as likely to cause noise-induced hearing loss. Employees in other industries will have very great difficulty in establishing their claims.

(iv) The fourth problem is to identify a particular employer or employers from whom the compensation is due. This may not be too difficult if the hearing loss occurred suddenly or the employee has been employed by one employer in a noisy industry all his working life, but it becomes very difficult with employees who suffer gradual hearing loss and have changed employers, or even changed industries. Some statutory assistance has been provided in most systems.

Generally speaking, the hearing loss is deemed by statute to have been caused by the "noisy" employer who employed, or had most recently employed, the employee at the time when the claim for compensation was instituted[16]. Except in Queensland, this employer can require contributions (in proportions determined for the particular case by the compensation tribunals) from previous "noisy" employers of the employee. By "noisy" employers, I mean employers who exposed the employee to working conditions of a type which may give rise to noise-induced hearing loss. In some States there is a time limit of, say, three years on how far back in the employee's history one can go seeking other employers liable to contribute.

A further restriction on retrospectivity is that some legislation, for example in Tasmania, requires claims for noise-induced hearing loss to be made while the employee is still employed, or within three months of his ceasing to be employed, by the employer from whom compensation is sought.

In Queensland, unless the hearing loss is total, a

claim for a lump sum can only be brought by a person who is still employed by a noisy employer (or is only temporarily out of such employment) and who for five of the previous seven years has been employed by a noisy employer in Queensland. These restrictions can exclude many would-be claimants.

The system outlined above can be unfair to employers in some ways. In practice, they may have to compensate for a degree of hearing loss which did not arise out of, or in the course of, employment by themselves or any other employer. The last employer may have to pay for hearing loss of which little or none occurred while the employee was in his employment. This may apply even if the employer can prove by audiometric data that the loss did not occur while in his employment, but cannot prove which other employment caused the loss. Broadly speaking, most of such "unfairness" is necessary to avoid even greater unfairness to employees, who often would face insuperable difficulties in establishing their claims without the assistance of these statutory provisions. In view also of the low rates of compensation, the generally cavalier attitude of many employers towards hearing conservation, and the fact that any unfairness is spread by virtue of insurance and provisions for contributions, employers have little cause to complain about the general situation in this area. Even with the present statutory assistance, many employees with meritorious claims, especially if they are not in notoriously noisy industries, may find it impossible to establish the necessary facts to obtain compensation.

However, to varying degrees in different schemes, there are serious, and in my view inexcusable, ambiguities in the legislation (including recent amendments) relating to workers' compensation for noise-induced hearing loss. This applies particularly to the onus of proof as to whether hearing loss was caused by exposure to noise in the course of employment, to the provisions defining which employer is liable to pay the compensation, and to the provisions applicable to noise-induced hearing loss arising suddenly or from some cause other than damage to sensory nerves. Some blame may be laid at the door of the policy-makers, but most must remain with

those responsible for the detailed legislative drafting. In some instances it is employers, and in others it is employees, who suffer as a result of these failings.

4. Workers' Compensation and Common Law Actions

The great advantages of workers' compensation by comparison with negligence actions are that the employee does not have to show that the employer was at fault, and that statutory assistance has been provided for establishing the cause of the hearing loss. On the other hand, a successful negligence action may result in more compensation than would be obtained under the workers' compensation scales.

An action for breach of statutory duty does not require proof of fault, but in the past there have been few relevant statutory duties upon which to base an action for hearing loss. As has been mentioned earlier, this situation is changing and the action for breach of statutory duty may become more popular as an alternative to a workers' compensation claim.

An employee can take a common law action as well as seeking workers' compensation, but employers are protected against having to make double payment. Thus, if an employee obtains common law damages, his weekly benefits will cease and the damages will be reduced by the total of any weekly benefits or lump sum compensation which the employer has paid.

New, or proposed, noise control legislation may have considerable impact on workers' compensation for hearing loss. This topic is considered in the next two sections of this paper.

C. INDUSTRIAL HEALTH LEGISLATION

Workers' compensation legislation may compensate some workers for industrial deafness, but it does not seem to have had much general effect in reducing noise levels in workplaces. The costs of compensation have simply been passed on to the consumer. However, there have been some signs of an increase in successful compensation claims for industrial deafness during the last few years, and some employers and insurers are now taking a greater interest in preventing hearing loss. This change has been accompanied, and perhaps caused, by an upsurge of interest in enacting new legislation aimed primarily at prevention rather than compensation.

Throughout Australia industrial health legislation, aimed at protecting the health, safety and welfare of employees, has existed for many years. However, until very recently the legislation contained no detailed provisions for controlling noise in the workplace.

In 1973 the National Health and Medical Research Council, a federal government advisory body on public health, published "Model Regulations for Hearing Conservation". These constitute a proposed code of statutory rules to reduce noise-induced hearing loss in the workplace. In 1973, the Standards Association of Australia published a Standard entitled "Hearing Conservation Code" (AS1269). This Standard has no legal effect but is intended to act as a guideline to employers and employees. It specifies methods for measuring and controlling both noise and hearing loss. Another relevant Standard is "Hearing Protection Devices" (AS1270).

These Standards and the Model Regulations (each amended somewhat since their original publication) have acted as the major sources of inspiration for various State Governments wishing to control occupational noise. Hearing conservation regulations based on these precedents took effect in South Australia in 1976, in Queensland in 1977, and in Victoria in 1978[17]. At present, no other State or Territory has taken similar action, although in New South Wales and Western Australia draft regulations have existed for some time but have not yet been made law. In Western Australia it may be necessary to enact a new statute before the draft regulations can come into effect, whereas in Tasmania the requisite statute has been passed but no regulations have been made under it. As yet, neither of the Territories has hearing conservation regulations.

Since most of these regulations are only in draft form, not always easily obtainable, subject to change, and too often poorly drafted, it is difficult to summarise their content. However, it seems desirable to attempt a rough, general summary of them, i.e. of the Model Regulations, the existing regulations and the draft regulations. For convenience, this outline is expressed as if the draft regulations are already in force, but it should be emphasised that at the time of writing regulations

have been made in Queensland, Victoria and South Australia only.

1. Prescribed Noise Limits

Generally speaking, the regulations prescribe that no employee is to be exposed to -

(i) a noise level exceeding 115 dBA, unless wearing a hearing protective device;

Presumably, this means also that when the device is fitted the noise reaching the ear must not exceed 115 dBA. Apparently, in New South Wales and South Australia the level must not exceed 115 dBA "outside" any device which may be worn. In Western Australia the only limit of this kind is 150 dBA "outside" any device which may be fitted.

(ii) a Daily Noise Dose exceeding the equivalent of exposure to 90 dBA for eight hours.

The Model Regulations proposed this limit for existing premises, but it suggested that a limit of 85 dBA for 8 hours should apply to all industrial premises established after the regulations came into force, and that five years later this lower level should apply to all premises.

Some regulations follow the Model Regulations by requiring the employer to measure levels and doses annually, while others merely require employers to measure when required to do so by the Agency (i.e. the Commission or government department, usually Health or Labour and Industry, responsible for administering the regulations.) However, an employer may need to monitor levels and doses more frequently if he is to be reasonably sure that he is complying with the prescribed limits. The Agency may also make its own measurements when it wishes. Employees cannot insist on measurements being made, though employers or the Agency may heed their requests. The employer does not have to disclose the measurements unless they are requested by the Agency or they show levels in excess of the prescribed limits, and even in these situations there is some uncertainty as to whether disclosure must be made to the relevant employees. However, the Model Regulations specifically mention that if the Agency agrees to a request by employees for a measurement to be made, the result must be

disclosed to the employees.

2. Exemptions

Despite the importance of the point, most regulations are not entirely clear as to the consequences of exceeding the prescribed limits. However, whether or not expressly stated, the general position seems to be that if it is not "reasonably practicable" ("best practicable", in New South Wales) to comply with the limits, the employer will be granted an exemption by the Agency.[18] Basically, it is the Agency which decides what is "reasonably practicable", though if the Agency's decision is challenged the matter may be resolved by a court of law. The criteria are likely to be similar to those which are actually specified in the Western Australian regulations, namely "local conditions and circumstances", the "current state of technical knowledge", and the "financial implications". In South Australia all exemptions granted must be published in the Government Gazette. In several regulations there is express power for the Agency to consult employees in relation to an application for exemption.

When seeking an exemption, the employer has to notify his reasons for seeking it, the period for which it is sought, the programme proposed to reduce the levels (for example, by installing sound-proofing, or reducing individual workers' periods of duty in noisy areas), and the interim hearing conservation programme to be implemented until the levels have been reduced to the prescribed limits. The Agency has express power to impose particular hearing conservation programmes and also, by threatening to withhold exemptions or granting them for short periods only, can force changes in employers' noise reduction programmes.

3. Imposition of Hearing Conservation Programmes

The regulations concentrate on two particular hearing conservation measures.

(i) Hearing Protection Devices

Where the prescribed noise limits are exceeded, the Agency has power to require employers to provide hearing protection devices for all exposed employees. It seems that this requirement usually will be imposed.

The regulations state that where the employer is required to provide hearing protection devices, he must provide each employee with a choice of his own individual muffs or plugs (if each would give adequate protection), instruct employees in their use, make proper arrangements for storage and cleanliness, and provide an alternative method of communication where its absence could be dangerous for workers wearing the devices. Most regulations state that if the employers are required to provide the devices, the employees must wear them "at all appropriate times", but there is some debate over the desirability of such a requirement and, for example, the Victorian regulations apparently leave the Agency to decide whether to insist that particular employees wear the devices. Rules on this point, and the others mentioned in this paragraph, probably apply even where the devices have been provided voluntarily by the employer rather than in response to an official requirement.

(ii) Audiometry and Medical Examination

Some regulations empower the Agency to require employers to provide free audiometric tests and medical examinations to employees who may have been, or are likely to be, exposed to noise exceeding the prescribed limits. Nothing is said as to when such power should be exercised. However, instead of leaving the Agency with this discretion, the Western Australian regulations follow the Model Regulations in imposing a detailed list of obligations on employers who exceed the limits. The employers must conduct regular audiometric tests of all employees exposed, or likely to be exposed, to excessive noise. The tests must be conducted by personnel approved by the Agency and must be conducted within three months of the employee's first exposure to the noise and annually thereafter. Where these tests show serious threshold shifts (defined in detail in the regulations), the results must be communicated to the Agency and to the employee, and the employer must pay for a medical examination. Under the Model Regulations, if there has been a less serious threshold shift, the employer must take steps to reduce the employee's exposure to noise and must provide six-monthly audiometric tests until no further shifts

occur.

Some regulations require records of all audiometric tests to be kept until a prescribed number of years after the employee has left the employment, and they state that the records must be available for inspection by the Agency and the employee. The employee is required to submit himself to any audiometric tests or medical examinations required by the regulations, and in New South Wales the employer must not knowingly employ a person who has refused to submit himself for audiometric or medical examination. This latter provision could be of great significance in future in relation to the establishment of common law and workers' compensation claims against particular employers. However, it does not actually require employers to insist upon tests for new employees. In general, audiometry results before, during or after employment could be used by the employer or employee in order to establish or rebut a claim that hearing loss resulted from particular employment. However, as was mentioned earlier, an employer may need to be able to show which employer did cause the loss, not merely that it was not himself.

4. Breach of the Regulations

Unless the employer has been granted an exemption, breach of the prescribed level or dose is an offence. In the States with draft regulations the proposed penalties are not yet known, but the $5,000 maximum penalty in South Australia may prove to be typical. This penalty is ludicrously low compared to the cost of many of the noise reduction programmes which would be necessary to avoid commission of the offence. However, it must be remembered that in many situations the employer may be committing separate offences, possibly incurring separate penalties, on a large number of occasions and in a relation to each of a large number of employees.

Breach of other requirements made under the regulations, for example concerning audiometry or hearing protection, will usually constitute an offence and incur financial penalties up to a few hundred dollars.

5. Some Weaknesses

The major weakness of these hearing conservation regulations is the level of the Daily Noise Dose. A permissible level of 90 dBA is much too high and its acceptance by governments around Australia shows a lamentable lack of vision and courage. The human cost of this level should be regarded as unacceptable in any civilised society. It is widely agreed by experts that 30% of employees exposed to this level of noise during a normal working life will suffer significant impairment of speech-hearing ability as a result. Even with an 85 dBA level, this figure will be about 20%. If the impact of presbycusis and other factors is added, the respective percentages rise to about 50% for 90 dBA, and 33% for 85 dBA.[19] The present level in England and the United States is 90 dBA but many experts, including the United States Environmental Protection Agency, have argued vehemently that it should be reduced to 85 dBA.[20] In some countries, such as Austria and Sweden, the lower level has been adopted.[21] Many experts believe that 80 dBA should be the ultimate goal.

At the very least, the regulations should have followed the Model Code by imposing an 85 dBA level on all new premises and foreshadowing a general reduction to that level in five years time. Even a major industrial country like West Germany, although lacking the resolve to adopt the 85 dBA as the maximum permissible dose, has required the provision of hearing protection devices to all employees exposed to doses exceeding 85 dBA. South Africa, from whom we are not accustomed to receiving enlightenment, has shown greater concern than Australia for the health of employees exposed to noise.

Extrapolation from English, American and South African estimates suggests that more than 100,000 Australian workers are exposed at their workplace to noise which may cause them hearing loss. The World Health Organisation believes that probably as many as 16 million employees around the world are exposed to hazardous noise levels.[22]

Perhaps the most effective way of forcing noise reduction upon employers would be to encourage and assist more employees to seek compensation for their loss, and thus bring home to employers (and insurers) the real cost of their noisy practices.

Although the levels set by industrial health legislation have no legal effect in relation to workers' compensation, it is possible that they will have considerable effect on workers' compensation tribunals having to decide whether a particular hearing loss was induced by noise in the course of employment. In this way employees whose exposure has not exceeded the 90 dBA may find it difficult to convince tribunals that their hearing loss arose from noise in the course of employment. It also seems highly likely that an employer who complies with the requirements of these new hearing conservation regulations will rarely be found liable in a common law action for negligence or nuisance. On the other hand, wide application of a 90 dBA level may lead to some employers being held liable where inexpert courts or tribunals might otherwise have been too timid to condemn a factory as too noisy. Of course, the levels will have direct application to actions for breach of statutory duty; breach of the levels or other requirements in regulations may render the employer liable to the employee for damages.

Another significant weakness in most of the regulations is that they do not make sufficient provision for mandatory disclosure to employees of noise level readings and audiometry results. The Agency will not have adequate resources to police the regulations widely; a Victorian expert has said that in the early years the Agency will be fully occupied dealing with employers who frequently exceed 95-100 dBA and will have to ignore employers who exceed the limits less drastically.[23] In this situation it becomes vital to provide employees with full access to the necessary information so that, with or without Agency endorsement, they can bring pressure to bear on their employers to comply with the law. Although the regulations envisage mandatory marking of "noise risk areas", they unfortunately do not require automatic disclosure to employees (without awaiting a request) of all level and dose readings and audiometry results. Also, there is no mention of continuous, visible noise monitoring in high risk areas. A most effective method of noise control in such areas might be to require prominent warning devices indicating when excessive noise levels

have been reached.

Another important aspect of noise control in the workplace is imposing maximum noise emission levels for particular items of equipment, whether at the time of sale or in use. At present, most relevant law of this kind is in legislation aimed primarily at controlling community noise, and thus it will be dealt with in the next section. However, it may, and should, become a major weapon in the fight against occupational noise.

D. COMMUNITY NOISE LEGISLATION

For many years in each State there has been some legislation relating to community noise. Legislation concerning minor offences relating to "public order" may include offences such as "offensive or riotous behaviour", or "using a noisy instrument for the purposes of advertising", in a public place. In addition, local councils usually have extensive powers to prohibit or regulate unreasonable noise, whether by general ordinances or by resolutions concerning particular instances. However, even when these provisions might have been effective to control noise, little use has been made of them. Accordingly, as concern for the environment has grown in recent years, there has been a tendency to enact comprehensive legislation aimed specifically at control of community noise. Although this legislation is concerned primarily with the emission of noise in public places or from premises, including workplaces, it may also have considerable impact on noise levels within the premises and thus on occupational noise.

Except in the Territories, new community noise control legislation has been enacted throughout Australia during the last few years.[24] The following is a general summary of the main aspects of the legislation which affect noise created on premises at which people are employed. The Queensland legislation was passed in the last few weeks, is not yet in force, and was not available to me at the time of writing. Accordingly, it is omitted from the following summary.

1. Restrictions on Noise Emission from Premises

Each of the new Acts puts restrictions on noise emission from premises. In New South Wales and Tasmania, the legislation does not specify particular maximum levels for emission. Thus, in New South Wales the prohibition is on "offensive

noise", which is then defined as "noise that by reason of its level, nature, character or quality or the time at which it is made, or any other circumstances, is likely to be harmful or offensive to, or interfere unreasonably with the comfort or repose of, people outside the premises". In Tasmania, the prohibition is on noise of a "volume, intensity or quality that is harmful to, or offensive to the senses of, any person outside the premises", and noise that is "capable of either directly or indirectly prejudicially affecting the health of, or occasioning offence, distress or irritation to, man".

In Victoria the legislation envisages the specification of precise levels rather than a subjective criterion, but no levels have been prescribed as yet. Western Australia adopts a position half-way between subjectivity and precision. Its Act prohibits noise which is "injurious or dangerous to health, or which occurs or continues to such a degree and extent that it has a disturbing effect on the state of reasonable physical, mental or social well-being of a person", but goes on to prescribe "acceptable" levels for different types of locality such as "rural" (40 dBA), "residential with heavy industry" (65 dBA) and so on. The Act then provides that if the emission exceeds these acceptable levels by more than 10 dBA, it is presumed to contravene the subjective test mentioned above, unless there is significant evidence to the contrary.

The Western Australian law was based on the Standards Association's Standard AS1055, entitled "Noise Assessment in Residential Areas", published in 1973. However, that Standard was amended in 1978 and now provides for the background level to be measured in the particular instance, rather than prescribed by statute, and says that noise is "likely to be annoying" if it exceeds the background level, but that "excesses of 5 dBA or less may be of marginal significance". Apparently, the relevant Agency in New South Wales is adopting a similar approach in interpreting the statutory prohibition on "offensive noise", and the Western Australian regulations will be amended soon to follow the new Standard also.

In South Australia, the level of emission must not exceed whichever is the higher of the following two levels:

(a) 5 dBA above the measured background level at the relevant spot;

(b) a level prescribed in regulations for the relevant locality and time of day (e.g., the "rural or predominantly rural" levels are 47 dBA between 7 a.m. and 10 p.m., and 40 dBA at other times).

The South Australian regulations contain tables for adjusting measured noise levels to allow for tonal and impulsive components and for intermittency. They also contain tables adjusting permissible levels according to proximity to busy roads.

Another set of South Australian regulations prescribes levels for emission from premises in relation to particular types of equipment and times of day. For example, power equipment must not be used after 8 p.m. at night if it causes noise greater than 45 dBA to be emitted from the premises. Most of the equipment mentioned, however, is not of a type likely to be found on industrial premises. Similar legislation exists in New South Wales, Victoria and Tasmania but relates only to domestic premises.

In South Australia, Western Australia and under Standard AS-1055, the specified limits apply to measurement at the boundary of any residential premises (or, in South Australia, premises at which any person is regularly engaged in remunerative activity) affected by the noise, rather than at the boundary of the noise-making premises. They do not, therefore, apply to noise levels in public places.

In each State the Act envisages specific levels being set by regulations, with reference to particular localities, industries or times of day. As yet, no such levels have been set in relation to non-residential premises, other than in South and Western Australia to the extent mentioned above.

Generally speaking, breach of the subjective criteria or specific levels concerning noise emission from premises -

(i) constitutes an offence; and

(ii) entitles the Agency, or in some States a Court, to impose noise control measures.

(i) No offence will be committed if an exemption has been obtained from the Agency, or if the emission was due, for example, to some accident. In New South Wales and South Australia, no offence is committed unless the Agency has given the employer a warning, and the excessive emission has continued thereafter. In Tasmania, there will be no offence if the "best practicable means in current use have been used to prevent or minimise" the emission, or if there are no practicable means in current use and the noise-making activity "is reasonably done in the normal course of living, gaining a living, or enjoying the use of the land". In the other States it may be necessary to seek an exemption on these sorts of grounds rather than just rely on them if a charge is brought to court; if the Agency refuses the exemption and prosecutes for the offence, the employer will probably not be able to put similar arguments to the court. The factors which are likely to affect Agencies in each State in deciding whether to grant exemptions are similar to those which are prescribed for the purpose in the South Australian Act; namely

(a) the technical feasibility and economic cost of reducing the noise;
(b) the effect of the noise on people's health or safety;
(c) the number of people affected by the noise;
(d) the frequency and level of the noise; and the times at which it is emitted.

The maximum penalties for offences vary somewhat, but may be several thousand dollars, and in some instances there is an additional penalty of a lesser amount for each day during which the offence continued to be committed.

(ii) If an employer emits excessive noise from his premises, he can be required to introduce a wide range of noise control measures, and in some instances to comply with specific levels in relation to emission from the premises. Noise control requirements can also be included as conditions upon which exemptions are granted. Possible noise control measures are usually not listed in the legislation but may include sound-proofing, replacement or repair of plant, use of noise control equipment and so on. Depending on the State,

the locality, the industry and the time of day, these powers may be exercised by a Court, a government department, a statutory authority, or local councils. Appeals from these bodies may go to a Court or, in Victoria, Tasmania and Western Australia, to an Environmental Appeal Board, usually comprising a lawyer and two non-legal experts.

Breach of noise control requirements is an offence and incurs penalties similar to those mentioned in (i) above.

2. Controls on Noisy Industries

In New South Wales and Tasmania the legislation includes a list of types of industrial premises, such as quarries or cement works, which are particularly likely to cause pollution problems. These premises are known as "scheduled premises". In Tasmania, employers using such premises must pay annual licence fees, ranging up to about a thousand dollars, to the Agency.

In New South Wales the proposed licensing system has not yet been put into force, but alterations or additions to "scheduled premises" must be approved in advance by the Agency if they are likely to cause, or increase, noise emission from the premises. The Agency can impose noise control requirements when granting approval. In both New South Wales and Tasmania, scheduled premises are subject to the imposition of noise control requirements by the Agency regardless of whether they are emitting any noise.

3. Restrictions on Emission of Noise from Equipment or Vehicles

In each State, legislation gives broad powers to make regulations prescribing maximum permissible noise levels for various items of equipment and vehicles. By contrast with the South Australian regulations mentioned earlier, these levels are set by reference to a distance from the equipment, regardless of whether any of the noise is emitted from premises. The regulations may prevent the sale of equipment which emits noise above a prescribed level or may relate only to the actual use of equipment emitting noise above a prescribed level.

South Australia, Tasmania and Victoria have prescribed maximum noise levels for the use of motor vehicles, and most

States also have prescribed noise levels governing the sale of vehicles. The most comprehensive regulations are in Tasmania. They cover cars, motor cycles, buses and trucks, and specify lower levels for cars manufactured after various dates in 1979. New designs must get "type approval" before going on the market. In Victoria, by comparison, the regulations relate only to passenger cars, and do not set lower levels for vehicles built in the future.

Tasmania also leads the way in prescribing maximum noise levels for other types of equipment on industrial premises. Its levels apply to equipment such as power tools, compressors, generators and so on; lower levels are set for equipment manufactured after 1978. Most States have not specified levels affecting the use of equipment on industrial premises.

E. PLANNING AND DEVELOPMENT LEGISLATION

In each State and Territory there is legislation giving government departments, statutory authorities and local councils various powers to control the use of land. Usually, these Agencies can apply noise control policies in the course of regulating building processes or deciding whether to grant development consent. This power is being used with increasing frequency either to refuse consent for a particular development or use of land, or to impose conditions upon the consent, because excessive noise is likely to result. The conditions may include noise emission levels, engineering and construction requirements, restrictions on the nature and duration of activities on the land, and so on. Designation of land use zones, such as residential or light industrial, is based partly on noise factors, but even within a particular zone a building or land use proposal may be rejected due to noise factors. Recent examples include proposed quarries and social clubs being rejected, and a child-minding centre being required to restrict its opening hours and the number of children using the playground at any one time. In some instances, councils have approved buildings on condition that the heavy equipment used in construction must not emit noise above specified levels.

One of the best solutions to noise problems is to avoid them by appropriate planning and development policies. Some

relevant Agencies, especially in Victoria, are taking a greater interest in this approach, but in most places it needs much more attention.

F. CONCLUSION

There is a very wide range of law relevant to occupational noise. Much of it has existed for many years but has not been used very effectively. During the last few years there has been a burst of legislative activity in relation to noise and other types of pollution. The new laws have many failings and many of them display disturbingly inept draftsmanship. However, they provide many opportunities for effective control of occupational noise. The major question now is whether there is sufficient political and public will to enable these opportunities to be grasped. Unfortunately, several recent events, most notably the failure to endorse the 85 dBA Daily Noise Dose recommended by the National Health and Medical Research Council, cast doubt on the strength of Government commitment to noise control. In this situation, the legislation, and the Agencies concerned with applying it, should put more emphasis on measures designed to inform employees and the general public of the noise hazards to which they are being subjected, and to enable them to take a role in the policing and enforcement of noise control laws. For example, employers should be required to measure noise regularly and to disclose the results to their employees; in particularly noisy areas, there should be continuous, visible monitoring to indicate whether prescribed levels are being exceeded.

I must re-iterate that the preceding summary of Australian laws relating to occupational noise is very broad and general. Some very recent legislation was not available to me, some proposed rules remain only in draft form, and there is considerable ambiguity in many other provisions. These factors, together with the wide variations between legislation in the various States and Territories, have forced this paper to be a rough overview rather than an attempt at a definitive and comprehensive statement of the law.

REFERENCES

1. The views expressed in this paper are personal, and are not to be attributed to the Commission of which he is a member. The Commission is not conducting any work on the topic of occupational noise or any other topic related to noise. Ms. Janette Nation has given considerable assistance in the collection of material for this paper.

2. This area of law is highly confused. For a recent case, see Neville Nitschke Caravans (Main North Road) Pty. Ltd. v McEntee (1976) Vol.15, South Australian State Reports, page 330.

3. E.H. McLeod v Rub-a-Dub Car Wash (Malvern) Pty. Ltd., Victorian Supreme Court 1972, judgment of Mr. Justice Stephen, page 8.

4. R. v Fenny Stratford Justices, ex parte Watney Mann (Midlands) Ltd. 1976 Weekly Law Reports, Vol. 1, page 1101.

5. See, for example, the cases mentioned in footnotes 2 and 3 above, and also Oldham v Lawson, Victorian Supreme Court 1976, judgment of Mr. Justice Harris.

6. The relevant principal legislation is:

N.S.W.	- Workers' Compensation Act 1926
Victoria	- Workers' Compensation Act 1958
Queensland	- Workers' Compensation Act 1916
South Australia	- Workmens' Compensation Act 1971
Western Australia	- Workers' Compensation Act 1912
Tasmania	- Workers' Compensation Act 1927
A.C.T.	- Workmens' Compensation Ordinance 1951
N.T.	- Workmens' Compensation Ordinance 1949
Commonwealth	- Compensation (Commonwealth Government Employees) Act 1971

   For a general comparative summary of the legislation, see Conspectus of Workers' Compensation Legislation in Australia, published annually by the Commonwealth Department of Social Security.

7. In Queensland this has to be a total loss of earning power.

8. In Tasmania this lump sum is due only if there has been a loss of earning power.

9. For detailed figures in the various systems, see the Conspectus of Workers' Compensation Legislation in Australia.

10. National Acoustic Laboratories, Procedure for Determining Percentage Loss of Hearing (1974)

11. In Western Australia, this onus perhaps applies only when the hearing loss led to a loss of earning power.

12. See Workers'Compensation Act 1927, 1st Schedule, Rule 7.

13. Support for regarding the employer as having a legal onus, even where this is not expressly stated in the Act, can be found in the judgment of Chief Justice Barwick in Sadler v Commissioner for Railways (1969) Volume 43, Australian Law Journal Reports, page 393. An interesting provision to be noted is section 31 of the Compensation (Commonwealth Government Employees) Act 1971.

14. See Sadler's Case mentioned in footnote 9 above.

15. In Western Australia, this onus perhaps applies only when the hearing loss has led to a loss of earning power. In a recent case, reported in the West Australian on 10th May 1978, the W.A. Supreme Court apparently held that under the W.A. legislation there is a further hurdle, namely to prove that the loss resulted from a "personal injury by accident". Under other systems such a loss is usually deemed by statute to comply with this requirement. The Court said that this was not the case in W.A., and that a gradual hearing loss did not satisfy the requirement. Amendments to the Act will be necessary to enable claims to be made successfully for gradual hearing loss.

16. In some systems, if the hearing loss led to a loss of earning power the former loss is deemed to have occurred whenever the latter occurred. In New South Wales there is some doubt as to whether the employer needs to be a "noisy" employer. In Western Australia and the Northern Territory the employer can avoid liability if he can prove that the hearing loss occurred during employment by another particular employer.

17. In South Australia, the relevant regulation used to be Regulation 49 under the Industrial Safety, Health and Welfare Act 1972. In 1978 this regulation was repealed and replaced by Noise Control (Hearing Conservation) Regulations under the Noise Control Act 1977. In Queensland, the regulation is the Hearing Conservation Rule under the Factories and Shops Act 1960. The Victorian regulations were made in August 1978 under the Health Act, and a copy was not available to me at the time of writing. For a discussion of the contents of these regulations and the draft regulations from other States, see the Standards Association of Australia publication, Seminar Papers on AS1269 SAA Hearing Conservation Code, October, 1977.

18. In Queensland there is no need to obtain exemption but the employer must notify the Agency that he is exceeding the limits and must indicate his noise reduction and hearing conservation programmes. The Agency then has the same powers as in those States where an exemption from the Agency is necessary.

19. See, for example, the figures in the Standards Association of Australia, Hearing Conservation Code (AS1269), p.29.

20. In England the level is in an advisory Government Code of Practice, rather than a compulsory law. In the United States it is prescribed under the Occupational Safety and Health Act 1970.

21. For a discussion of legislation in countries other than Australia, see, for example, H.H.E. Schroder, "Noise Control Legislation" (1977) Vol.10, Comparative and International Law Journal of South Africa, page 67. Some of the following material in this paper is drawn from this article.

22. For some overseas estimates see the article by Schroder mentioned in note 21 above, and the U.K. Noise Advisory Council, Noise in the Next Ten Years (H.M.S.O., 1974).

23. See the paper by R.G. Barden in the Seminar Papers referred to in note 17 above.

24. The principal relevant legislation in the various States is:-

New South Wales	- Noise Control Act 1975
Victoria	- Environment Protection Act 1970, Environment Protection (Noise Control) Act 1975, Environment Protection (Motor Car noise) Regulations 1976
South Australia	- Noise Control Act 1977, Industrial Noise Control Regulations 1978, Road Traffic Act Regulations 1961, Machine Noise Control Regulations 1978
Western Australia	- Noise Abatement Act 1972, Noise Abatement (Annoyance of Residents) Regulations 1974
Tasmania	- Environment Protection Act 1973, Environment Protection Act 1977, Environment Protection (Noise) Regulations 1977
Queensland	- Noise Abatement Act 1978

Discussion

Mr. Sharp: Would a successful action at workers' compensation prevent a subsequent action at common law?

Mr. Disney: The answer is no, basically. You could try both of them but by and large if you get something from a common law action you won't get workers' compensation.

Mr. Wyndham: If a government department succeeds in an action for a breach of regulations, where often the penalties are very low, and the person being proceeded against decides that it's cheaper to pay the penalty than do anything about the problem, what legal action can you take against them?

Mr. Disney: You may be able to proceed under the common law. It's a bit complex but there are various areas and various respects in which you can try to get an injunction to prevent them from going on and then if they break the injunction they're in contempt of court and the penalty can be increased. There is no limit on the penalties you can get in court so you may be able to increase them in that way.

Mr. Riley: This is not in the nature of a question but I would like to say that I am fairly optimistic about the effect of these regulations which are being brought into force. In my office we know of five very large manufacturing organisations in Victoria who, without waiting for the regulations to come out, have instituted comprehensive audiometric surveys of all employees and also have made a very satisfactory start on noise control measures within their industries to get the level down to 90dB(A). In some cases they have taken note of the recommendations of the National Health and Medical Research Council that the ultimate level should be 85dB(A), so I think that by and large things are beginning to move.

SURVEYING AND ASSESSING OCCUPATIONAL NOISE
DOLLARS AND SENSE

by

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It may seem that noise control engineering is a straightforward process. Job experience proves it to be otherwise.

The most important task in establishing a Hearing Conservation Programme must be to firstly determine where and how much noise control is necessary to eliminate employees' hearing hazard, where the hazard is defined by legislation.

Only after the problem has been fully and accurately defined can objective decisions be made on engineering, administrative and personal protection controls to provide the optimum overall solution.

The economy results from doing only the detailed engineering and noise control treatments necessary to comply with legislative requirements. Overspending by too much or too little noise reduction is avoided.

Why Noise Control at All?

In New South Wales, draft Hearing Conservation Regulations have been prepared by the Department of Labour and Industry for implementation under the Factories, Shop and Industries Act.

The legislation if successful will require the Employer:

- to determine if any of his employees are exposed to a noise level or daily noise greater than that specified.

- to ensure that no person employed in any factory shall be exposed at any time to a noise level exceeding 115 dB(A), or to a daily noise dose which exceeds 1.0 (equivalent to 90 dB(A) for 8 hours).

In other words, Management of all factories, large and small, will be responsible for protecting the hearing of their employees.

The legislation will require comprehensive noise surveys to be carried out by management to determine exposure hazard of employees, and the extent of the company's noise problem. For an industry found to be noisy it will require the introduction of a Hearing Conservation Programme.

The three key elements necessary for a total Hearing Conservation Programme are:

- hazard determination
- engineering and administration noise controls
- hearing protection programme

Hazard Determination

To the noise control engineer, hazard determination is more than just establishing an employee's noise dose according to the law. It is equally necessary to determine the locations contributing to the employee hearing hazard, and the noise reduction necessary to eliminate the hazard.

Determining who is in hazard leads to locating where hazard occurs. Establishing the hazardous location, with its design goal for sound level reduction required to eliminate the hazard, is one of the most important parts of economic noise control engineering.

Noise control at the proper location, for only the required reduction, eliminates the need to reduce all machine noise down to some arbitrary level, simply because the machines are noisy.

Hazard determination, then, should include identification of employee exposure to noise, a priority list of hazardous locations, and design goals for the minimum amount of noise reduction required at these locations.

Engineering economics demand that you should know in what order the hazardous locations should be worked on, and the minimum noise reduction required at each location to eliminate it as a hazard.

Making Sense of Measurements

Before planning the survey of your factory, it must be perfectly clear that you should commence with an occupational noise exposure or employee hearing hazard survey, not an engineering noise survey. As previously explained the occupational noise exposure survey is essential to define your problem, and in any case is required under the legislation.

The engineering survey is a detailed study carried out for the purposes of noise control design, and is not necessary until after you have defined your noise control objectives as a part of the overall Hearing Conservation Programme.

A clear understanding of the distinction between a 'noise exposure survey' and an 'engineering survey' is essential, as on this understanding hinges the engineering success and economic benefits of a logically planned noise control project.

Occupational Noise Exposure Survey

Occupational noise exposure is expressed in terms of a daily noise dose, which takes into consideration the level of noise in dB(A) and the duration of exposure.

This involves measuring the various noise levels in dB(A) throughout the factory, determining or estimating the corresponding duration of exposure for employees, and then determining the noise exposure indices by adding the partial noise exposure indices together to obtain a representative day (see Fig.1).

The steps to this approach begin with an inspection of the plant operations by the noise control engineer. During this and subsequent walk-throughs, the engineer is alert to what people are doing, where and how, covering the whole production process. Interviews are conducted with supervisors and management to establish work time patterns for each employee. Employees with the same job title often have different exposure locations and durations, and this should be defined.

In establishing the A-Weighted sound level for each location or operation, it is important to realise that few industries exist that have one steady state noise level for all of their operations.

Therefore, variations in noise levels must be considered, and they must be related to the single day criteria.

Where noise levels are steady, they may be directly measured by a hand held sound level meter.

Where the noise level varies with time at a particular location, or for a particular operation, then the noise level should be assessed in terms of the equivalent steady state noise level L_{eq}, as measured directly by a statistical analysis sound level meter.

Although an employee's noise dose can be directly obtained with an audio dose meter, its use is not recommended for the original hearing hazard survey. A significantly changing work pattern over a finite time period requires many readings to properly define an employee's exposure, even if he is co-operative and is fully educated in its function and use. More important is the fact that the audio dose meter does not provide any of the crucial information about what equipment or operation is causing the hazard.

Assessing the Results

Employees and their work patterns are then summarised by job title, operations, locations, exposure times, and noise exposure levels. This information is combined in a tabulated format to develop the noise dose for each job title directly related to each employee. Noise doses are calculated in accordance with the Australian Standard 1269-1976. That is, a Daily Noise Dose of 1.0 is equivalent to 8 hours at 90 dB(A); and a Daily Noise Dose of 0.33 is equivalent to 8 hours at 85 dB(A).

We have found that a most useful method of analysis is to evaluate exposure in terms of 'Noise Dose per Hour', as derived from Fig.1 to give the values shown in Table 1 overleaf.

For each separate 'Operation/Location' in the various work areas the following information is listed into the Summary Table for the project.

- Equivalent continuous noise level L_{eq} or steady dB(A) level for that 'Operation/Location' (from survey results).
- The 'Noise Dose per Hour' from this L_{eq} exposure (from Table 1).
- Hours of exposure per Shift (from supervisors).
- Resulting contribution to Daily Noise Dose.

TABLE 1

Exposure Level	Noise Dose per Hour	Exposure Level	Noise Dose per Hour
85	.041	95	.40
86	.052	96	.50
87	.062	97	.66
88	.083	98	.80
89	.100	99	1.00
90	.125	100	1.32
91	.165	101	1.60
92	.200	102	2.00
93	.250	103	2.64
94	.330	104	3.20

Thus, the Summary Tables provide the base information to readily calculate the Daily Noise Dose for any Employee, either for 8 hours continuous exposure to one 'Operation/Location', or for a composite 8 hour day, comprising a number of different 'Operations/Locations'.

To calculate the total Daily Noise Dose for an employee, simply multiply the 'Noise Dose per Hour' by 'Hours of Exposure' for each of his Operations/Locations, to a total of 8 hours exposure per day. The summation of the result gives the Daily Noise Dose for that employee.

A typical case history Summary Table will demonstrate the procedure for three employees operating a large, multi-step production unit.

	Operation/ Location	L_{eq} dB(A)	Noise Dose per Hour	Employee	Hours Exposure per Shift	Daily Noise Dose Contribution
1.	Control Panel	87	.062	A	5	.31
				B	3	.19
2.	Feed Position	98	.80	A	1	.80
				B	1.5	1.20
				C	3	2.40
3.	Delivery	91	.165	B	3	.49
				C	4.5	.74
4.	Break Area	101	1.60	C	.5	.80
5.	General Area	94	.33	A	2	.66
				B	.5	.17

Considering the exposure profile of each employee gives the following Daily Noise Doses, related to work stations, for comparison with the Criteria Dose of 1.0.

Employee	Noise Dose Contribution					Daily Noise Dose
	Loc'n.1	Loc'n.2	Loc'n.3	Loc'n.4	Loc'n.5	
A	.31	.80			.66	= 1.77
B	.19	1.20	.49		.17	= 2.05
C		2.40	.74	.80		= 3.94

Not only does this method establish real daily noise dose, but more importantly, it clearly established the operation or equipment which is causing the hazard.

The noise exposure survey has now:

- Identified employee exposure to noise
- Established a priority list of hazardous locations
- Defined noise control design goals for the minimum amount of reduction (if any) required at each location.

Strategic Planning

The basics of the problem having been fully and accurately defined by the noise exposure survey, the strategic planning of the Hearing Conservation Programme may proceed.

Objective decisions can now be made on engineering, administrative and personal protection to provide the optimum 'value-for-money' noise control programme.

The priority list is the valuable tool and key to success. It points out which areas and machines deserve first attention if noise control expenditure is to have the greatest effect.

The strategic planning of the project, which makes use of the priority list, will be organised around a list of design goals - the minimum noise reduction requirement at each location, for each machine or operation, to accomplish the overall goal of bringing all the employees below a noise dose exposure of 1.0.

It will become apparent for noise sources near the top of the priority list, that noise reduction at one location to bring one employee out of hazard may also reduce the dose received by other

employees, sometimes to the extent that no reduction at all will be required at other locations on the priority list. Again, a number of locations near the bottom of the priority list may well have design goals of zero. The economic implications are obvious, as in general, the greater the noise reduction required at any location, the higher the cost will be.

Where the dose exceeds the criteria, then one or more of the following methods is used to achieve the required noise dose -

* engineering noise controls to the source, or between source and receiver
* administrative controls to limit daily exposure of employees by control of the work schedule
* issue of suitable hearing protector devices

You can now detail your Hearing Conservation Programme knowing where you are heading and how to get there. In this way, both the noise control engineer and management will have control of the programme, and can budget costs and allocate time and effort to best suit the operations of the company.

In addition, this creates a time frame in which the noise control is to be accomplished.

You have established, on a dB for Dollars basis, where you are going and how you will get there.

Engineering Surveys

When engineering design is chosen as a means of reducing employee noise hazard, it is usually necessary to carry out narrow band frequency analysis of the noise emission from the machine or operation in question. The specific purpose is the development of the most economic and practical noise control methods that will attain the desired noise reduction goal.

The principles of noise control in industry are well established, and there is a wide range of back-up expertise available from Acoustical Product Suppliers, specialist Contractors and Acoustical Consultants.

It requires a great deal of experience in acoustical engineering to design, time and cost estimate, and implement noise control treatments if overspending by too much or too little noise reduction is to be avoided.

Survey Records

An additional function of the original noise exposure survey is to clearly and accurately define the existing baseline noise exposure situation for all work operations and locations throughout the factory. This baseline information should be recorded with full details of plant operation and test conditions for future reference. The progress of the Hearing Conservation Programme will be plotted against these baseline values.

Additional reference measuring locations are frequently selected to more fully define the acoustic environment throughout the whole work place, as well as the immediate vicinity of machines. These locations are usually on an easily repeatable grid system, say at 3 metre centres, or as defined by structural and architectural features of the building.

These readings can often be combined to produce noise level contours within the work place. Noise contour charts can be extremely useful in helping to establish the priority list of noise sources in the building. For this reason, their use should be seriously considered in the early stage of the investigations as an extension of the noise exposure survey, particularly in large factories or multiple noise source zones.

For similar reasons the engineering survey, which is carried out in terms of octave or 1/3 octave band readings, is often extended to produce noise contours (on an octave band basis) around a particular machine or operation which is being evaluated for noise control design. This type of noise contour survey should be restricted to individual critical noise sources, as field experience has given no justification to extend the survey to include the whole work place.

Acoustic Instrumentation

The measurement instrumentation to be used depends on the information needed, type of survey, size of factory and workforce, number of noise source machines and operator locations.

The skill and experience of the person carrying out the noise measurements must not be in question, as major engineering and economic decisions will be made on the results he produces. For small factories, or areas in which the noise level is steady, it is reasonable to use a dB(A) scale meter for the occupational noise survey.

At locations where an employee is exposed to a time varying noise level, it is always preferable to carry out a direct measurement of noise dose (in terms of L_{eq} dB(A)) using a statistical analysis type of precision sound level meter.

Engineering surveys for noise control design purposes require the investigation of complex noise sources, usually dominated by discrete frequencies, and narrow band analysis equipment is a necessity. Depending on the noise source, this could include portable precision sound level meters with octave or 1/3 octave band facilities, discrete frequency analysers, chart recorder, vibration pickup and oscilloscope.

The use of a dose meter is not recommended until after a Hearing Conservation Programme has been successfully planned and established, and employees have been educated into the programme, and trained in the purpose and use of the dose meter. At this stage of the project a dose meter can become an extremely useful tool for monitoring a wide range of employees, particularly those who are potentially most exposed to high noise levels, on a continuing basis. At the same time, it is monitoring the progress of the overall Hearing Conservation Programme.

A most useful tool for any size company at any stage of the project is a portable sound level meter. For small companies a simple A scale meter is satisfactory, whereas for larger organisations the additional cost of a meter with octave band facilities is probably justified. The instruments purchased should comply with the requirements of the relevant Australian Standards, and must be accurately maintained in calibration at all times.

The cost probably prohibits all but the largest companies from purchasing the necessary instrumentation to carry out both their occupational noise exposure surveys and follow-up engineering noise control surveys. In most cases the back-up facilities of outside Specialist Consultants will be required for some part of the investigations, particularly where their expert involvement can be beneficially extended into the more difficult noise control problem areas.

Summary

To achieve compliance with the regulations and to protect employees' hearing at minimum cost requires a total, well thought out Hearing Conservation Programme, carried out under the control and

direction of an experienced engineer with the full backing of management. The key to success if based on an occupational noise survey to firstly establish exposure, and to identify the rank noise sources. The 'Dollars and Sense' value is the engineering and economic savings to be gained by meeting the legislative criteria with the minimum noise controls to eliminate employee hearing hazard.

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1. Australian Standard AS1269 'Hearing Conservation Code'.

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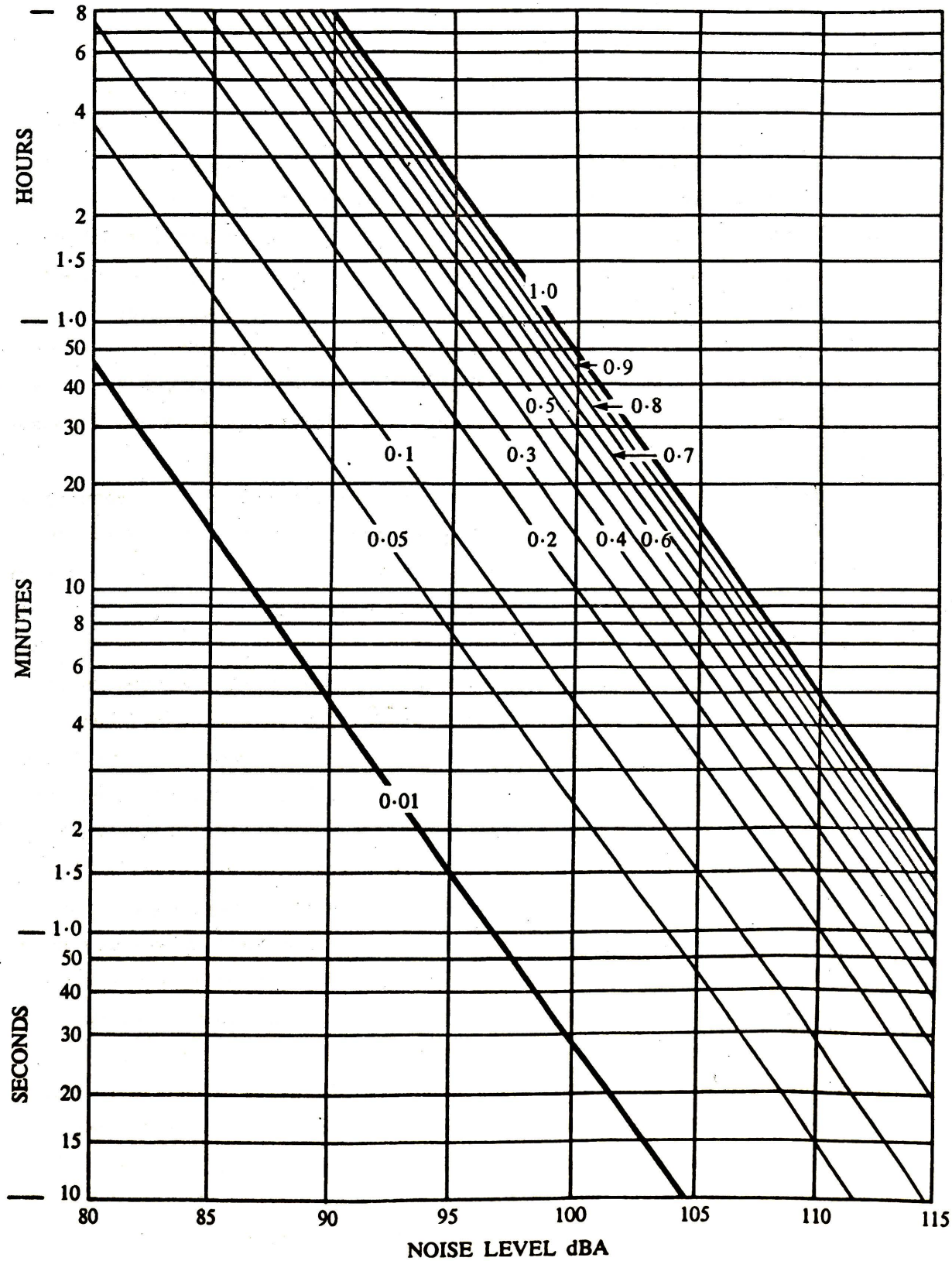
Daily Noise Dose Calculation Chart



Discussion

Mr. Cracknell: You mentioned the word practicality there, but you didn't pursue it. I'd like to ask how you go about measuring the amount of exposure of a particular employee when that employee could be moving about quite considerably. For example, I know of a case in a paper mill where it takes approximately 30 seconds to change a reel and in that 30 seconds the exposure in terms of noise level reaches 115dB(A). The other thing I noticed in your chart is that no account seems to be taken of lunch breaks, morning tea, clean-up, start-up, answering the calls of nature and so on. Also I'd like you to comment on the dosemeter, which is an instrument which can accumulate the dose a person is exposed to wherever they are and eventually produces a dosage reading.

Mr. Madden: In answer to the first part of your question concerning a man moving around from position to position, what you must do is establish a base work pattern for him. It may be 5 or 10 minutes, it may be an hour, but in any case it is basically a repeated pattern. If you can't do that then you can define areas that he is in for some period of time and fairly accurately time those areas. If he's moving around in some sort of pattern then you need a statistical analysis type of sound level meter which directly reads out the Leq and somebody has to follow that man through his tasks, a cycle of his tasks, to establish an Leq for it. Then you have an Leq for the task and the time of the task.

In establishing the exposure pattern of employees it's no good believing what management thinks because what they believe their men do is not necessarily what they actually do. You have to get out onto the floor to find out what the men do. You have to talk to the supervisors and the area managers and frequently the men themselves tp find out exactly what they do. Having established this, you may find that they have a break every half-hour and take 5 minutes - that's 10 minutes per hour by 8 times per day - and further you have to consider the noise level in the rest room since this can vary quite significantly too.

The third part of your question concerned the dosemeter. It is certainly a very useful tool but, I believe, after the hearing conservation programme has been established, not when you're trying to set out to establish the programme. It doesn't tell you where the noise is coming from, it doesn't give you the information that is on the chart I showed - all of those men coiuld have been wearing dosemeters and they would have shown Daily Noise Doses from 1 point something up to 2 or 3. Great. Now how do you go about solving the problem, that was

what I was trying to get at.

Mr. Cracknell: Could I come back on that by saying I think the way I would go about it would be to use a dosemeter first to find out if and where you have people with excessive doses and then go into a survey to find out where it's coming from.

Mr. Madden: Well, if you're starting an investigation in an area or a factory where there has been no previous investigation, where they don't understand what's going on, where you have no educational programmes - in other words the hearing conservation programme hasn't even started to get off the ground - they're frightened by these instruments, they don't know what they are and they don't know what's going on, you have to get the measurements carried out by people who know what they're doing, who can get through to the people on the floor to allay their fears in order to get meaningful measurements. Once you've got through all that part, once people know what the dosemeters are for and their benefit for them that's great, but otherwise you have all sorts of funny little things happening to the dosemeter.

Mr. Wilkinson: Jim, I was most interested to observe the simplicity of your calculated hourly rate dose. The question I wish to pose relates to the title of your paper, which says assessing occupational noise. I think in your address you have assumed that there is a problem in terms of a noise dose exceeding 1. In many real life situations there are employees exposed to noise levels only one or two of which are exceedingly high, say above 90dB(A), and in assessing that situation management has to decide that even though the Daily Noise Dose is less than 1 they will or they won't do something about these, as we'll say, excessive noise levels just on the basis of their annoyance rather than their potential for causing hearing loss. Does that situation coincide with your own experience?

Mr. Madden: Yes, I believe so. It's a management decision of course whether they are regarding a noise dose of 1 as being 90 or 85dB(A) or somewhere in between. They make that type of decision after they have this information. In the proposed legislation the responsibility is on management to ensure that each employee does not have a dose exceeding 1, so if you take that to its ultimate every employee has to be evaluated. You may find that a majority of them are exposed to a DND of 1 or less but management may also be interested to know how many are exposed to a DND greater than .33, so this information would be very useful from that point of view. I've had experiences where the people you least expect

to have a high noise dose are in fact amongst the highest noise-exposed in the factory. A typical case was in a very large factory with a lot of noise, mostly around 90dB(A), where two men in a control room turned out to have the highest noise dose of anybody in the factory. The simple fact was that even though they were in an air-conditioned control room at 65dB(A), every hour they had to go around and check a few thermometers and a few oil pressure gauges and while they were doing this they were standing something like 3 or 4 minutes next to a ball mill at 114dB(A). Everybody envied them - they had a beautiful job in an air-conditioned control room but in fact they were going deaf at a rapid rate.

MANAGING AN ENGINEERING NOISE REDUCTION PROGRAMME

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Whilst most engineers tend to think of engineering noise reduction in terms of nuts and bolts and bullswool, the practicalities of the situation are far reaching and more complex.

Engineering noise control, whilst practical, is expensive and can in many circumstances result in marginally profitable industries becoming uneconomic in the face of imported products produced where noise criteria is not an economic factor.

This paper looks at the problems of implementing engineering noise reduction from a management, economic and technical standpoint and presents a planned approach based on our experience in a wide sample of Australian and overseas industries.

Introduction

Over the last fifteen years, all of us involved in engineering noise control have changed our approaches based on the pragmatic practicalities of the Australian industrial scene.

The reasons for this pragmatism relate to a re-assessment of the basic values and factors of our society and the technical philosophy of our clients or employers.

To judge from many technical blurbs, text books and learned papers, a noise reduction programme consists of lagging, enclosing, fitting mufflers, providing constrained layer damping and isolating machines on spring and rubber bases. This was basically the approach that was applied by most practitioners in the sixty's and by many in the seventy's.

This approach has been likened by many people in the top echelons of management to a *"band aid"* approach that is unproductive, adds additional cost, reduces acceptability and visibility, causes safety hazards, reduces reliability and has little or no positive pay back.

The practitioners will counter these statements with the viewpoint that this approach utilises well-proven techniques, is fairly straight forward in its application, and could even be costed out with reasonable accuracy before the project goes to tender.

Management is always quick to counter that this type of noise control procedure always results in an unfavourable impact on other aspects of the machine and its operation and always makes the machine more expensive.

The concept that a change of design to reduce noise can solve other problems at the same time, and may actually make the machines less costly to produce would, in most cases, still appear to be a case of *"wishful thinking"* (or a case of *"a theory looking for validation"*). Notwithstanding the *"pipe dreams"*, there are many good examples both here and overseas to support the concept that a properly managed engineering noise reduction programme, backed up by sensible research can lead to better solutions. Even so it is particularly hard to assign realistic costs and cost advantages resulting from a fully researched re-design of a process or plant.

In the sixty's and early seventy's, there were many examples of ad-hoc acoustical treatment to noise problems experienced by Australian industry. The solutions were badly researched, some of the approaches ill-conceived and the results were often poor. The basic premise put forward by engineers and middle management was that what was wanted was a quick solution for minimum cost. The implications of performance, service life and the possibility of secondary benefits resulting from the solutions were all but ignored in the rush to keep the documented accounting costs to the lowest possible level.

There are very few cases in this country where firms were prepared to sponsor exhaustive investigations or determine the complex inter-relationships between noise source generation and the associated cost benefits of rationally planned engineering noise control.

Out of fairness to the firms concerned, it must be pointed out that in very few cases was management able to see the need. The legislative and social pressures were not yet sufficiently strong to assist the responsible engineer or administrator to justify the costs that were involved in such a programme.

That situation has now changed, not just in Australia, but also overseas. With it has come a new awareness and better understanding of what is involved in a properly planned programme. This now means the highest incremental (or differential) noise reduction per dollar spent, or the best performance at the minimum operating cost or, the exact amount of treatment to *just achieve the specified criteria.*

Implementing an Engineering Noise Reduction Programme

One of the most basic steps in implementing an engineering noise reduction programme should, ideally, take place at the procurement stage of new equipment. All new plant should be procured with the tender documents containing the relevant acoustical criteria in clear concise terms. The documentation must be based on rational, achievable and, hopefully, justifiable criteria.

In the late sixty's and early seventy's many Australian firms and quite a few consultants wrote *"pie in the sky"* clauses into documents expecting manufacturers to be able to change basic technology and to modify standard production equipment at the drop of a hat. Such approaches are totally impractical and result either in the standard *"waver clause"* or a *"decline to tender"* response. What should have been requested were cost differentials for various stages of noise reduction as well as for basically unmodified units for comparison purposes.

There are a number of basic steps involved in implementing a noise reduction programme. If we restrict ourselves to industrial noise then the steps become illustrative of a set piece or scenario with which many of us are quite familiar.

The first step is for management to be aware of, or accept that a problem exists. Today this generally comes as a result of a complaint from middle management, staff, neighbours, and on some occasions, the State Pollution Control Commission or Environmental Protection Agency. Equally important is the realisation that there are now legal *"big sticks"* hanging over the heads of firms who do not respond in the appropriate manner.

The second step is for management to decide who they will use to assist them in an area where they are technologically ignorant.

In the past if there was any sort of operational problem management would have automatically turned to the plant engineer with their acoustical problem and said *"fix it"*. After letting the plant engineer play around with it for a while without necessarily fixing it, they would probably have tried another solution such as calling in a firm of package dealers who offer to *"design and construct"*. Alternatively they might have called in an experienced acoustical consultant whose independence, ability and experience are an advantage.

Let us examine the *"pros and cons"* of each of the above approaches:-

The plant engineer has had much to answer for in the past because of his inexperience in acoustics. The path to his solution was often strewn with failures. The cost in time and funds was often embarrassing to both the engineer and to his employer.

The package dealer can offer his experience, and hopefully his integrity. In many cases his desire to use his own products may unfortunately limit the scope of many of his solutions. Even if his experience is wide, his costs may not be lower than the next alternative.

The consultant offers his independence, his integrity and his ability to select solutions and products from the full range available. After his chosen solution is documented he is able to offer the price advantages accruing from open tendering and bidding.

Irrespective of which of these three groups management may utilise, it is important that they should consider the following steps:-

(1) Before allocating resources or funds for such a programme, they need to know the extent of their involvement. They also need to know the likely costs so that they can allocate the necessary funds.

(2) The priorities of the problem need to be determined and the resources and time allocated accordingly.

(3) If the problem is a hearing conservation problem, the questions of compensation, audiometry and both short term and long term goals need to be considered.

(4) If the problem is associated with community noise standards, the implications of shift times, transportation noise, tonal and impulsive characteristics of noise emitted have to be considered. Often, re-scheduling the noisiest operations to other times or locations is a practical solution. The building enclosing the factory, the processes involved and the proximity of the neighbours to the site are only elements in an equation. The catalyst is money which always seems to be in short supply.

The factors involved may be not only technical but also political and social as well. For example, a frequently encountered political problem is how to explain the implications of meeting noise criteria which may seen unjustifiable to management. They often tend to believe that the *"foreground"* noise due to passing traffic for example is more significant than the steady *"background"* noise due to factories and the like.

In the social sphere it is often very difficult to justify hearing conservation criteria to management where staff already wear hearing protection. There are firms where it is almost impossible to provide practical or economical noise control and where the staff are already in the final stages of advanced noise induced deafness. What has happened in these industries, which produce impulsive peaks in the 140 to 150 decibels range, is to do nothing because the costs appear to be ridiculously high. Instead they choose to pay compensation as this may only cost $3,000 - $4,000 per employee.

It is a salutory thought that *"noise induced hearing loss tends to fall most heavily on those in our society with very few other resources to lose"*.

The Costs of Engineering Noise Control

The costs of engineering noise control appear to most management to be totally unjustifiable as there is no *"pay back"*. All too often consultants or management may find themselves in a situation where the costs of solving the problem appear to be out of all proportion to either the benefit or the viability of the plant.

In the last few years we have seen increasing numbers of cases where industries have closed down rather than go through the rigours of implementing an engineering noise control programme which they believed that they could not afford.

It is an equally salutory thought that the majority of imported products with which Australian manufactured products have to compete are not restricted by the economic penalties resulting from expensive engineering noise control programmes.

The Problems and Solutions of Engineering Noise Control

The acoustics engineer invariably finds a multitude of technical problems. These require all his technical knowledge and experience to provide solutions. Whilst the text books and learned papers are full of standard procedures based on:-

(a) reduction of noise at the source;
(b) reduction of the noise in the path;
(c) reduction of the noise at the ears of the listener;

there are many other solutions involving variations on and combinations of these themes which the acoustical engineer must evaluate in order to provide better solutions.

The best solutions result from lateral thinking and their application is not tied to any one person or firm, in fact, more often than not they may be suggested by the people who have commissioned the study. The client has a unique understanding of the principles and problems associated with his particular process and frequently provides the catalyst needed to gell the best solutions.

The most critical aspect of a plant engineering noise reduction programme is the complete assessment of what has been achieved and at what cost at the end of the programme. All too often in this country after having paid for the technical report or having called tenders and purchased the equipment, the final step of total assessment of what has been achieved is neglected by management. In many cases it is avoided as an unnecessary additional cost. This practice appears to have been more prevalent in this country than in others. It positively robs the acoustical engineer of his chance to get the feed back on the overall performance and efficacy of his design.

Equally importantly, it foils the engineering management's and the accountant's chance of determining the real costs in terms of what benefit was achieved.

Conclusion

The next decade promises to be far more exciting and technically demanding than the last. Firstly, the acoustical engineer will have to provide better solutions for less money. The clients are becoming brighter and many are more educated than they used to be. They not only know what a decibel is, but also will discuss criteria on equal terms with the acoustician.

The situation of clients not wanting to spend money on follow-up reports is now starting to be replaced by the client doing his own follow-up report to check up on what he has actually received for his money.

The package dealer and the consultant had both better be on their toes for the next decade is going to make demands on both of them which will be totally different from the last decade's.

Discussion

Mr. Challis: I'd like to take this opportunity to elaborate on a point I touched upon briefly in my paper, when I remarked "It is a salutory thought that noise-induced hearing loss tends to fall most heavily on those in our society with very few other resources to lose". I fear, in the rush to continue on with the paper, that this point may not have received the consideration necessary. It's more true of countries like America than it is of Australia, where you find people from Mexico, Costa Rica, Bolivia and other countries who sneak in across the border and are what I'll call second or third rate citizens, being converted into the cannon fodder of industry and they are generally given the lousiest, dirtiest, nastiest work to do, because they are regarded as lacking the social strength and economic support to protect themselves from unscrupulous employers.

These people who really have the least to lose as well as not being able to speak the language lose their ability to be able to hear it. Over the last twenty years in Australia new Australians in the steel industry, in the mining industry and in other industries where hearing conservation has been at a low priority, have found themselves in exactly the same position. They who I regard as having the least to lose, in that they do not already know the language, are more likely than not to be those who are penalised by losing their ability to ever learn the language properly because they've lost a large and significant proportion of their hearing. So I want to re-stress that concept, that it is a salutory thought that noise-induced hearing loss tends to fall most heavily on those in our society with very few other resources.

MANAGEMENT OF A HEARING PROTECTION PROGRAMME IN A MINING COMPANY

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In the mining and mineral processing industry, certain processes involving rock breaking and haulage are associated with higher noise levels and engineering noise controls have generally proved impractical or impossible. Until equipment manufacturers become aware of the need for hearing conservation and design quiet machinery, personal hearing protection is the only way of avoiding hearing damage, especially in those operators using pneumatic or diesel equipment.

The methods of choosing suitable hearing protection, and their advantages and disadvantages are described. The problems of successfully implementing a hearing conservation programme, with respect to education and area classification, and of operator acceptance of hearing protection are described.

INTRODUCTION

Mount Isa Mines Limited operates a copper and lead-zinc-silver mine and smelter complex at Mount Isa, in north western Queensland. Some 5000 employees work for the Company, including approximately 2000 men in mining and support services underground and 500 men operating the ore concentrating plants and smelters. The Company has to provide much of the essential infrastructure which industries in more populated centres would normally expect to be provided externally. These facilities include electrical generating plant, mobile equipment servicing and workshops, and water supply.

NOISE CONSERVATION PROGRAMME

Mining and mineral processing have traditionally been very noisy industries. With the introduction, over recent years, of larger and more powerful pneumatic and diesel equipment, noise levels in certain areas underground have increased. Conversely, in other areas, eg, in the ore concentrators, the use of automatic control has insulated the operators in sound attenuated control rooms.

The Company has pursued an active hearing conservation programme for about 15 years. A Noise Control Committee containing Engineering, Purchasing and Occupational Health personnel was established to set up a hearing conservation policy and practicable programme for the Company. The main aspects of this programme are:

1. A policy of preferentially purchasing new plant and equipment with, where neither performance nor costs are greately adversely affected, the lowest noise level. The main aim is for plant emitting noise at 90 dB(A) or less. This policy, however, is often thwarted because many equipment suppliers, in many cases merely Australian agents for overseas manufacturers, have often ignored the noise specification clauses, were unaware of noise levels of the equipment, or unaware of the methodology of measuring the noise levels. A change in this attitude is now becoming apparent as anti-noise legislation is being enacted in many countries. However, quiet mining equipment is still a long way off.

2. The employees' pre-employment and periodical medicals by Company medical staff includes a hearing test. All employees are screened in an audio-booth and their results entered sequentially on an audiogram history card, which allows quick assessment of hearing loss in the interval since the previous test (Appendix 1). A 15 dB loss in any of the frequency bands centered at 500 Hz, 1000 Hz, 2000 Hz, 3000 Hz, 4000 Hz, 6000 Hz and 8000 Hz is regarded as significant and requires a full audiogram to be carried out on the employee for baseline and diagnostic purposes. Where hearing deterioration is observed, the employee is advised of the fact and questioned concerning his job. Where adequate hearing protection is available, the employee is counselled on its correct usage. In very high noise level areas, where the effectiveness of the protectors are at the limit, the employee is given the opportunity to transfer to quiet jobs. New employees with significant hearing loss are medically classified so that they are restricted from high noise hazard areas.

3. All areas of mine and plant have been checked to determine locations or processes where the noise is at hazardous levels. Extensive use is made of personal dosimeters, as well as sound level meters, to quantify the noise exposure dose the employee receives during the typical working shift. Where possible, worker and noise source are separated, eg, by the use of sound insulated control rooms, or enclosures for operating machinery. Where the operator is exposed to noise sources such that the shift average exposure is greater than 90 dB(A), personal ear protection is advised and is regarded as "part of the job".

SELECTION OF HEARING HAZARD AREAS

The noise levels from the various plant and equipment at Mount Isa vary up to levels of 124 dB(C) for types of mining machinery. Levels for various problem areas of the plant have been previously described (1). The underground situation exacerbates the noise situation because the highly reverberant, confined spaces where machines have to work will increase the sound pressure levels by 3 - 4 dB over the levels measured in a free field.

Most areas of surface plant, and underground activities, have had measurements of sound pressure levels and have been classed as shown in Table 1.

TABLE 1

S.P.L. Range	Classification	Hearing Protection
< 80 dB(A)	Nil	Not advised
80 - 90 dB(A)	Nuisance	Personal preference if worn
90 - 100 dB(A)	Low hazard	Protection advised to be worn (refer Figure 1)
100 dB(A)	High hazard	Protection mandatory (refer Figure 2)

The above tables has to be qualified in that it refers to workers with normal hearing capabilities. Should a person working in a noisy area prove to develop significant hearing loss due to known noise exposure, he would be classed as having "sensitive" hearing, and then would either be moved from the noisy area or allowed to continue working there provided adequate hearing protection was worn.

A prior approach, whereby sound pressure levels were signposted in each area together with allowable times for exposure without protection (Figure 3), was abandoned when it became obvious that employees were confused when moving between areas, each stating differing allowable exposure times. Also the time spent in the areas is determined by the job, not by the noise level.

Apart from the straightforward measurement of area noise with sound pressure level meters, where personnel move between different areas or use different tools, their average noise exposure is estimated by the use of personal dosimeters worn over the shift. Should the shift average exposure prove to be greater than 90 dB(A) then the worker is advised to wear hearing protection. In the underground situation, activities rather than areas are classed as hazardous with respect to noise, since areas are constantly changing as mining progresses.

SELECTION OF HEARING PROTECTION

Mount Isa Mines Limited has a high usage rate for hearing protectors (Table 2) so that to simplify stock holding, distribution and costs, it is preferable to minimize the different types of protectors on hand. The range of 5 types of protectors listed in Table 3 is considered sufficient to cover all needs and allow some choice for employees.

TABLE 2

12 Months' Usage of Ear Protectors to May 1978

Type	Numbers
"Wax Wool" disposable plugs	67 383 pairs
"Foam Type" disposable plugs	41 837 pairs
Light weight muffs	3 753 *
Heavy duty muffs	350
Hat mounted muffs	23

*includes muffs repaired and reissued.

It must be remembered that hearing protection is but one item amongst a range of protective equipment that operators may be required to wear on the job. Thus, selection of suitable hearing protectors is partially restricted by the fact that in all production areas the use of safety helmets is mandatory, and in most cases, the use of safety glasses is also required.

The range and costs of hearing protectors available on the Australian and overseas market is constantly being reviewed. Attenuation characteristics are assessed by use of SLC_{80} figures issued by the National Acoustic Laboratories (Waugh (2)). When a protector appears to have "suitable" attenuation characteristics that better fulfil a need than the protectors in use at the time, a batch is procured for on-site testing for comfort, acceptability, ruggedness and useful life. Protectors which do not meet these practical criteria are rejected, regardless of attenuation characteristics.

The range now in use covers a wide spectrum (Table 3). When an area is investigated for noise hazard, the "C" weighted sound pressure level (dB(C)) is always measured so that the most suitable protectors on hand can be recommended. However, employees have the opportunity to use other types of protectors in the available range. Muffs used by the Company are shown in Figure 3.

TABLE 3

Attenuation Characteristics of Ear Protectors Presently in Use at Mount Isa Mines Limited

TYPE	VALUES IN dB	TEST FREQUENCY (HERTZ)							SLC_{80} dB
		125	250	500	1K	2K	4K	8K	
"Wax Wool" Plug	Mean	-	10	12	16	27	32	-	10.4
	Standard Deviation	-	9	9	8	11	9	-	
Foam Plug	Mean	12.6	14.7	15.2	18.6	27.0	35.9	28.9	15.9
	Standard Deviation	7.5	7.3	6.7	5.3	3.8	7.8	9.3	
Light Weight Muff	Mean	5.3	8.6	16.0	26.4	29.2	35.4	25.1	19.2
	Standard Deviation	4.6	2.5	4.7	5.0	5.9	4.4	5.8	
Hat Mounted Muff	Mean	9.8	13.7	20.3	32.6	31.8	31.7	28.3	22.3
	Standard Deviation	4.5	5.5	5.1	5.3	4.0	6.7	5.9	
Heavy Duty Muff	Mean	9.3	15.5	26.1	37.9	37.5	36.6	27.8	26.2
	Standard Deviation	4.1	4.1	3.7	3.7	5.5	6.3	3.9	

N.B. Values taken from National Acoustic Laboratories Publications

SLC_{80} values are used to determine attenuation characteristics of commerical protectors. This has been found to be the simplest and most reliable system available. At one time, calculation of noise levels at the ear after attenuation by protectors was calculated using the frequency spectrum of the noise and published information on the mean and standard deviation of the protectors' attenuation (method described in reference 3). However, this time consuming method produced results approximately equivalent to SLC_{80} predicted values when distribution statistics were taken into account.

Also, sales literature for protectors may show results that are calculated using overseas test procedures or that tend to be on the optimistic side. In at least one case to our knowledge, the attenuation characteristic of the sales literature was 10dB better than that published by National Acoustic Laboratories. To maintain a stable base from which to choose and compare the attentuation of new protectors, SLC_{80} values are used.

ADVANTAGES AND DISADVANTAGES BETWEEN DIFFERENT HEARING PROTECTORS

Acton (5) has given a very good account of problems associated with the use of hearing protection. Where employees are advised to wear hearing protection, the final choice as to which type of protection used is usually left up to the individual, and hence the various pros and cons between the different types of protectors may reflect personal preference.

It is absolutely critical that at least one particular type of protector is worn by the individual, and that he wears it the whole of the time he is in a noisy area. The mathematics of noise exposure are such that a super protector, giving infinite protection but worn only 90% of the exposure time, will give protection equivalent to a device giving only 10 dB attenuation but worn all the time. (Walsh (4).)

Objectively, some points can be itemised as to general guidelines for protector usage. These are:

- Attenuators chosen should give sufficient attenuation with a margin of safety but not completely isolate the wearer from all audible sensation.
- Attenuators should not significantly interfere with speech intelligibility, i.e. not attenuate excessively at the low-middle frequencies.
- Plugs should not be used in excessively dusty or dirty areas. Where plugs are used, emphasis must be given to correct insertion with clean hands to prevent ear infection.
- Where personnel have to travel to differing parts of a plant during a shift, e.g. maintenance personnel, they may not always think of taking ear protectors. In such circumstances, hat mounted muffs have a particular advantage where hard hats are universally worn.

Hat mounted protectors usually have a lower attenuation than the same protector on separate band. However, a moderate protector worn is infinitely better than an excellent protector in a locker. Arguments that mounting muffs on safety helmets will either invalidate the safety helmet or tear ears in the case of falling impact, are somewhat emotional. Well designed hat mounted muffs will have 10 - 15 mm vertical play in the springs and there is additional room inside the cup. In any case, there is at least one brand of hat mounted protectors on the market which are not rigidly fastened to the hat shell but kept on by use of a slip-on band.

If eye protection has to be worn concurrently with hearing protection, then plugs have the advantage that they do not interact with glasses. Where muffs are to be worn, then glasses having pliable stems produce less of an attenuation loss by breaking the muff seal, than would glasses having rigid, inflexible stems.

IMPLEMENTATION OF A HEARING PROTECTOR PROGRAMME

Even within the one Company, there have been several approaches to hearing protection education.

Every employee joining the Company is given a half-day induction in which the role of the Company in the community and aims of the Company are explained. Part of this induction includes talks on safety attitudes including a film on hearing conservation. The new employee will also then undertake a specific area induction, depending on which part of the plant he is assigned to. In these, particular locations of noise hazard in that area are discussed and precautions advised.

The employee is issued with suitable safety supplies (hard hat, safety glasses, etc) and if in a noise area, muffs or plugs will be issued. In addition, plugs are freely available at substores located around the plant, or at automatic dispenser outlets (Figures 4 and 5). Areas in the plant where noise levels exceed 90 dB(A) have been signposted.

To follow up the initial safety talks at induction, regular safety meetings are held in all areas of plant. At these meetings, talks, films, etc, are given on various themes, including hearing protection. Where a group of workers express the desire for indepth talks on various safety issues, then this is usually given by expert Occupational Health staff.

It is the experience of this Company that patient explanation of the need for hearing conservation will be as conducive to employees wearing protectors as mandatory rules, especially in areas where levels are typically less than 100 dB(A).

It is extremely difficult to convince "Old Timers" to wear hearing protection. Where significant noise induced hearing loss can be detected by audiograms, then freedom ofchoice is removed and the employee either has to agree to wear suitable protection or be relocated to a noise-free area. Relocation may involve reductions in remuneration. Conversely, the information given to employees on noise hazard should not be so detailed as to be confusing.

The two separate approaches were tried separately in the same areas of two similar but separate concentrators. In the grinding areas of these concentrator the noise levels are typically of the order of 91 - 97 dB(A). In one concentrat signs were located indicating the sound pressure levels in each area, together with allowable exposure times for unprotected personnel. Because it was not explained that for the remainder of the time the employee had to work in a noise-free area so that his cumulative allowable daily dose would not be exceede people were confused and the signs were not a success. In the other concentrato conversely, the whole area was declared a noise hazard area and hearing protecti was advised (Figure 1). In the vicinity of particular machines where the noise levels,arehigher than the average and typically reach 105 dB(A), the requirement for hearing protection is emphasised for workers there (Figure 2). At the time the plant was made a noise hazard area, each worker was issued with a memorandum (Appendix 2) giving the reasons behind the decision, the necessity to wear hearing protection, types available and how they could be obtained. This approach has met with a favourable response from employees. In the normal course of their duties some 1/3 of concentrator workers wear plugs as a matter of habit, and up to another 1/3 wear muffs continuously. Working around a particularly noisy machine, maintenance personnel will usually have 100% rate of wearing protectors.

In the underground jobs the situation is rather different in that activities, e.g., pneumatic drilling and diesel operations, and not areas are designated as noise hazards. For such activity a safe work procedure has been drawn up documenting proper work methods and safety equipment required for the job. This may include hearing protection. Underground workers accept this requirement, and on a recent survey that collected information on usage of personal protective equipment underground over the periods January - April 1978 it was found that 77% of persons operating pneumatic drilling equipment and 86% of those operating diesel equipment were noted actually wearing hearing protectors on the job. In these areas hearing protection is mandatory and the need is also fairly obvious. Pneumatic drilling rigs operate with sound pressure levels in the range of 110 - 120 dB(C) and diesel operators are exposed to levels of 95 - 115 dB(C). Many operators wear both plugs and muffs simultaneously. This of course does not give a simple additive effect, but does provide some marginal additional attenuation. However, it must be remembered that at this high noise level, bone conduction becomes important, and this factor cannot be greatly protected against with muffs or plugs.

EMPLOYEE REACTION TO HEARING PROTECTION

The course of acceptance and utilization of hearing protectors by employees has not always been smooth. For example, when a new type of ear plug was introduced for trial in the Workshops there seemed to be good acceptance and stocks were depleted rapidly. However, there did not appear to be a corresponding increase in wearing of the new plug. It was then discovered that the younger members of the workforce were requesting them, not to use as hearing protectors, but to use the small chrome chains on the boxes as bracelets.

Complaints against hearing protectors usually hinge on nuisance or discomfort factors. Hence, it is essential that a limited range of suitable protectors are available so that these factors can be minimised. However, it must be remembered that heavy duty muffs will usually tend to be heavy and tight fitting.

Mount Isa's weather is such that it can be extremely hot for one half of the year. Consequently, wearing of ear muffs can be a physical burden on some jobs at some times. Self motivation is very important in having operators wear ear protection. For example, personnel are more likely to wear protectors on their own initiative when the noise level is continuously above 100 dB(A) than when it is just above 90 dB(A).

There is a definite increase over the past few years in operator awareness of the hazards of noise as the result of increasing publicity in the news media. This awareness can initially result in concern on the part of the individual about the hazard of his workplace. At this point, a factual discussion on the effects of noise and a factual description of the sound pressure levels in that workplace, and what the management is doing to quieten processes or machinery, will go a long way to answer their concern. Such talks are also the best psychological moments to present the health benefits of hearing protectors. But facts presented must be true or else management's credibility suffers and the damage to a hearing protection programme irreparable.

The best path is to aim to achieve habitual wearing of ear protectors on the jobs where they are required, if engineering controls are not feasible. If appropriate ear protection has been chosen and discomfort factors are minimized, the operator learns to prefer to work in a quiet micro-environment than in a noisy one. He will then look after his own hearing protector and ensure it is clean and functioning properly. This will be the hallmark of a

successful hearing protector programme. The hallmark of a successful hearing conservation programme is a minimal loss of hearing amongst the workforce due to industrial noise. Amongst the Mount Isa Mines workforce over the past five years, 19 workers have been reclassified owing to industrial hearing loss.

It must be repeated that hearing protectors should only be used where engineering solutions are not forthcoming or until process changes are carried out. The ongoing objective of informed management is to ultimately provide a working environment where personal protectors are not required. This may take many years, and may even be impossible under present technology. Personal protectors fill this gap in the meantime.

ACKNOWLEDGEMENT

The author wishes to thank Dr. R.H. Marston for his invaluable assistance in the preparation of this paper, and to the management of Mount Isa Mines Limited for the opportunity to publish and present this paper.

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Figure 1 Signs indicating low hazard noise areas where hearing protection is advised.

(Black on Yellow)

Figure 2 Sign indicating localised area where muffs are mandatory. (Black on Yellow)

Figure 3 Ear muffs used in the Company. (Clockwise - hat mounted muff, light duty muff, heavy duty muff.)

Figure 4 Sign used on prior approach to outlining times that unprotected personnel could safely remain in area before daily admissable dose was achieved.

Figure 5 Self dispensing station for foam plugs.

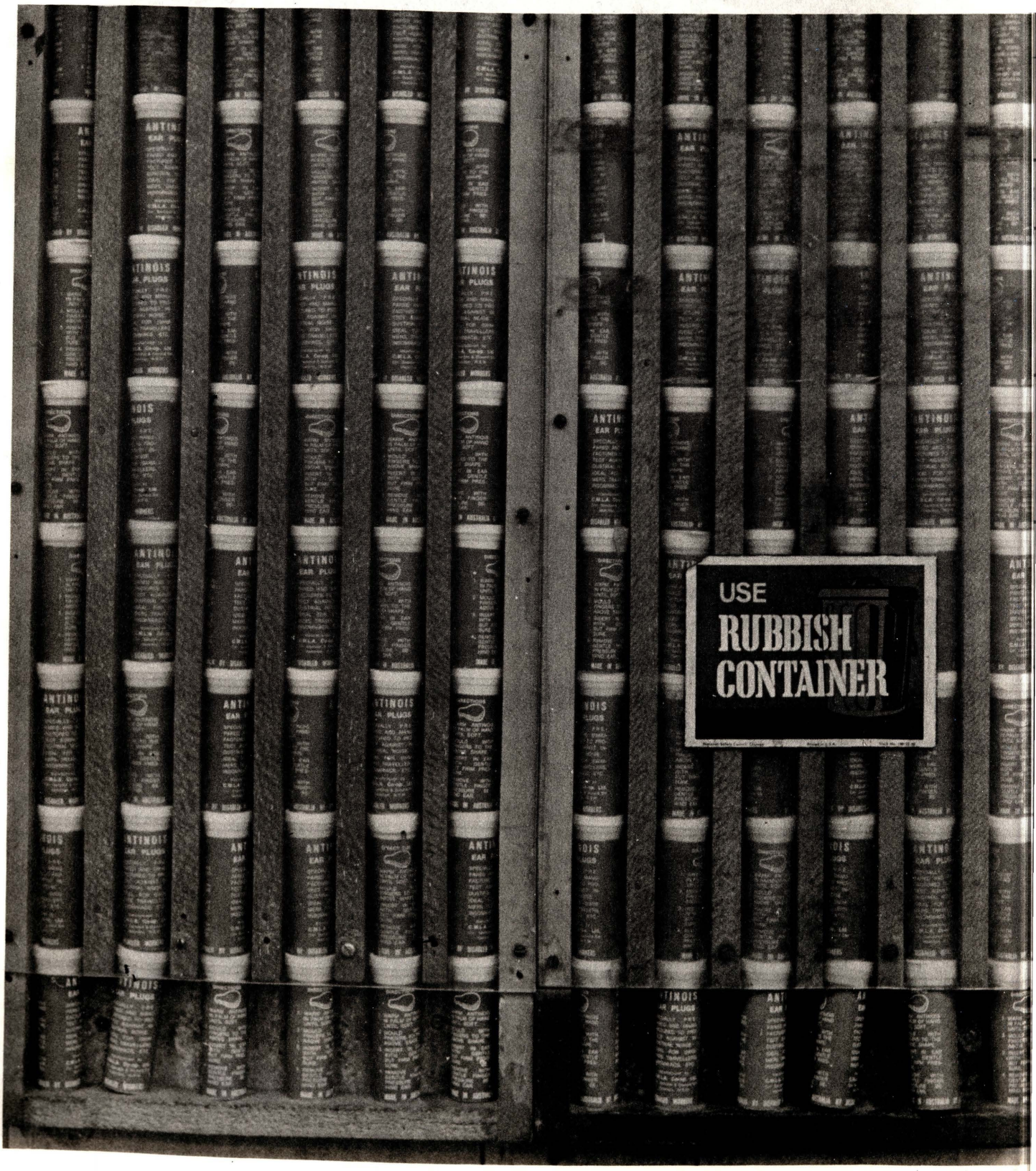


Figure 6 Self dispensing station for wax-wool plugs.

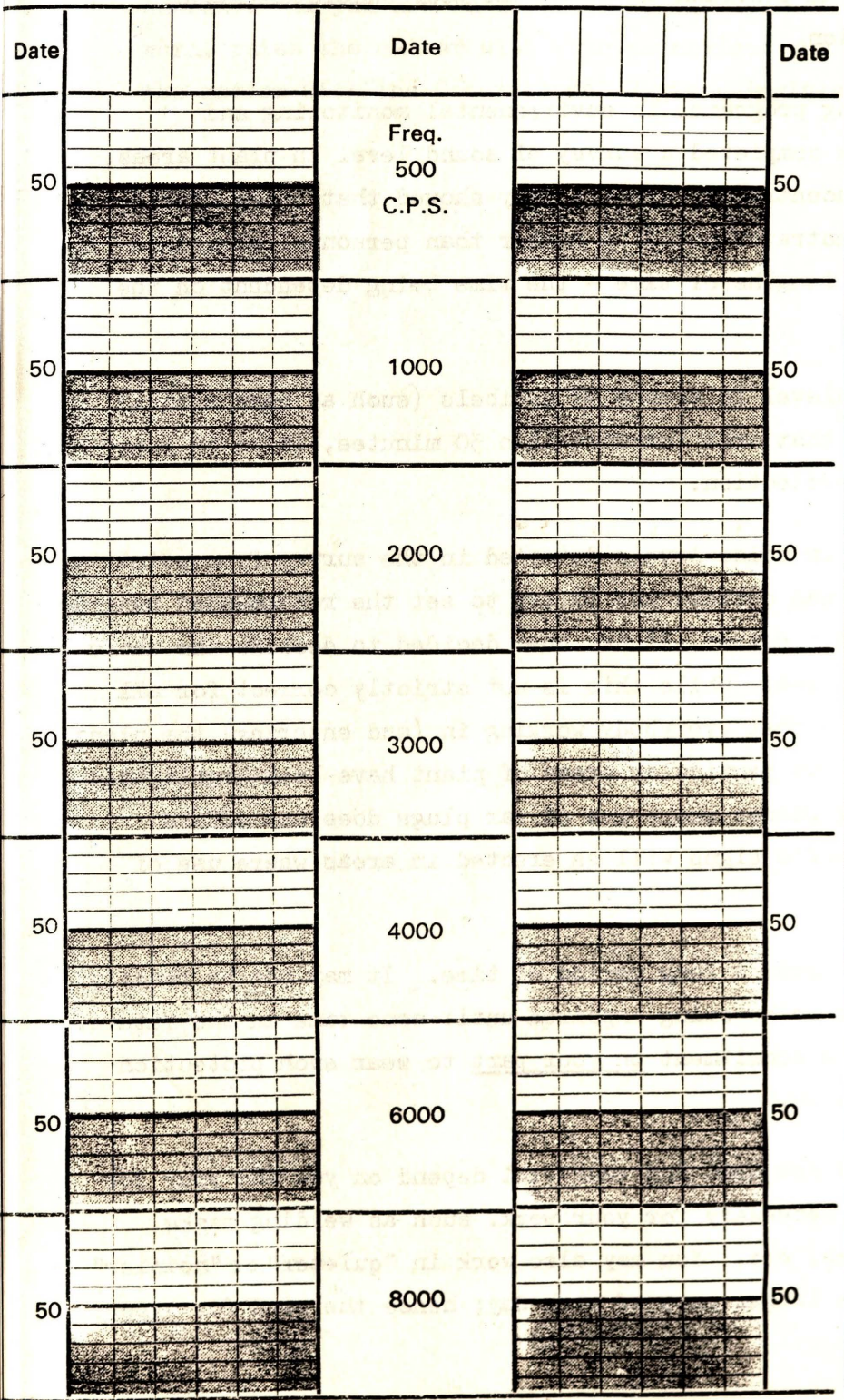
APPENDIX 1

AUDIOGRAM HISTORY CARD

NAME: | No. | D of B

HISTORY OF EAR DISEASE: (ISA MINE 40 7/77)

AUDIOGRAM



Previous History Noise Exposure

M.I.M. Noise Exposure:

Comments:

APPENDIX 2

CONTENT OF MEMORANDUM ISSUED TO CONCENTRATOR EMPLOYEES

USE OF HEARING PROTECTION - CONCENTRATOR

During the next few weeks recommended usage of hearing protection within operating area of the Concentrator will be adopted on a uniform basis.

Signs stating this will be posted at all entry points to the plant.

The following information is provided to assist in your understanding of the need for such protection.

1. As part of a continuing programme in environmental monitoring and control, vacation students completed a survey of sound level in plant areas, including areas in the Concentrator. This survey showed that noise levels in some areas of the Concentrator could be higher than personnel should be subjected to for extended lengths of time - the time being dependent on the "decibel" level.

For example, if the noise level is around 97 decibels (such as near a mill) and if you are working in that area for more than 30 minutes, it is in your interest to wear hearing protection.

With the large variations in noise levels detected in the survey from point to point in the plant, it was decided not to try to set the recommended maximum time exposure in each area. Rather, it has been decided to declare the whole plant area a noise hazard area. While this is not strictly correct for all plant areas, it will ensure that everybody working in (and entering) the plant is aware of the hazards. Two particular areas of plant have been highlighted in item 5 (below) as being places where use of ear plugs does not afford adequate protection. Specific signs will be erected in areas where use of ear muffs is necessary.

2. Hearing loss can occur over a long period of time. It may not be readily apparent that your hearing is becoming impaired until some time in the future. Consequently, it requires a commitment on your part to wear such protection now as a preventative measure.

3. The type of protection you need and wear will depend on you and your job and the equipment that is necessary for your work, such as welding masks, prescription lenses, gloves, etc. You may also work in "quieter" or "noisier" areas of the plant for the larger part of each day; hence the need for types of hearing protection.

4. The need for some protection applies to everybody who works in the Concentrator plant area on a daily basis.

5. When in the plant you will note that two particular items of equipment are highlighted, namely rod mills and crushers. Due to the greater noise levels emitted by the processes of crushing and primary grinding, ear muffs are the only suitable equipment that will provide you with adequate hearing protection in the immediate vicinity of these machines.

6. Your co-operation is requested in using hearing protection for your own benefit. If you are in doubt as to the type of protection that should be worn, raise the matter with your supervisor who will be able to clarify the matter with the Occupational Hygiene Engineer.

Discussion

Mr. Corey: I'd like to ask is it compulsory for your employees to wear ear muffs or ear plugs and, secondly, where did you get those signs with the symbols on them?

Mr. Ruschena: The sign comes out of the British Department of Employment Code of Practice for reducing the exposure of employed persons to noise. As for mandatory hearing protectors, in certain areas yes, in other areas it becomes highly advised. Where the noise level is above 100dB(A) it usually becomes mandatory. In other areas there is a sliding scale where it is not a requirement but of course if an employee comes in with a noticeable hearing loss since his last audiogram then he's advised strongly to wear hearing protection and he may be told: you either wear hearing protection or you change your job.

Mr. Corey: Is there any union resistance to wearing hearing protection?

Mr. Ruschena: No, the union situation is that hearing protection is regarded, like all safety requirements, as part of the job if it is required to be worn. There is never any untoward pressure from unions to do away with this. On the other hand in certain high noise areas it becomes exceedingly obvious that protection is needed and those are the areas where it's mandatory.

Mr. Challis: I think most of us are aware of the hearing hazard associated with jumbo star drills of the type you showed a photo of. What has the efficacy been of the earmuffs, earplugs and the heavyweight earmuffs in terms of preventing hearing loss in operators wearing those respective classes of protection?

Mr. Ruschena: The simple answer is we don't know. We haven't done studies of whole classes of operators and the type of protective equipment they use and associated that with noise levels and hearing loss at the job.

Mr. Harper: Have you compared audiograms taken during employment with pre-employment audiograms and if so have you noticed any additional loss?

Mr. Ruschena: The employee is given an annual medical examination, including a hearing test, but I can't give any answer on statistics because they haven't been done.

Mr. Wyndham: To what extent has there been any move towards hydraulic drilling as against pneumatic drilling equipment and do you know what the relative noise levels are?

Mr. Ruschena: Yes, we have at the moment a hydraulic rig under test at Mount Isa and to date it would appear that the noise level is very

comparable with the pneumatic drills. There's no significant difference in our drilling environment. We have a very hard rock to drill through and the noise levels are very comparable, certainly within 1 or 2dB.

Mr. Satory: I liked the use of your sign. May I suggest you add to it - the sign with the minutes on it - "This is 50% of a Daily Noise Dose" or some such thing as that. This would seem to be a way to get the point across.

Mr. Ruschena: We are doing away with that sign altogether and going to the other approach where we're saying the whole area is a Noise Hazard Area. It would probably be alright to identify a particular machine as more noisy than the rest and advise the men to wear hearing protection around that particular machine if the operators were more stationary in the job, but our operators wander throughout the plant and signs on particular machines tend to become irrelevant in that situation. Other situations would be different.

Mr. Cracknell: I know you can't be terribly accurate, what with the coming and going of new employees, but what would you say the percentage acceptance is of hearing protection as an overall thing?

Mr. Ruschena: You couldn't say overall. It really has to be stated for different areas. Underground, in certain very noisy jobs, it's around 70 to 80%. On the surface you're looking at maybe 60%. In other areas it's damn hard to get anybody to wear any of it. So it really comes to this: successes in some areas and dismal failures in others. Where the noise level is just above 90 it's very hard to get people to wear hearing protectors. The higher the level the more obvious it is to them that they need hearing protection and therefore the easier it is to sell hearing protection.

Mr. Brown: A further comment on your sign. You had one photograph showing three different signs together. One said "safety helmet area", the next said something like "eye protection must be worn in this area" and the third seemed to be a far less definite one saying something like "caution - noise levels may constitute a health hazard and you may have a problem after extended exposure". It seems to me that you've got two different types, like a compulsory road sign and an advisory one. I was wondering whether perhaps a simple message like "hearing hazard area" on a large sign, the same as "safety helmet area", may not be more effective in the long run.

Mr. Ruschena: Yes, we're still trying to find the optimum approach and it's not finalised yet. Head and eye protection are definitely mandatory. I suppose you could say that accidents in those areas are extremely

obvious - a man loses his eye or has his head stove in. The wording of the hearing caution sign is in fact designed because we can't say "if you go in there you will get hearing loss". The whole thing is probabilistic. The higher the noise level the more probable it is that you will get hearing loss but we still can't guarantee it.

Anon.: Just to continue this, a hammer falling on a head also has a low probability hasn't it?

Mr. Ruschena: True, but it's very spectacular when it happens. It's one of those things where you've got to look at both the probability of the effect and the significance of the effect. The probability may be low but if the effect is very serious or the risk very high then you make protection mandatory. Eye protection and head protection are things that stem from the dim and distant past - everybody's accepted them, everybody uses them. Hearing protection is something much newer and we're still in the starting stage.

Professor Davies: There are three questions I'd like to ask. Have you any idea what the programme costs the company? Secondly, does the effect of hearing protection on communication have some bearing on the attitude to wearing it and, thirdly, what is the attitude of people to the safety aspects of wearing hearing protection? People can argue that it lessens their awareness or their ability to hear some sound which alerts them to danger.

Mr. Ruschena: The answer to the first question, on costs, is that we don't know because we don't break down the safety costs. We could probably get costs of individual protectors but I haven't these to hand although I'm sure it's quite high.

Professor Davies: The notices are expensive too.

Mr. Ruschena: We couldn't work out what the exact cost is. The notices are put up by the operating department and so would go directly into it's operating costs. Earplugs and earmuffs would be costed as part of all the safety supplies along with hats, glasses, gloves, safety shoes, etc.

Concerning the second question, on communication, we haven't found to date any situations where persons were involved with an accident because they didn't hear an alarm or a command or a warning because they were wearing hearing protection, so from that sort of negative evidence I can say it virtually hasn't affected communications. In my own experience, when you go up to a man who is wearing hearing protection and ask him a question he usually takes it off or opens it up. So only in this negative way I'd say it hasn't adversely affected us.

Mr. Campbell: I think you'd probably do better if you removed your three signs and put up one which simply said Total Protection Area.
Mr. Ruschena: It's not as simple as that. What do you define as total protection? Total protection to a miner is something completely and vastly different to somebody on the surface. When you watch a miner go down underground he looks like something out of Dr. Who. He's got his helmet with his lamp on top, he may be carrying a dust monitor to see how much dust he's exposed to, he's got his glasses on, a respirator, he's wearing a safety belt that usually contains his three or four tools as well as his lamp battery. He's probably wearing gaiters, he's carrying gloves - probably both a leather type and a plastic type - and down the bottom he's got safety shoes on. So what is total protection?
Mr. Campbell: That which is necessary in a particular area.
Mr. Ruschena: That's very useful if you've got a thinking person there but unfortunately that simple common-sense solution doesn't always seem to apply. You really have to spell it out and say "you need this, that and the other". If you just say " do the job as safely as possible" people will still do stupid things, so you have to go to "do A, B, C, etc." - a sort of recipe approach.
Ms. Jones: If you have someone who is working in a high hazard area who refuses to wear hearing protection do you let them continue to work or do you remove them or have you got means of enforcing wearing?
Mr. Ruschena: Unfortunately we have to wait until he gets a hearing loss, then we bring him out. It's one of those situations where you can say it's for your own good but they can refuse and go their own merry way until they develop a loss and then you can say "well that's it mate, out you go!".
Ms. Jones: And then they can turn around and claim compensation.
Mr. Ruschena: Presumably yes, but I don't think they could claim we didn't warn them. Certainly the warnings are glaring out. It's not a flash in the pan, it's there all the time: you have to work the safe way, that's the message that we try to put across all the time and in a lot of cases it's successful. But you always get the individual who will refuse no matter what you do.
Mr. Sponberg: Has there been any significant decrease in the compensation claims made against the company since the introduction of the hearing conservation programme?
Mr. Ruschena: I'm afraid that I don't know any of the claims made against the company. That sort of thing is handled by top management.

Anon.: What legislative requirements, if any, apply to Mount Isa Mines? As I understand it mines don't come under the Factories and Shops Act. Does that apply to the surface as well as the underground?

Mr. Ruschena: Yes. The Queensland legislation is in fact under the Factories and Shops Act, Rule 11, the hearing conservation rule. In the front of the Factories and Shops Act there is a brilliant clause which says all leases subject to the Mines Regulations Act will be exempted. In the existing Mines Regulations Act there is no mention of noise. In the draft Regulations (which still have to be promulgated) there is a two line clause that says "Employees exposed to noise levels of 90dB(A) or more shal- take precautions as advised by the Inspector". That's the noise legislation.

Anon.: Following on that, I think you'll find that there are about ten lines in the proposed rules for coal mines.

Mr. Ruschena: Even when the draft Regulations are promulgated it's still going to be minimal. We are doing our own thing and making sure oue employees are safe. It's a bit difficult to get top management to read a hefty engineering proposal if there's no legislative punchline and it doesn't look like there is going to be a legislative punchline for a long time.

Mr. Kimpton: We make it mandatory in some areas to wear hearing protection. We find this only tends to break down at the local level where the overseer doesn't enforce it very much, although good education in our training school generally overcomes this. But the question was with regard to earplugs: to your knowledge is there any significant increase in medical ear problems as a result of such a high usage of ear plugs?

Mr. Ruschena: We haven't had any significant problems at all. We have two doctors on the staff and they get to see most of the problems concerned with employees' health so no, we haven't had any significant problems. For example, the wax plugs that are worn underground: people usually put them in at start of shift and they probably remove them at the midday break, insert them again before they go back into work, and then leave them in until they finish the job. The underground situation is where they use most of them, plugs as well as muffs, and there is little break in the flow of the job. The miner works for 3½ hours, has a break, then works another 3½ hours and that's it. There are no other breaks or smokos or whatever.

Mr. Clutterbuck: You mentioned earlier something about the wearing of plugs and muffs together and I was wondering why the two forms of protection were combined?

Mr. Ruschena: Partially it's tradition; that's the way they always work. Partially it's because the best muffs that we use have an SLC80 of about 26dB. Now in a noise situation of 124dB(C) that still leaves 98dB(A) at the ear so if you can get another 2 or 3dB it's worth it.
Mr. Clutterbuck: Would the fact that muffs are worn over the plugs relieve a lot of the problems caused by dust?
Mr. Ruschena: Yes, it probably does. The people who wear only plugs underground are very very few. Most people either wear muffs or muffs and plugs and they would certainly act as a dust barrier.

REQUIREMENT FOR VALID AND RELIABLE INDUSTRIAL AUDIOMETRY

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Audiometry in the industrial setting is a relatively costly procedure which should be undertaken only after careful analysis of the cost benefits.

There is little disagreement about its use where noise levels and consequently the risks of hearing damage are very high. There is however no general agreement that the benefits of routine audiometry justify the cost at the lower levels of exposure.

A decision to introduce audiometry as part of a hearing conservation programme should only be made with a clear understanding of the requirements for satisfactory results.

The two most important requirements relate to the reliability and validity of the measurements obtained.

A number of factors may influence reliability and validity and these include:

1. The test environment and in particular the levels of ambient noise in the test environment.
2. The test equipment including departures from standard calibration.
3. The test subject and his attitudes to the test.
4. The test operator and his attitudes to the test situation.

Audiometric measurements which do not have high reliability and validity are worthless and misleading and waste valuable resources.

In the simplest terms audiometry refers to the measurement of hearing. S.A.A. Hearing Conservation Code AS1269 distinguishes between two types of audiometric measurement, full audiometric examination or reference audiometry, and monitoring audiometry.

For full audiometric examination measurements are made at the following frequencies:

500Hz 1000Hz 2000Hz 3000Hz 4000Hz and 6000Hz

For monitoring audiometry measurements are only made at 3000Hz, 4000Hz and 6000Hz. Both types of audiometry require measurement of the actual hearing threshold.

The code also specifies when each type of audiometry should be used in the industrial setting.

Audiometry is never a very cheap procedure, however, and we should look at the aims of the programme and how well it can achieve them.

The main purpose of audiometry in the industrial setting is usually quoted as the determination in quantitative terms of the hearing levels of individuals and the monitoring of hearing levels during the period of exposure to noise in order to control the risk of occupational hearing loss.

There is little disagreement in the literature about the value of routine audiometric measurement where noise levels are very high. In this situation, where the risks are high, audiometry appears to be a valuable aid in the early identification of personnel suffering damage as a result of inappropriate, defective, or ill fitting, ear protection.

At the other end of the scale there appears also to be general agreement that routine testing of employees whose noise exposure does not exceed 85dBA is not necessary in the ordinary course of events.

Above 85dBA it is usually conceded that there is a risk for some people. There is however no general agreement that the benefits of routine audiometry justify the cost of the programme at these lower levels.

As the British Health and Safety Executive Working Party on Noise points out "introduction of audiometry at the lower levels would necessitate examination of very large numbers of workers, making it essential that any decision is based upon the widest possible discussion of the practical implications both in terms of the uses which should be made of the results and the extent to which these uses justify allocation of resources".

They continue "The working party is also aware that some people fear that the balance between expenditure of resources on the control of noise and on the medical supervision of workers could be seriously affected to the detriment of the working environment, by an undue emphasis on the adoption of audiometry at the expense of noise control".

One might add that at the lower levels of exposure the expenditure of resources on education, supervision, and proper ear protection, may make routine monitoring audiometry quite unproductive.

Where it is considered there is a need in industry to introduce audiometry, either for monitoring or for reference purposes, a decision to proceed should only be made after a thorough examination of the requirements in terms of equipment, test conditions, and trained staff, necessary to produce results which have satisfactory validity and reliability.

In this context reliability means the results obtained on any one test subject will be consistent on repeated testing in the short term.

Validity on the other hand means that we are measuring what we set out to measure, i.e., the subject's hearing acuity for pure tones, and not his response to some artifact such as hiss or hum generated by the equipment.

Test results which, for some reason or another do not have high reliability and validity are literally worthless, in that they provide a false picture of the hearing status of the individuals examined. False information in this context may in fact be worse than no information at all.

The fact that satisfactory validity and reliability can be achieved in the industrial setting has been shown by several American studies (High and Glorig 1962, High and Gallo 1963). To achieve this however certain requirements must be met.

These requirements relate to four main areas of the audiometric situation:

1. The test environment
2. The test equipment
3. The test subject
4. The tester or test supervisor

I propose to discuss each in turn.

The Test Environment

High, Glorig and Nixon (1960) presented a comprehensive catalogue of factors contributing to variability in the measurement of auditory threshold. Prominent on their list was the level of ambient noise in the test environment.

Auditory threshold for pure tones is defined as the lowest level that the subject can detect. Unless the test environment is sufficiently quiet, the subject cannot respond down to the limit of his hearing ability because the test signal will be masked or blocked out by the background noise. Too high a noise level in the test environment therefore, has the effect of making it appear that the subject has a hearing loss.

At first sight it looks simple to deduct the effect of background noise from the measurement in order to arrive at the correct value. For example, if a normal hearing subject cannot hear below 40dB because of noise in the test room, it is suggested that 40dB be deducted from all results obtained in that room. Such a procedure however is incorrect. All subjects with true hearing levels between 0dB and 40dB will give test results of 40dB due to the background noise. It is in fact impossible to make measurements below the level of masking caused by the noise. There is in fact no acceptable method of making allowance for the effects of noise in the test environment. Either the test environment has levels of noise which will permit reliable and valid measurements to be made, or it has not.

Bryan (1976) illustrated this with measurements of thresholds by automatic audiometry for 26 ears in two test environments, Test Room A and Test Room B. The following table shows octave band noise levels in the two situations.

TABLE 1

Octave Band Noise Levels in Two Test Situations

Frequency (Hz)	125	250	500	1k	2k	4k	8k
Test Room A	52	44	37	33	29	19	10
Test Room B	31	19	11	5	5	6	6

Table 2 shows the difference in mean threshold measurement for the 26 ears.

TABLE 2

Mean Threshold Values for 26 Normal Hearing Ears Measured in the Two Test Rooms

Frequency (Hz)	500	1k	2k	3k	4k	6k
Test Room A	15.4	8.4	3.7	4.9	4.7	5.7
Test Room B	4.2	-0.2	1.0	2.9	2.9	6.0
Difference A-B	11.2	8.6	2.7	2.0	1.8	-0.3

He reports all shifts in threshold from one test environment to the other are statistically significant except at 6kHz. Test Room A must therefore be regarded as unsatisfactory for threshold measurement over this frequency range.

Berry (1973) has calculated the maximum allowable sound pressure levels for ambient noise in audiometric test environments for various ranges of test frequencies and for various hearing levels to be measured.

Based on his work the Australian Standard AS1269 of 1976 sets out maximum acceptable background noise levels in octave bands over the frequency range recommended.

TABLE 3

Maximum Acceptable Background Noise Levels

Octave Band Centre Frequency (Hz)	125	250	500	1000	2000	4000	8000
Max. Acceptable Octave Band Level dB re 20×10^{-6} Pa	52	35	15	14	29	36	28

It should be noted that these levels are intended to permit accurate measurements to 0dB hearing level ISO 1964 using MX41AR ear cushions.

It could be argued that hearing should be measured to a level less than 0dB ISO. If an employee's true threshold is at -10dB ISO and the lowest level measured is 0dB ISO, the employee must in fact lose 15dB of hearing acuity before he registers the smallest loss on the test. A loss of 15dB may in fact represent a significant loss of acuity for this employee.

The working group of the British Health and Safety Executive have in fact recommended measurement should be made to -10dB ISO 64. Such a level would require a 10dB reduction in the acceptable background noise levels shown in Table 3.

These levels of acceptable background noise are low and are not going to be found readily in industry. Since the figures refer to the levels at the ear canal of the test subject, however, and not just to the test environment, it is possible to use some form of attenuation to isolate the subject from background noise.

Audiometer earphones are fitted with earcushions and/or noise reducing headsets which provide varying degrees of attenuation of ambient room noise at the ear canal.

The following table gives an indication of the degree of attenuation available.

TABLE 4

Attenuation in dB of Audiometer Ear Pads

Frequency in Hz	MX41AR Earcushion	Auraldome Headset AR-100	Audio Cups
125	1.2	10.9	5.7
250	0.7	7.3	6.2
500	1.0	13.6	16.8
1000	7.9	28.7	26.7
2000	17.9	26.3	33.9
4000	24.9	33.4	40.7
8000	14.3	24.5	36.2

Accurate audiometer calibration figures for noise reducing headsets other than the MX41AR have not yet been agreed upon.

If further attenuation than that shown in Table 4 is required, it can be provided by the use of a sound treated test room.

A system of grading sound treated test rooms proposed by Hirschorn and Singer (1973) uses 3 grades with the following attenuation characteristics.

TABLE 5

Noise Reduction Values (dB) for Audiometric Test Rooms

	Octave Band Centre Frequency in Hz						
	125	250	500	1000	2000	4000	8000
Grade 1	18	32	38	44	51	52	50
Grade 2	28	36	46	53	58	61	63
Grade 3	48	64	79	81	79	83	80

Technically therefore it is possible to provide attenuation to ensure adequate noise levels for reliable and valid audiometry in all but areas with the highest ambient noise levels.

In industrial audiometry as in other areas of life one does not get something for nothing. As the level of attenuation required increases so also does the cost of the installation. Since costs are a major factor in deciding whether to introduce any programme of this nature, the expected benefits from the programme must be considered with great care.

Equipment

A potential source of error in audiometry is the incorrect calibration of the audiometric equipment. Audiometers are sensitive electronic devices calibrated to produce test stimuli within very fine tolerances. Their output may drift from calibration standards without warning.

Regular checks are necessary by qualified technical personnel under laboratory conditions. In between these examinations, checks on a subject with known hearing thresholds should also be carried out.

In recent times self recording automatic audiometers have won popularity because of their simplicity in use, and the exclusion of bias on the part of the tester. Robinson and Whittle (1973) reported no significant difference in threshold obtained with manual and self-recording instruments under the same test conditions. More than one audiometer of this type can be supervised by a test supervisor allowing a number of employees to be tested at the one time.

A more recent development involves the use of microprocessor control of the self-recording audiometer to administer the test, check reliability, record results and classify subjects according to pre-determined criteria. Banks of these machines have been used to test up to six subjects simultaneously under the control of a single operator.

Both manual and self-recording audiometers use the same type of earphone and headset and there is evidence to show that a significant variation in test results can result from incorrect fitting of the earphones to the ears. The tester or test supervisor, who should be trained in this procedure, should fit the earphones on the subject.

All audiometers may develop faults which can cause their output to vary from standard specification. Hum, leakage of the signal to the non test earphone, and frequency shifts, are possible and may result in invalid or unreliable test results if undetected.

The Test Subject

The nature of audiometric measurement is such that the co-operation and motivation of the test subject is necessary to produce satisfactory results. Overseas experience has shown that it is possible to achieve a satisfactory level of both in the industrial setting.

All audiometric test programmes, however, must have a built in method to enable the tester, in the case of manual audiometry, or the test programme, in the case of self recording audiometry, to check the subject's co-operation motivation and reliability.

Where a test subject is unco-operative and the test results are unreliable, it is very important that this fact be recognised and recorded. It is unlikely that the skills, equipment, and time, will be available in the industrial setting to overcome this unreliability, but ear protection and hearing conservation can proceed without delay.

The assessment of an unco-operative subject's true thresholds is an important part of compensation audiometry, which requires a properly equipped clinic.

The Tester

A manual test technique limits the throughput to one subject at a time, and the reliability and validity of the results will be strongly influenced by the skill of the tester and the test technique used. There is universal agreement that the tester requires formal training to develop the necessary skills.

A programme using self recording audiometry will also require a test supervisor to instruct subjects, position headphones correctly, and monitor results. More than one instrument can be used, and more than one subject may be supervised at the same time.

The reliability and validity of the test results under these conditions may be influenced by the rapport established with the subject and test instruction given the subject.

Part time training courses are available in some states to train personnel in the skills required to carry out industrial audiometry at a satisfactory standard.

The widespread introduction of audiometry in the industrial sphere will require the establishment additional training courses.

The introduction of audiometric testing as part of a hearing conservation programme will involve the outlay of considerable resources, if the programme is to produce results which are accurate and which can be used with confidence.

Results produced under conditions which are not satisfactory are virtually worthless, and misleading.

There will be many small and medium sized organizations which could never justify the outlay required to establish permanent facilities of the standard required. There does, however, appear to be a need for them to have access to suitable facilities to carry out audiometry.

A solution to this problem, popular overseas, it to hire mobile sound proof facilities, test equipment, and trained staff to carry out a survey of personnel as often as is required. It could be suggested that such a service should be provided by government as a public service.

Finally whether audiometric facilities are provided as part of an in plant medical centre or as part of a mobile service, careful attention must be paid to the use which is made of the results of audiometry. The identification of people who have sustained some degree of damage is an obvious advantage in an audiometric programme but must be followed up with the appropriate protective procedures. The code specifies the need for medical consultation where abnormalities are detected and since audiometry will detect all other hearing disorders besides noise induced hearing loss, this is an obvious necessity.

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Discussion:

Mr. Cracknell: You were talking about the attenuation capabilities of soundproof rooms and the auraldome or audiocup. In a situation where you've got a room and an octave analysis reveals that the levels in the room aren't low enough, could you advise me, when using either auraldomes or audiocups in addition, how you would work out the effect of extra attenuation?

Mr.Fifield: Perhaps one of our engineers would be happy to answer that for you.

Mr.Rose: It would just be a matter of straight addition.

Ms.Grimmett: I wonder if you could speak about the use of automatic audiometry in compensation testing?

Mr.Fifield: Compensation audiometry I think we must regard as being something quite separate from the sort of thing we are talking about. It requires a complete clinical evaluation. Now it is possible to use automatic audiometry for this purpose but I think most audiologists would prefer to examine the subject initially using manual audiometric methods. In the clinical setting, automatic auidometry has got a slightly different emphasis other than the establishment of hearing threshold. It can provide corroborating evidence of the manual aduiometric results. For compensation purposes it is particularly useful in documenting unreliability. It is very easy to demonstrate on an automatic audiometer that a subject is being unreliable and not consistent. It has a further most important use in helping to determine the site of the lesion and to rule out or document the possibility of lesions further back than the cochlea itself.

Mr.E.Williams: As a practising safety officer I recognise that the best time to do an audiogram is early in the morning before a shift starts. But in a big company where you have a lot of people and you are doing it annually and people have been exposed to noise during the day can you compensate for a temporary threshold shift when you are actually doing the audiometric test?

Mr.Fifield: No, it's not really possible to do this. One method which has been mentioned in the literature quite frequently is to make sure that subjects who are going to be tested later in the day use adequate hearing protection prior to their audiometric evaluation to avoid temporary threshold shift. There is no way of predicting the amount of TTS without a set of serial audiograms taken in the noise and in quiet.

Professor Lawrence: Do you take into account the upward spread of masking when you are specifying your ambient noise requirements? I

noticed in those three grades of test rooms you only went down to 125Hz. I recently measured inside a booth something of the order of 25dB(A) but about 70dB(A) Linear. I only had a portable octave analyser with me but I got down to about 30Hz and the peak of the spectrum seemed to be somewhere round about there. In the industrial situation there could well be a lot of low frequency noise.

Mr.Fifield: The Australian Hearing Conservation Code does take the upward spread of masking into account. I'm not absolutely sure at the moment whether those three grades of figures do. My understanding is that they were taken into account.

Mr.Murray: How would you suggest that an industry with no particular expertise in this area go about setting up for audiometric testing, including selection and purchase of equipment, calibration, the test environment and staff training?

Mr.Fifield: With great care! I would feel that a proposition such as you are suggesting would require professional advice. You need to look at what sort of problems you've got in establishing audiometric facilities and the amount of audiometry that is going to be required in order to do your sums and decide whether the benefits are going to be worth the resources that are going to be invested or whether the problem should be tack led in some other way. For instance, it may in fact be better to invest the resources in noise reduction in the first instance. I think that professional advice would be well advised.

Mr.Benbow: It's quite possible when you put a factory employee through his very first audiogram that there is a very marked error due to his ignorance of the test. Even though you give him a trial tone you could do a repeat test at a later stage and find quite a big difference in the test results in a number of cases. What would you suggest would be a good manner of rectifying that error?

Mr.Fifield: That raises a number of interesting issues. It's the sort of thing that I was trying to allude to in the paper. That situation should not arise if your technique is adequate. What is essential is that you must be aware that that is occurring at the time of the test by some means or another. If you are using manual auditometry then your testers must be sufficiently skilled to detect that they are not obtaining the subject's true threshold. In the case of automatic audiometry the test programme must have a means of evaluating the reliability of the subject's responses. This is usually done by test/retest methods - you come back and make sure there is adequate agreement among several measurements. The audiometric test itself is a relatively simple procedure. It's been simplified to the extent that all the

subject is required to do is to signify the presence or absence of a single pure tone. Now in a clinical situation audiologists regularly get children about twelve months of age to do this - to signify the presence or absence of a tone, and that's the sort of level of skill that's required. So that it's eminently possible to get even people who are non-English speaking instructed in a test technique which will produce reliable results. But unless your testing technique is adequate that's just the sort of situation that you will find - that you are getting results which are not reliable.

Mr.Benbow: Yes, there's more to it than just carrying out the procedure as outlined in the Australian Standard (AS1269).

Mr. Fifield: Yes, there is a lot more to it than just pressing a button. You have to know what you are doing and training is most definitely necessary in order to be able to get results which are accurate, otherwise you've got a tester variable.

First Panel Discussion:

Mr. Lyon: I'd like to address my question to Mr. Ruschena. You mentioned that your company hadn't had any great difficulty getting your employees who are working in the mine to wear hearing protectors. Could this in fact not be in an attempt to protect their hearing but rather in an effort to keep the dust out of their ears?

Mr. Ruschena: I think the answer to that is quite simply that they are trying to protect their hearing. If you stand beside one of those machines you know all about noise exposure.

Mr. Kateifides: Mr. Challis, in your address this afternoon you covered the roles of three bodies hopeful of solving noise problems for the management of a company, ie. the company plant engineer, the package dealer and the consultant. I feel that you have failed to include one additional body in this role and that is the environmental noise or industrial noise protection authority which has the executive role of enforcing compliance with criteria. I refer specifically to the State Pollution Control Commission, which not only has authority under the act to specify levels to which noise is to be reduced but also to specify noise reduction programmes to be carried out. In so doing, it sets the goals of the other three and would therefore be more important than them because the companies would have to comply with the criteria specified by the authorities. Would you like to comment on that additional body as I have suggested?

Mr. Challis: The issue raised by Mr. Kateifides is a very interesting and technical one, and I hope that my fellow speakers on the panel will also address themselves to this question. If we look overseas before we look at the SPCC or the EPA we find a rather interesting situation. In none of the countries that I can think of, including the USA, the UK, Germany, Russia, Holland, Denmark, Sweden and Norway, where I have had a look at some of the organisations concerned, would the executive engineers, scientists or technical personnel see fit to do more than specify a criterion. Whilst many of them would involve themselves with research work I do not believe that they would tell the firm concerned how to solve the problem. The reasons for this are, I believe, quite explicit and have a very firm basis. I would recommend that the people in the SPCC or EPA should very carefully consider how can you penalise a firm for not achieving a criterion if they have done exactly what you told them to do. I believe that from a legal standpoint, having told them what to do, they could sue you for damages if you tried to put a

a noise stop notice on them. I feel that maybe the SPCC or its officers have been very gifted, very talented, or just very fortunate. Time will tell. I for one, and, I am sure, the other consultants from this and the other states will be only too delighted to back up a client of the SPCC who, having felt themselves wronged by bad advice, sought legal redress through the courts. I would hope that that situation would never happen but I really think that the SPCC should very carefully evaluate its position.

Mr. Madden: First of all I think you have raised a very interesting question. There are a lot more authorities than have been mentioned that can be very helpful to all of us in all of our work problems. We have the Experimental Building Station, the National Acoustic Laboratories, the SPCC, the Health Commission's Occupational Health Division, the various universities, the Water Board, the Electricity Commission, the Railways - it goes on and on. There's quite a talent available from which to obtain advice in certain areas. I do believe that there are many cases when the SPCC or others can probably give advice and it's fairly straight forward and very obvious. What does concern me is when the advice given - probably in the best of faith but without the necessary involvement in time and research, measurements,testing, probing and so on to really find out what the problem is - is not necessarily the best way to go about the solution. But let me say that you can, through your client, very rapidly contact the SPCC and see further advice and the SPCC are very gracious.

Professor Davies: Could I make a comment on those last two replies. I don't think that the situation is unique, it happens all the time. For example, fire regulations: the local fire authority tells you what you've got to do and you do it. Now if your place gets burnt down I don't know who would carry the can but this is an exact case where the person who has the authority to enforce the regulations also gives detailed instructions as to what's necessary. I think there are also other examples. Local authorities in England have the responsibility, I think, for implementing the Factory Acts, the New Health and Safety at Work Act and the Environmental Protection Act and the local inspector is often asked for advice as to what's to be done and if he's fool enough he gives it. So I think it isn't a unique situation. The problem is that many of the difficulties in many of the problems are specific. What is going to happen is that the official is going to fall back on the rules and it just depends on how the rule book has been written as to what he'll say you've got to do.

Mr.E. Weston: I'd be inclined to think there'd be a bit of difference

between acoustic requirements and those of fire, for instance, as you mention. Anyway I look to Louis Challis to answer this.

L. Challis: Professor, while I'm sure in some areas what you say may apply, I'd like to raise the issue of what I've called in my paper, the big stick. The SPCC and the EPA in our country have the power to stop a factory from operating. Suppose a factory which manufactures furniture has a four-header or some other highly potent noise source and the EPA or SPCC come along and says "Your factory is too noisy. Here is a noise stop notice. Until you stop that noise you can't produce any more products. Oh, by the way, you can solve your problem by putting up this beautiful patented veneered timber finish around the outside of your factory". The manager in good faith puts up the patented veneered panel but of course the four-header noise goes through it like a knife through butter. We could then theoretically find the situation where the manager may have spent $200,000 to put this expensive veneer around the outside of his factory and he now wants to sue for damages and says I have no more money to do noise acoustical treatment. In the case of the fire authority, however, the fire authority people could, I acknowledge, close down a public building such as a theatre or restaurant but they would be unlikely to close down a factory in the same way. I feel that the advice they would give to a factory would be in terms of removal of dangerous flammable materials, the addition of suitable fire stairs, and the provision of materials whose smoke production would be sufficiently low to stop the people from suffocating in the event of a fire. It is my belief that the two situations do have some parallels but are not really the same.

Mr.Kotulski: It seems to me Mr.Challis that perhaps you're making a very strong case for government officers to take out professional insurance like the consultants do against their mistakes.

Mr.Challis: I've never given any thought to that one. I would have presumed that, given the authority to give advice, the Authority concerned would provide such insurance through the statutory funds of Her Majesty's government. But let's look at it from another angle. I don't in general object to such advice being given, I can see the definite advantage of good advice being given. What would worry me, however, is the situation where bad advice is given, where because the officer concerned has too much on his plate - has to go and look at that factory and 10 others in the same day - gives what I will describe as a perfunctory glance at the problem and thinks of the most expensive treatment that is most likely to work (what I call the belt and braces solution). In this circumstance the poor man who in good faith is

is applying the solution is given something that is far less than the best in terms of advice, and may pay far more than he would have paid by going to, say, a consultant or to a package dealer who would have given him something that was better engineered and cheaper.

Mr. Kotulski: To get over the last point Mr. Challis raised, perhaps government instrumentalities should recommend the provision of such-and-such a structure or equivalent, thus placing the onus on the occupier of somebody else to find a suitable cheaper one. Also, I'd like to ask a question of Mr. Ruschena. A level of 90dB(A), according to the NHMRC, implies that something like 25% of the population over a working lifetime will suffer hearing impairment. Now, considering that (1) those prognostications have been based on the Burns and Robinson data, which were based on fast response measurements of sound level whereas a lot of the regulations require measurements using slow response, and (2) that there may be some evidence of other pathologies affecting hearing - such as increasing circulatory disability amongst people due to our way of life - you may find that the percentage of people suffering hearing impairment is actually far greater. Bearing in mind the new NAL criterion of begining impairment it could be that a 90db(A) we are looking at something like 45% of the working population suffering permanent impairment. Have you any comment?

Mr. Ruschena: Until a couple of years ago we in fact used 85dB(A) as the goal to aim at. We acknowledge that at 90 you are going to get some people getting hearing damage. However, in the mining industry it's a matter of getting those high levels down and then in any new installation to get as low a level as possible. We're at the moment installing a new plant in our copper smelter and the levels there are in the low 80's. As far as mining machinery goes, where our big problems are, there is still no machinery that gets below 100dB(A). Its a question of a practical objective. At the moment we feel that 90 is a practical objective. Once we achieve 90 we can look again. At the moment 85 is pie in the sky.

Mr.Kotulski: I'd like to bring out that that means in principle you'd like to get to some level like 80 but due to economic constraints you are setting your sights a bit lower and saying we'll settle on 90 at the moment.

Mr.Ruschena: It's not only economic constraints. In 90% of cases it's technological constraints. The technology does not exist to mine or to carry out certain processes quietly. The best you can do is try to isolate the operator. Perhaps the next era in technology is to have large machines controlled by a distant operator. Again I would suggest

that this sort of technology is not here yet.

Mr. Lim: A subject can have hearing improvement after a noise exposure and this is commonly known as sensitisation. We have got this sort of result at Sydney University and it has been reported a few times in the Journal of the Acoustical Society of America. What I want to know is how it happens.

Mr. Kotulski: I know of a case where the plugs conveying the audiometer connections through the walls of an audiometric booth were not properly insulated against electrical hum pick-up. Since the amount of hum getting through to the audiometer earphone varied from one day to another, spurious audiograms, many of them showing apparent hearing improvement, resulted. An artifact could also occur if the people in whom the supposed "sensitisation" is demonstrated were not adequately screened for uncontrolled noise exposure in the period preceding the experiment. If a subject, unbeknownst to the experimenter, was actually recovering from a temporary threshold shift, an experimental noise exposure of say 80dB(A) could appear to result in hearing improvement when in fact it is the person's ongoing recovery from the earlier, unrecorded, exposure that is being measured.

Mr.Carter: I can confirm that sensitisation does occur in temporary threshold shift experiments. I've seen it and I believe it's not an artifact but I do not know what causes it; I don't think anybody does. I believe that it will occur in a small proportion of subjects, possibly as high at 10%, even when the average TTS is about 20dB. I'm not sure of its relevance to this discussion but that's what I've observed.

The Interpretation of Industrial Audiograms

Dr. V.G. Bulteau
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Pure tone audiometry is a reliable, proven method of measuring the effects of industrial noise on an individual worker. It can help to identify those who are particularly susceptible to noise exposure and those who have lost hearing from high noise exposure levels. Until other test procedures offer superior refinements, the pure tone thresholds will provide the audiometric pattern on which interpretation is based. In the preceding paper we saw how a valid audiogram can be obtained. It should then be considered, as in most medical evaluations, as one test result that may have a bearing on making a diagnosis. Frequently it is only when other individual factors are taken into consideration that probabilities can be rated. Precision may be elusive. Further investigation may be necessary.

The Standards Association of Australia (SAA) Hearing Conservation Code AS1269-1976 sets out recommendations for interpreting test results. If the pre-employment test shows "significant hearing impairment" which is confirmed at a second examination on a different day "every encouragement shall be given to induce that person to seek specialist medical advice". The question immediately arises; when does a hearing impairment become significant? Roger Maas[1] considers the criteria for distinguishing abnormal from normal hearing to be an average hearing loss in the speech frequencies exceeding 25dB, an unusual irregularity or an abrupt loss beginning at 2KHz.

The SAA Code then goes on to refer to monitoring audiometry which "shall be performed within 90 days of initial exposure for comparison with the pre-employment audiogram". A threshold shift greater than 10dB should be followed by further full audiometric examination and review.

The cause of the hearing impairment may be in the external, the middle or the inner ear and its connections with the brain. Those in the external and middle ears are referred to as conductive impairments while the others are classified as sensorineural (sensori for the cochlea itself and neural for all the connections). There may even be various combinations.

The classical pattern of a noise induced hearing loss (NIHL) is a notch or dip at 4KHz on a pure tone audiogram. By itself it may not be diagnostically conclusive but it is a strong presumptive indicator when other causes such as advancing age, head injury, ototoxic medication, systemic disease and familial causes have been excluded.

Frequencies above and below 4KHz may be involved, particularly with prolonged exposure. This may produce a shift of the notch to the right or left of 4KHz or a widening of the notch. Uncertainty creeps in when the pattern shows a continued downward slope above 6KHz or below 1KHz. Beyond the age of 35-40 years presbycusis starts to make its presence felt with main emphasis on the high frequencies. It then becomes impossible to determine how much value to attribute to ageing and how much to noise exposure. Some assessments take the age factor into consideration, others do not. This looms large in compensation claims, a topic which comes up later in the programme. For strict interpretation of the audiogram, however, there is no reliable formula for evaluating either of the two components. If the downward slope is progressively greater towards the lower frequencies a noise-induced component is less likely.

Other uncertainties may also arise when there are other ear conditions which may produce hearing impairments. Any lesion which affects the middle ear conductive mechanism may produce a difference in hearing threshold levels by air conduction and by bone conduction, thus producing an air-bone gap. The pure tone audiogram will not produce any additional evidence over and above this. It is only when all the various lesions which may affect the middle ear have been evaluated by means of the history, the appearance of the tympanic membrane and acoustic impedance studies that one can come to a fairly accurate diagnosis. If a conductive hearing impairment is present, the question frequently arises whether it prevents or modifies the noise induced high frequency notch. The evidence is somewhat conflicting[4]. Attempts have been made in some assessments to discount the possibility.

When it comes to the other causes of sensori-neural hearing impairments the situation may require further audiological investigation before any reasonably accurate diagnosis can be made. This usually involves a battery of several different types of audiometric tests in order to determine the site of lesion. There are a few pointers which may help. First, is there a noticeable difference in the thresholds in the two ears? Admittedly a greater high frequency drop-off may

be evident in an ear that has been more exposed to the source of the noise than the other ear, eg. in shooting, but if there are differences throughout the whole frequency range between the two ears, further testing is advisable. Next, are the pure tone thresholds not in keeping with the test subjects's ability to carry on an ordinary conversation? If so there are again various audiometric tests which will give a useful lead on to whether the test subject is responding reliably to the test procedure. One of the simplest is to repeat pure tone audiograms on several different occasions with intervals of a day or so in between them. It is not easy for the test subject to be able to reproduce exactly the same pattern of audiogram unless he is responding honestly to the test procedure. Thirdly, the shape of the audiogram when the lower frequencies are more affected than the high frequencies suggests that another factor may be responsible particularly in the middle age groups. Usually this is concerned with alterations of the fluid pressure inside the inner ear; frequently accompanied by giddiness. Finally, there are other causes of the sensori-neural hearing impairment which may be classified as retro-cochlear. This term embraces any pathological lesion of the auditory pathways right from the 8th cranial nerve itself up through the brain stem to the auditory cortex of the brain. Again there are elaborate test procedures which can help to determine the site and cause of the hearing impairment.

In these two relatively short paragraphs I have summarised an enormous area of otology and audiology. The appropriate investigations necessary to narrow down the diagnosis may take several hours and considerable skill. The important principle, however, is to realise that any worker who is exposed to loud noise can still be a possible victim for the multiplicity of causes of a hearing impairment which may yet have nothing to do with noise. It may even happen that the noise-induced component may be present concomitantly with any of the other causes mentioned earlier. It is only by constant awareness of this that proper evaluation can be achieved. To put the matter in more simple terms; if there is something about the pattern of the pure tone audiogram which does not seem to be in keeping with what is to be expected from one's knowledge of the test subject and his amount of exposure to loud noise the wisest plan is to seek further help. In addition to saving compensation being paid to those whose hearing impairments are not noise-induced, it may be possible to identify the other causes of hearing impairment which lend themselves to amelioration by either medical or surgical means. In saying this I am well aware of the difficulty

in deciding whether it is the employer or employee's own responsibility to see that these further test procedures are instituted. I am also aware that it may add further expense and loss of working time to what can already be costly. However, if hearing is going to be conserved, a price value-judgement has to be made. How much benefit can the community gain? How much can industry afford?

Feldman and Grimes[2] discuss the balance that needs to be struck between the industrial and clinical approach. How much licence is allowed in reviewing results? They also question the ethical and possible legal implications if the reviewer does not draw attention to other conditions that may lead to hearing impairments. On the other hand they warn of the possibility of over-referral weakening the efficacy of a programme.

Another factor in interpretation is the important question: is this audiogram valid? Sataloff and Vasallo[3] point out that "there are medical folders in plant dispensaries in which at least 30% of the audiograms are neither valid nor reliable". There can be several reasons for this, not the least being the controversy whether automatic audiometry is more or less reliable than operator-controlled audiometry in the industrial situation. (Computerized automatic audiometry is gaining favour in some quarters.)

Recording of audiometric test results also needs to be mentioned. Certainly the method of graphic representation on a conventional pure tone audiogram lends itself to easy and rapid interpretation. With the addition of subsequent monitoring audiograms however, the graph is apt to show many broken lines of different colour that can eventually become hard to disentangle. For monitoring purposes numerals in columns are easier to compare.

In the U.K. a different approach to interpretation has been put forward by the Health and Safety Executive Working Group on Audiometry in a discussion document published in 1978. The proposal is set out in the form shown in Section 5 of their document[5] (reproduced here in an Appendix). This method of assessment seems somewhat more liberal than the S.A.A. Code.

Conclusion

The industrial audiogram is a small piece of paper showing circles, crosses, square brackets or numerals. They express the level at which certain pure tones can just be heard through an earphone in a carefully controlled test environment. Nothing more. You may legitimately make the point that this is an inadequate representation of the

subtleties of human hearing. True. But not your immediate concern in the industrial situation. You want to know the effect the noise in this industry is having on its workers. Pure tone audiometry is the best available way to find out. But do bear in mind that other factors must also be taken into consideration, namely:

Medical history
Otoscopic appearance
Noise levels on the job
Last noise exposure (number of hours)
Previous noise exposure
Previous protection
Audiometer and test conditons
Audiometrist
Need for supplementary tests

Armed with this information an interpretation can be made which will serve as a guide for both occupier and employee.

References

1 Maas, R.B. Industrial Noise and Hearing Conservation, in J. Katz (Ed), Handbook of Clinical Audiometry, Baltimore, The Williams and Wilkins Company, 1972, 795.

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3 Sataloff, J. and Vassallo, L.A. Hearing Conservation. Industrial Medicine, 24(2), February 1973, 23-26.

4 Brasher, P.F. et al. The Influence of Middle-Ear Muscle Activity on Auditory Threshold Shifts Induced by Noise. Research Memorandum S/3, Ministry of Defence, Army Personnel Research Establishment, c/- Royal Aircraft Establishment, Farnborough, Hants., U.K., December, 1970.

5 Great Britain, Health and Safety Executive. Audiometry in Industry. Report of the Health and Safety Executive Working Group on Audiometry. London, Her Majesty's Stationery Office, 1978.

APPENDIX

Action following audiometric testing

43 Initial assessment of audiograms should be undertaken by the qualified person or by the designated medical practitioner. For this purpose, the hearing levels of each ear should be summed over the low frequencies 0.5, 1, 2 kHz and the high frequencies 3, 4, 6 kHz, and the audiogram categorized according to the following scheme.

44 If the sum of the hearing levels, either for low or high frequencies, shows an increase of 30 dB or more when compared with the immediately preceding audiometric examination, or 45 dB when the interval of time since the preceding examination exceeds 3 years, the case should be categorized 1.

Note: *Comparisions with preceding audiograms may be unreliable unless testing conditions were similar.*

45 If the difference of the sums of hearing levels between the two ears exceeds the following values, the case should be categorized 2:

For low frequencies 45 dB
For high frequencies 60 dB.

Note: *Unilateral hearing loss, falling within this category, will not usually be due to the effect of occupational noise alone.*

46 The sums of hearing levels for each ear should be compared with the values in Table 3 below, entering the Table at the appropriate age. If the sum for either ear exceeds the 'referral' level, either for low or high frequencies or both, the case should be categorized 3. If the sum for either ear exceeds the 'warning' level, either for low or high frequencies or both, but in no case exceeds the 'referral' level, the case should be categorized 4.

Note: *It is useful to annotate which ear and which frequency range determine the categorization in these cases (e.g. category 3, both ears, high frequencies).*

Table 3 Chart for categorization of hearing levels

	Sum of hearing levels			
	0.5, 1, 2 kHz		*3, 4, 6 kHz*	
Age in years	*Warning level*	*Referral level*	*Warning level*	*Referral level*
20—24	45	60	45	75
25—29	45	66	45	87
30—34	45	72	45	99
35—39	48	78	54	111
40—44	51	84	60	123
45—49	54	90	66	135
50—54	57	90	75	144
55—59	60	90	87	144
60—64	65	90	100	144
65—	70	90	115	144

47 Cases which do not fall into any of the above classes should be categorized 5.

48 The designated medical practitioner will be responsible for deciding on appropriate action to take in the case of persons categorized 1, 2, 3 or 4.

Note: *Further medical action as recommended would follow allocation to categories 1, 2 and 3. In category 4 all persons would be told of the 'warning' status indicated by the audiogram and recommended to take precautionary measures to preserve their hearing. The exact medical action, such as the nature of the advice and possible follow-up, would be at the discretion of the designated medical practitioner.*

Discussion:

Mr. Murphy: Suppose that a person with a hearing loss applies for employment with a particular firm and he's given a pre-placement audiogram. What type of action is going to be taken on the basis of that audiogram - is it going to be used to decide whether on medical grounds a person is going to be permitted to carry out a certain type of work? I'm sure that, as industrial noise legislation becomes general pre-placement audiometry is going to become an essential part of the pre-employment examination, is there going to be a level of hearing loss beyond which people will not be employed?

Dr. Bulteau: In my experience this is usually determined not on medical grounds, nor on audiometric grounds, but more on how much that particular industry needs that particular man or, in relation to the armed services, whether he is a valuable man to them. I don't know of any set level at which you can determine it. It seems more equitable to me that the facts should be made known to the man and his employer and he should then be given the choice but I don't know of any level that you can set as a criterion.

Dr. Lewis: The situation in South Australia is that if at the time of a pre-employment audiogram it is found that a person has a hearing loss then that person is virtually unemployable because of our compensation laws. But I'd like to ask a question in relation to the frequency at which this dip occurs in noise-induced hearing loss. I assume, and I'd like you to comment as to whether or not my assumption is correct, that it occurs at the frequency of the noise which is being emitted. Now this puzzles me a bit because surely people in industry are exposed to the broad spectrum of noise so why does the loss only occur around 2000 to 4000Hz, that is in the high-frequency range. If it does occur in other ranges, would you care to comment on whether people in say the agricultural industry are likely to suffer losses in the lower range?

Dr. Bulteau: I think there's a lot of controversy about what causes the 4000Hz dip. Attempts have been made to explain it in terms of vascular and hydrodynamic causes but I think Lehnhardt in Germany has given probably the most likely explanation for it. Although classically occurring at 4KHz the notch can go up to 6KHz, it can come down to 2KHz. I think the bulk of it is at 4KHz but the actual explanation I don't think I can give you in about half a dozen words although I don't think it is related directly to the frequency of the noise which caused it. I think a psychoacoustician like Norman Carter could give you more information on that than I could.

Mr.Carter: Well I certainly couldn't add anything on the causes but I think the fairly small amount of evidence suggests that in spite of the wide range of spectra that you encounter in industry the notch does generally appear to continue to deepen first at 4000Hz. That has been confirmed and it has been confirmed even for sounds with a great deal of low frequency energy in them. The pattern is generally fixed at 4000Hz even though the temporary change might occur at quite low frequencies.

Mr. Crehan: If you recall the four slides that Dr.Rosen showed yesterday morning one or two showed an increase in the hearing threshold at 125 and 250 Hz relative to the threshold at 500Hz, which suggests to me that that may probably be a testing environment effect rather than an actual threshold shift.

Dr. Bulteau: I agree with you. That was my immediate reaction to that. Also I got the impression that in some of her slides there was some presbyacusis as well as a straighout noise induced component. As far as the low frequency component goes I would associate that with the test conditions.

A HEARING CONSERVATION PROGRAMME - SUCCESS OR FAILURE

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Hearing Conservation Programmes are well known and appear uncomplicated in their implementation. Such a programme in a large industrial organisation with the problems encountered is discussed. Compensation for hearing loss as a complication to the programme is highlighted.

I must thank your organizing committee for inviting me to speak today. I make no pretence of being a learned person in this field but rather an occupation health practitioner who believes that employees should not suffer adverse effects from their employment. This ideal may never be achieved in its widest concept but it should be possible in the case of exposure to industrial noise.

The industrial revolution brought with it noise and an increasing number of people have been exposed to industrial noise. Unfortunately modern technology has introduced sources of noise, quite apart from industrial noise, for us to subject ourselves to. Noise would appear to be almost a necessity in modern civilization.

The ubiquitous transistor radio is one example which suggests that quiet is not desirable during waking hours for a large segment of our population.

This aspect of noise exposure has increased the task of evaluating the impact of industrial noise exposure on hearing.

When I first considered the need for a hearing conservation programme I was aware of the rather unique opportunity it presented. We would have pre-employment audiometry, monitoring audiometry and as a self insurer company the processing of compensation claims for hearing loss.

It is this story I wish to talk about today.

In 1966 I started discussions with management for a hearing conservation programme to be started. At that stage my main concern was for the principle that a programme was needed to be recognised.

Hearing Conservation Programmes had been in operation in some industries in America for a few years at that time but virtually nothing

was happening in Australia. These programmes consisted of the well known components:-

1. Noise surveys to locate areas of excessive noise.
2. Noise reduction at source or isolation of the worker from the noise.
3. Administrative control by which the time a worker is exposed to noise is adjusted to keep his noise dose below maximum permissible levels.
4. Provision of personal hearing protection.
5. Audiometric monitoring.
6. Education of the worker.

None of these components are without their own special problems.

Our plant at Port Kembla is a fully integrated Steelworks employing some 19,000 people. The production units vary from Blast Furnaces to Plate Mills, Coke Ovens to Diesel Loco Repair Shops. The diversity of structures is matched by the diversity of potential noise exposures. Considerable skill in the techniques of noise level testing, noise suppression, administrative control and personal protection were required - we did not have them at that time. Experience in audiometry with its practical problems in industry was yet to be acquired. No doubt ignorance is bliss.

In 1968 a company wide noise level survey was undertaken and was quite properly directed towards noise control. This survey by our present standards was rudimentary and superficial but the very size of the exercise was a limiting factor. Arising out of this survey however were the beginnings of noise control. This control has progressed at the company's plants.

In 1970 we introduced audiometry into our pre-employment examination at our Port Kembla plant. This was undertaken to give us experience and also a datum base on which to make future decisions. We acquired a Tracor automatic audiometer, a manual screening audiometer and a sound proof booth. All potential employees were given a simple screening at 4,000 cps and if they showed a loss of 30dB or more at this frequency a full audiogram was performed.

This expedient was unfortunately necessary as we were at that

time starting new employees at the rate of about 5,000 a year. All but a small few had to be processed in the mornings and they were never evenly spread through the week.

Another real problem was language. A high percentage of our new employees were migrants with little or no English and I can only congratulate our Nursing Sisters, who were engaged in this work, on their patience and the good results they obtained.

All the audiograms were calculated for hearing loss using the then accepted C.A.L. tables. A record was kept separately of all those with an A.H.L. of 25dB or more; 25dB being the level which at that time attracted a percentage loss for compensation in N.S.W.

We also kept a money conversion tally.

In this way we knew how much potential compensible hearing loss we were acquiring. I will have some more to say on this matter later.

Nobody was rejected on account of a hearing loss.

Towards the end of 1971 a formal hearing conservation programme was started in our Plate Finishing Department. The department which employed about 700 people was selected for a number of reasons. It had a high noise level due mainly to steel plates passing over rollers. It was a well defined area and the management of the area was co-operative.

Before we even started an education programme and audiometric testing the union delegates in the department, no doubt misinterpreting the reason for the programme, took the employees out on a 24 hour strike and demanded that ear protection be provided immediately for all employees in the department. A choice of ear muffs or Bilsholm wool was immediately provided. About 25% of the employees started wearing protections. This was not a very good start to what should have been a happy co-operative exercise.

After a cooling off period of about a month the education programme was started and we commenced audiometric monitoring. It had been agreed that if any employees were found to have a compensible level of hearing loss they would be told and advised of their rights to make a claim for compensation.

Due to the size of our plant at Port Kembla the Medical Centre is about 4 kilometers from the Plate Finishing Department. We decided

that there would be real difficulties in transporting the employees so we started our audiometric testing in one of our Medical Units which was situated within walking distance of the department. There was no sound proof booth in this Medical Unit and we did not think to get ambient noise levels taken in the unit.

As we were advising employees of their compensation rights, claims started to be processed through our Compensation Department. We are self insurers as I previously stated.

All employees had their initial audiogram performed at the beginning of a shift before exposure to noise at work. This gave an interval of a theoretical 16 hours free of noise. For those who claimed compensation a second audiogram was done at the Medical Centre in the booth after a roster-off period which would be two or three days.

Marked discrepancies between the two audiograms soon became apparent and we felt it could not be simply accounted for by the time difference of freedom from noise exposure. Continuous monitoring of the noise levels in the room where the initial audiograms were done was carried out over a 48 hour period. What a shock! Most of the time the ambient background noise was above a satisfactory level for undertaking audiometry.

This background noise came from machinery, compressors and passing traffic all of which were not obvious until after the noise level monitoring and we started listening for the sources.

I wonder how many E.N.T. specialists who perform audiograms and give authoritative reports on hearing loss have had the background noise in their rooms checked or use sound proof booths.

We decided to carry out all audiometry in the Medical Centre. The audiometric results started showing a greater consistency but another problem developed.

The distance from the department and the extra time off the job slowed down numbers being sent to the centre for audiometry.

This particularly applied in the case of those who were to come for annual monitoring audiometry and monitoring has at present almost ground to a halt. I am not laying the blame at anyone's door but rather highlighting practical problems which have been a traumatic learning process and from it we are hopeful of rectifying the situation.

About three years ago there was a marked upsurge of activity in noise reduction which had been going along steadily. This activity involved a greater interest by individual departments in the hearing conservation concept and many of them started their own programmes. Our Medical Centre started being inundated with requests for audiometry. Endeavouring to cope with the numbers we were forced to test men during their shift.

Those with a compensible degree of hearing loss would then be retested after a "rostered-off" period and frequently it was necessary to do a further test to validate results.

Concurrently there has been an increase in claims for compensation for hearing loss being initiated by employees approaching our Compensation Department or through solicitors.

I regret that what I envisaged 10 to 12 years ago as an occupation health problem, which could be reduced by appropriate measures of noise reduction and control, has developed into a multi-million dollar scramble for compensation.

I believe that our experience is in many ways typical of what industry in general is experiencing or is going to experience.

What are the elements out of which this situation had developed?

Firstly as I mentioned earlier our concept of a hearing conservation programme has been developed mainly from the American experience. The very wording used in model regulations is virtually identical with the American.

H.C.P's in America were able to be developed virtually free of a compensation component. Admittedly many American industries agree that the foreseeable introduction of compensation was a stimulus. Ten years ago very few states in America had effective compensation legislation for hearing loss and where it did exist there were usually disincentives against employees making claims.

So, companies were able to proceed with their programmes in an almost clinical atmosphere.

This brings me to the second element which is the research and development of techniques for testing hearing. I am sure that other papers at this conference will highlight this area. Despite

progress in methods of assessing and diagnostic tests to localise the cause of hearing loss, pure tone audiometry remains the only technique available from which a percentage hearing handicap can be determined.

Just what handicap it measures depends on the range of frequencies tested. The concept of "hearing loss simpliciter" has not really been resolved.

I at times wonder what we are measuring with pure tone audiometry. Our experience suggests that the results of pure tone audiometry frequently do not reflect the subjects own perceived loss of hearing.

This brings me to the third element, that of compensation. I will confine any comments to N.S.W. legislation. The development of legislation in relation to hearing loss has been a piecemeal effort starting virtually in 1953 when His Honour Judge Rainbow, in the case of Milne -V- International Combustion Australia Ltd, held that Boiler Makers deafness was neither a disease nor a disease of gradual onset within the meaning of Section 7(4) of the Act which deals with diseases of gradual onset. The present Act still refers to Boiler Makers deafness or like disease.

The Act still does not indicate how a percentage hearing loss should be assessed.

The tables especially prepared by the N.A.L. for the use of the N.S.W. Compensation Commission to satisfy this State's monoaural method of assessment still have only de facto recognition.

I believe it to be accepted that a binaural assessment of hearing loss reflects more truly the subject's handicap. Despite that, because legal argument finds otherwise, N.S.W. persists in monoaural assessment.

The other component for concern in industry is that it will pay for all sensori neural hearing loss however produced excepting some few cases when it can be proved to be drug produced.

I must say that with the mill-like processing of claims, there is little interest in the medical or legal profession to altering the situation.

Since measures were first taken to reduce noise exposure in the Steelworks at Port Kembla, over a million dollars has been expended. This campaign is ongoing in both the areas of noise reduction at source

and isolation of the worker from noise.

The return to the Company so far for this endeavour has been a pay out in compensation from January 1970 to June 30, 1978 of $1.3 million with half of this amount accounted for in the last 12 months. The number of claims for that period is just short of 1000, with the numbers increasing each year. There were 325 claims paid in 1977 and 235 paid in the first six months of 1978. By the end of this year we should top 500 claims for 1978.

I would like to return to our pre-employment audiometric experience. As mentioned previously, a separate record of all potential compensible hearing loss in new employees was kept. We were using the C.A.L. calculation and the results were therefore conservative for as you are aware, the N.A.L. calculations produce a higher percentage loss of hearing. The change from Commonwealth to National at least serves a useful purpose in identifying the two tables.

We surveyed a five-year period 1972-76 during which 27,300 new employees were examined. The results showed an average of 1% of compensible hearing loss per person. The real situation was that 1.9% of new employees accounted for 80% of all the potential compensible loss. This group had a loss of 20% or more. Several of these new employees have subsequently been paid compensation for the hearing loss with which they entered our employment. The total potential compensation pay out at current rates for the intake over those five years is $1.9 million.

Early this year a decision was taken to reject prospective employees with a hearing loss in excess of 20%. This rejection, of course, would be subject to review if the loss had been compensated by a previous employer.

I personally regret the necessity to take this action. As the cost of sensori neural hearing loss to industry becomes fully recognised this practice will undoubtedly spread. Legislation which has been developed to protect the worker's compensation rights is backfiring.

I would be the first to agree that industry generally should pay for the hearing loss it has produced but it is now called on to pay for virtually all sensori neural loss as well as much conductive hearing loss which is unrelated to the employee's work.

What have we learnt? Where do we stand now? What of the future?

Firstly we have learnt that a hearing conservation programme must be well organised and well rehearsed which ours was not. The development of the programme progressively throughout a large Works has to be well planned and takes time. Adequate staff with sufficient training and expertize to carry out the programme is essential. The calls upon the time of this staff group increases as the programme spreads. Finally in the learning process has been the realization that prevention of future hearing damage involves also compensation for past damage to hearing.

At the present time we are endeavouring to cope with an increasing demand for audiometry solely for compensation purposes. This is creating a situation in which monitoring is virtually at a standstill.

We are anxious to revitalize the hearing conservative programme. A time sharing computer terminal is being installed in our Medical Centre and it's initial function will be related to audiometry. The programme will give us greater control over the recall of employees for monitoring audiometry. This is an area in a large work force where manual checking is not practical. The scheduling of appointments for audiometry will be facilitated as well.

Of equal importance will be the ability to review any audiometry changes occurring and so monitor more closely the effectiveness of noise reduction efforts or the wearing of personal protection.

The title of the paper was "A Hearing Conservation Programme - Success or Failure". On the debit side I have highlighted what I see as failure. The lack of initial organisation with its subsequent train of problems, the topsy-like growth of individual efforts in departments throughout the Plant, and the all pervading compensation overlaying, have given me a sense of failure.

It would be very wrong for me to minimise the success side. Noise levels have been reduced in many sections of the Plant and frequently quite dramatically. Hearing protection is being worn by hundreds, if not thousands, of employees who seven years ago would not even have heard of it much less been prepared to use it. There is an awareness to reduce noise starting at the design stage of Plant and equipment.

As a long term occupational health preventative programme we must be on the credit side.

Discussion:

Mr. Murphy: Well, Dr. Howe I would still say that the endeavours and investigations into hearing conservation programmes at your plant have been most impressive. Perhaps I could start off the questions by asking when there is a claim for hearing loss, where is the audiogram done on which payment is made? Where does the industrial audiologist come into this programme?

Dr. Howe: I'm afraid it's a sad situation in which we're placed. If we look at the claim that comes through our solicitor, an ENT specialist has already examined the claimant, has produced an audiogram, has done his calculations and said what percentage loss there is in each ear, has said that this man has had no previous ear disease, no present ear disease, it is a typical sensorineural type hearing loss audiogram and if this man has been exposed to noise, undoubtedly that is what has caused it. We will then do our own audiogram to see if we're close enough and if it is close enough to recommend payment. Now it's all very well talking about further investigation, but it costs money and the end result is the same. You get nowhere with it unfortunately. Of course we have the Workers' Compensation Commission - which is there as the Workers' Compensation Commission not as the employers' compensation commission - and its a very simple exercise: if a man has a loss which appears to be a sensorineural loss and you've exposed him to noise - and it hasn't got to be 85 or 90 dB(A) for 8 hours a day, five days a week, for years: it's enough if he's walked through a department of 90dB(A) once - that is enough. Now that might sound ridiculous but within the Commission that is enough. And so you beat your head against a brick wall to argue about whether we gave it to him or not: if it looks like it and we think the amount of loss that man has agrees with the specialist we pay him. That doesn't quite answer your question but that's the facts, I'm afraid.

Mr.Murphy: Perhaps I could add something further about our experience in the Commonwealth Department of Health. When compensation claimants who have had examinations elsewhere for hearing loss, are then examined by the National Acoustic Laboratories, with adequate time, appropriate equipment, booths and so forth, we find that lower thresholds are obtained and this reduces money paid out in compensation. That's why I mentioned a place for audiologists in the industrial sphere.

Anon: Could I ask Dr. Howe two things: does he consider any areas of his plant make it dangerous for the workmen to use hearing protection - I continually find people telling me that a coal miner can't wear

earmuffs because he can't hear the roof talking to him or a crane chaser can't wear some appropriate form of hearing protection because he can't hear a dogman yelling out. Following that up, is there any way you can overcome active discouragement at the foreman level to the wearing of hearing protection. There are arguments on all sides but I think most ENT surgeons would agree that after ear surgery, especially stapedectomy, it is advisable to wear some form of hearing protection in noisy areas but I have found that there is at times active discouragement of this - is there any way apart from education of overcoming it?

Dr. Howe: In answer to your first question, our experience is that the greater the need for hearing protection, the less the risk is of any signal not being heard. In other words, if the background noise is so great, they are not going to hear the signal anyway. Put on hearing protection and you will hear the signal better. It's certainly easier to talk in a high background noise if you've got earmuffs on. In low background noise with earmuffs communication is more difficult so if you are being over-fussy and wearing hearing protectors in low levels you could concievably run into communication problems. If there is a real need for protection the risk isn't there. Now your second question: we haven't found any active resistance on the part of foreman to people wearing hearing protection. Our greatest problem is to get foremen to wear it as an example.

Mr. Campbell: Dr. Howe, I wonder if you could tell us what component of your 1.3 million dollar cost was in common law claims or if there were any, in fact.

Dr. Howe: They are all straight Section 16. There are no common law claims.

Anon: What are the effects of refusing employment to people who already have a hearing loss on their freedom to move from one job to another?

Dr. Howe: You're talking about the policy I mentioned that we don't take them on if they've got a 20% loss. Sure, it's a problem. We didn't make the legislation and the simple facts are that if someone has a sensorineural loss which can be shown to be noise-induced and they work in an industry the nature of which can produce that hearing loss that employer shall pay for the total hearing loss he has. Now once you've got that paid up he can go and work where he likes. No one is going to stop him then because he is not bringing a liability into the organisation. It tends to flow back all the time to the last employer. Some people get caught in the razzle-dazzle of course and

don't find it easy to get compensation, especially if they are a migrant just arrived from Yugoslavia.

Dr. Bulteau: I was interested in your comment concerning communication while wearing earmuffs. There is a U.K. study that two workers both with high frequency losses and wearing earmuffs perform worse communicating with one another with muffs on than with them off.

Dr. Howe: I was talking about people with normal hearing rather than those with a hearing loss in responding to the question I was asked about whether using earmuffs as a protection against hearing loss affected communication. I think there's a different problem altogether of course where you've got someone with a sensorineural hearing loss and you put them into earmuffs.

Dr. Bulteau: They are the ones who complain about their difficulty in communicating in my experience.

Dr. Howe: Yes, I suppose, theoretically, you would expect that to be so and what we should be doing is moving those people out of noise altogether. They're obviously susceptible, they're obviously going to get increases in hearing loss and even with protection you can't be sure that they are going to protect themselves all the time. You've got to really take them away - personal protection is the poorest form of protection in any aspect of safety.

Mr. H. Weston: Having worked for many years in a very large steel industry in Port Kembla, I think Dr. Howe has achieved something very remarkable in what he had already done. In reference to one thing he mentioned about compensable hearing loss affecting new employees, I wonder whether he might consider giving that employee the option before rejecting him of lodging a claim with his previous employer.

Dr.Howe: We do. We tell him of his rights and it's up to him then to make a claim.

Dr. Scrivener: I too would like to congratulate Dr. Howe for getting a programme started under what have obviously been extremely difficult circumstances. I wonder if he can tell us a little bit about how he managed to get started, in particular the question of training the sisters in doing the audiometry and secondly how he handles the malingerers. The word is out amongst the boys now about the golden ears and I think we all have the experience of examining people who can converse very well on neutral subjects but when the question of deafness is discussed, in particular with reference to their work, they become increasingly hard of hearing and when they are brought near any sort of formal testing situation it works like the inverse square law: the closer they get to the audiometer the greater, by the square, becomes

the intensity of the hearing loss. The result is that some of these patients, by the time they have the earphones on, are almost totally deaf in both ears. Now this is the experience we have sometimes, not all the time, in clinical situations, so I wonder if Dr. Howe could tell us how he got this programme started from the point of view of training the sisters and how they manage the malingerers.

Dr. Howe: The sisters develop their experience as part of working in the field. There is no formal training whatsoever. Again a problem of trying to persuade management. What we had to tell them was give us the equipment and we'll do it. It's as simple as that - how many more people would you need? No more people, we can do it with the staff we've got. At that stage to suggest that we send one or more sisters away for formal training for several weeks would have been the death knell of the programme. I must say things are different now. So they have become sensitive and skilled in the art if not in the science and they are the ones who seem to be able to sniff out the malingerers. Now what happens with those of course is that we've got to then send them to an ENT specialist. As practioners of occupational medicine we have to rely on their expertise and advice to tell us what we ought to do. If they come back and say the man's not a malingerer we're not in a position to argue.

Mr.O'Keeffe: Mr. Chairman, I think Dr. Howe was a little unkind to the Workers' Compensation Commission of New South Wales. I don't belong to that august body but they do happen to be a body of appeal for cases under the Commonwealth legislation. We had a case earlier this year in which the NAL assessment on which we had made payment was 8.1%, but claimant appealed against the determination and came up with audiograms from a specialist - I won't mention any names - that went as high as 39.5%. That case went to the court at the Workers Compensation Commission of N.S.W., acting in the Commonwealth jurisdiction. I noted that the judge commented that the initial audiogram on which the NAL assessment was based was taken, I think, by Mr. Fifield and mentioned that he was a well-qualified audiologist. We subsequently had him re-tested at NAL because we couldn't see how there could be such a big difference. On the second occasion he was tested by Mr. Smither whom the judge said was also a highly qualified auditologist. The outcome was that the judge decided that the original determination stood, which was based on the 8.1%. Now I make the point that perhaps your problem is that you don't produce before the Workers' Compensation Commission people who can be held to be highly qualified audiologists.

Dr. Southgate: I'd like to ask Dr. Howe whether he has the Unions on side in his programme and whether there is any education programme for the Union leaders and shop stewards?

Dr. Howe: The answer to the first part of the question is that I never know. The answer to the second part of the question is that there isn't any specific education as far as the Unions are concerned.

Dr. Southgate: As far as I can see that is the main reason for the slow take-off of any programme and the slow progress during the running of the programme. The Unions are not "for" in the mining industry either. I think it's a great shame the Unions are not more interested because deafness is a very serious complication of exposure to noise and the Unions by their inaction are condemning their fellow members to great problems in their later years.

Dr. Howe: I'm afraid there are a number of reasons why the Unions don't become involved in these matters and I guess to some extent they very much parallel the same reasons that management isn't too enthusiastic about it. Perhaps it's the opposite side of the coin but it's pretty much the same kind of reason.

Mr. Satory: I would like to report that at the conference in Spain it was agreed by several people who presented papers that there is a loss of ability to detect direction of sound when wearing earmuffs, particularly for sounds from behind, and for this reason people have allowed the use of other types of protection than muffs where there are fork lifts travelling down a runway or other hazards of a similar kind.

Mr. Murphy: Thank you Dr. Howe for a very down to earth and practical paper. I'm sure we've got no stars in our eyes and that's a very good thing.

FIFTEEN YEARS EXPERIENCE WITH HEARING CONSERVATION PROGRAMS

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The Department has provided hearing conservation programs involving on-site periodic audiometric and medical assessments for both private and government industries as a free service for fifteen years.

The development of the programs will be discussed from the first beginnings to the present system, and will include details of the latest sound-proof caravan.

The computer-aided reporting program will be described, namely the output it produces and the way in which decisions are made within the program to produce the output.

Results of continuous records will be documented showing comparisons of long-term results.

Because of the considerable, lengthy field operations with both identification and experience of practical problems, comments will be offered on audiometry as a mandatory requirement.

SEPTEMBER, 1978.

The South Australian Department of Public Health first began to provide hearing conservation programs for industry in the early 1960's and has maintained a continuing involvement in the area ever since. This paper aims to outline the evolution of the program highlighting developments which have been particularly important and instructive. The co-authors hope that this historical review will provide useful information for those who are now considering or commencing hearing conservation programs in industry.

THE FIRST TWO PROGRAMS

Experiences gained at two government workshops in the early 1960's are particularly instructive.

Site A

Late in 1960, the Workshop Superintendent of a government woodworking factory requested a noise level survey of the plant. The workshops in question consisted of a machine shop housing a number of different woodworking machines and an adjacent joiners' shop. As anticipated, the noise levels were high, reaching a maximum of 106dB at the feedman positions of two of the planers.

An attempt was made to isolate one of the planers and did, in fact, achieve some reduction in noise levels, but the overall improvement to the workshops was disappointingly low.

On the advice of engineering consultants, extensive noise control measures were undertaken over the next two years, consisting of total enclosure of four machines and sound absorbent treatment of the entire roof and the partition which separated the machine and joiners' shops.

The lesson to be learned from this early experience was that engineering noise control is no field for well-meaning amateurs and it has become our practice to advise industries to obtain the services of qualified acoustic engineers.

The first audiograms had been taken at the workshops in March, 1961, and showed that most of the 23 employees presented some noise-induced hearing loss in one or both ears. Recommendations were made for the provision of ear plugs for those employees.

In his final report to the Workshop Superintendent in 1964, the consultant engineer suggested monitoring audiometry to test the

effectiveness of the noise control measures.

Thus in 1964 an audiometric testing program was begun and has continued ever since. The value of periodic audiometry was demonstrated by the observation that, by 1968, further losses were being reported in a small number of employees. Investigations carried out in conjunction with the Safety Officer on work methods, showed that some men had altered their working patterns since the machines had been enclosed. A further noise level survey revealed that some machines, including new installations, were not below the acceptable safe criteria. Consequently additional hearing protection measures were required.

Site B

In 1962, employees in the boiler and carpentry shops at another Government workshop were becoming anxious about industrial deafness. In conjunction with the Boilermakers' Society, the matter was discussed at a Departmental Safety Committee meeting, and a suggestion was made to approach the Commonwealth Acoustic Laboratories (C.A.L.).

C.A.L. conducted a noise survey and "reported that the noise generally in the boiler and carpentry shops was or would be in time, injurious to employees. They recommended that employees be encouraged to wear hearing protectors".[1] It was decided to introduce a hearing conservation program and ear plugs were issued to employees in the two shops.

Officers of the Occupational Health Branch became involved in November, 1963, when the first hearing tests were conducted. Regular audiometry still continues. The first tests showed that some workers in the boiler shop had noise-induced hearing loss, and over the next few years further deterioration in hearing occurred in some workers. There was poor acceptance of the ear plugs, with complaints including soreness to the ear canals, ear infections, poor fitting and general hygiene. After about three years, recommendations were made to change to ear muffs and, after a pilot study, the new hearing protection was issued at a film and lecture session, conducted by our Medical Officer and their Safety Officer.

By 1970, because of continuing losses and the fact that hearing loss was recognised for Workman's Compensation, the Safety Officer requested that an investigation be carried out to examine the

feasibility of engineering noise control in the boiler shop. This was done, but "the first attempts bore little success".[2] In 1972 the new Engineering Noise Control Section of the Department of Labour and Industry offered assistance, and since then several projects have been successfully completed.[3]

FURTHER DEVELOPMENTS

In the years 1964 - 1968, officers of the Occupational Health Branch pursued, initiated, and promoted hearing conservation programs. As a result there were many requests for noise level surveys and recommendations were made concerning the introduction of hearing conservation programs where the noise levels were excessive. A small number of private and government organisations accepted the offer of the free service, and some still continue with their programs. Other companies began programs and then, after a few years, withdrew for reasons which included - "not interested"; "introducing engineering noise control"; "directed by the insurer"; "don't consider noise a problem". The manager of one timber mill stated in 1965, "a fuss is being made over nothing - by drawing attention to the problem labour availability might be affected and unrest precipitated".

In February 1968, a Symposium on Noise in Industry was sponsored by the Departments of Public Health and Labour and Industry, with the assistance of the University of Adelaide and the active support of a number of private industries. The Symposium caused a considerable upsurge of interest in industrial hearing problems and subsequent years saw an expansion in the number of hearing conservation programs provided. By 1971 fifteen programs were being conducted in a variety of industries, including five different factories which employed occupational health nurses. The numbers of workers involved in those five sites was close to 1,000 and testing was provided every six months.

As an alternative to the service provided by the Departmental team, it was suggested that a more effective program could be implemented if the periodic testing was performed by the on-site occupational health nurses. They could provide continuous advice and surveillance, educate new employees in the need for hearing protection, and do pre-placement audiometry. Proposals were made to the five managements for us to train their nurses in audiometry; continue to provide support in the form of noise level surveys; advise on hearing protection; and provide medical oversight, including visits on request. An important requirement was

that the organisations should support their nurses and provide them with the authority to continue their hearing programs, and the necessary equipment and facilities which included an audiometer, suitable testing area, and storage for confidential records.

These proposals were accepted, the arrangements proceeded, and have proved generally satisfactory. As a result, it has become an objective of our program to initiate and develop services for industries and wherever possible to hand over control of the established programs.

The effects of legislation on hearing conservation programs.

Rumoured, impending, or proclaimed legislation has affected the demands for hearing conservation programs.

In 1971, noise induced hearing loss was included in the second Schedule of the Workman's Compensation Act. Industry's response to this was to retreat from programs, fearing an avalanche of claims if workers were informed of hearing losses. There were very few requests for new programs for several years. In fact very few workers did claim compensation for noise-induced hearing loss at that time.

Regulations based on the National Health and Medical Research Council Model Regulations for Hearing Conservation were introduced in South Australia in 1975. Regulation 49 - "Noise levels and protection from noise", required employers to reduce noise exposure to the allowable limits by means of either -

(a) engineering noise reduction, or
(b) administrative noise control, or a combination of both.

The Regulation required hearing conservation programs to protect the hearing of workers until engineering noise control could be implemented, but did not include a requirement for mandatory audiometry.[4]

As soon as the Regulations were passed, there was a rush of enquiries and many programs were introduced - to the point where we were obliged to increase our staff and improve our system and facilities. The computerized reporting system and mobile test facility described later in the paper were responses to this demand.

In recent months, with the down-turn in industry and the increase in the numbers claiming Workman's Compensation for noise-induced hearing loss, industry has once again retreated from hearing conservation programs.

The Noise Control (Hearing Conservation) Regulations, 1978, under the Noise Control Act, 1976, which had been anticipated for some months, were passed by Executive Council in July, 1978. Again, there was no mandatory requirement for audiometry, but, the new Regulations are more specific than the former Regulation 49 and require that all audiometric tests shall be conducted in accordance with requirements of Australian Standard 1269 - 1976.[5]

COMPONENTS OF DEPARTMENTAL HEARING CONSERVATION PROGRAMS

As a result of experience over the years, programs with the following elements are now offered.

1. Initial Contact

In the early years, hearing conservation matters had to be actively promoted by officers of the Occupational Health Branch, a situation which still applies. As knowledge of the programs and their availability grew in industry, requests came from managements, trade unions, government departments, or affected individuals.

2. Follow-up Discussions

Following the initial contact, the nature of the program is discussed with those responsible for the request. As a general policy, programs are not implemented unless there is agreement that the full range of activities should be embraced. Several employers, for example, have requested pre-employment audiometry but are not interested in engineering noise control, hearing protection or on-going surveillance. Their requests were therefore refused.

3. Noise Level Survey

The first step in the implementation of a program is for a noise level survey of the plant to be undertaken by scientific or technical staff of the Branch. All noisy work positions in a plant are monitored, using sound level meters, with both dB(A) and dB(C) readings being taken. An octave band analysis is performed in special circumstances. It has not been the practice to use noise dosemeters or other such methods to take fluctuations in noise levels into account, and this has been recognised as a possible defect in our survey technique. The noise level survey results serve three main purposes:-

3.1 They identify areas for engineering noise control.

3.2 They enable advice to be given on appropriate hearing protection devices.

3.3 They identify persons to be included in the audiometric testing program.

Our experience over the years has shown that if the selection of workers to be included in the audiometric testing program is based on the noise level survey, few problems arise. Persons exposed to noise levels above 85dB(A) are considered to be "at risk", depending upon the duration and levels of exposure.

The report of the noise survey should be regarded as public property within the company, and displayed as such.

4. Engineering Noise Control

Where the noise survey identifies areas for engineering noise control, the management is advised to obtain the assistance of competent acoustic consultants. As a health authority, we do not aim to provide such advice. The Department of Labour and Industry in South Australia has an Engineering Noise Control Section for this purpose and private engineering consultants are also available.

5. Employee Protection Measures

5.1 Advice on hearing protection devices

In the early days the range of hearing protection devices was very limited and if progressive deterioration in hearing thresholds were found, the only resort was to recommend heavier muffs. Since 1975 the National Acoustic Laboratory's SLC_{80} method of hearing protection device assessment, together with measured attenuations, has made objective selection of hearing devices possible.[6]

5.2 Introductory Educational Sessions

Our experience very quickly showed that the only way to introduce new programs was to inform all levels in an organisation of the nature of the program and to provide an opportunity for comments with questions and answers. Some early failures occurred where this was not done.

Consequently, a new program is introduced at a lecture/discussion session conducted by a departmental medical officer using films and visual aids, management and unions provide support and information, and the opportunity then follows for free discussion. This provides the opportunity to explain the program in detail and comment on reporting and recording procedures, referral policies, and any other matters of concern to those involved.

5.3 Hearing Loss Assessment

5.3.1 Personnel

Initially audiometry was done by scientific and technical staff and persons with losses were referred to their own doctor for assessment. With increasing numbers enrolled in the program, it was considered advantageous to involve a medical officer in the program to provide immediate medical assessment and advice. Nurses are now used as audiometrists. Workers are tested and medically examined on site and the efficiency of the system is appreciated by both workers, managements, and the program staff.

Until recently, consultant advice and support was also provided by Consulting Otologists to the Department of Public Health's Deafness Guidance Clinic, which was established principally to advise on hearing problems in school children.

Persons with markedly abnormal losses could be referred for evaluation, testing under ideal conditions and advice from the Consultant. The return from this service was considered insufficient to justify its continuation and it has therefore ceased.

5.3.2 Audiometric Test Procedures

Test procedures followed the recommendations of the Commonwealth (now National) Acoustic Laboratories

and, more recently, the procedures laid down in AS 1269 - 1976.[7]

5.3.3 Test Frequency

Six monthly testing was instituted initially to maintain interest in the programs and has remained the recommended test frequency for the following reasons:

* Protective equipment wearing rates fall off with time and a retest is of considerable value in maintaining wearing rates.

* Changes in hearing threshold are often detected in this time.

* Participants in new programs and new participants in old programs need instruction and reinforcement in the early stages of their involvement.

5.3.4 Test Facilities

Initially, audiometric tests were done on Mondays in quiet areas of the plant before production started. Such facilities were usually unsuitable, even for screening audiometry and consequently, with growth of the program, better facilities were required.

In 1970 a truck was converted to provide a mobile test facility containing two sound-proof rooms. Although considered acoustically satisfactory then, the truck was impractical, lacked air-conditioning and does not meet current acoustic standards. Eventually, with increasing workloads, a caravan was designed and has been in use since December, 1977. It has proved an eminently practicable and workable design.

Features include two rooms, each containing a sound-proof booth, convection heating, and multi-split air-conditioning with the remote condenser on the draw-bar of the caravan and a compressor unit in each room.

From the plan (see Appendix A) it will be observed that the two booths are on one side of the caravan. The problem of weight distribution (the two booths weigh 2½ tons) has been solved by additional leaves in the springs of that side, as well as independent suspension.

The walls and ceiling of the caravan have been insulated, and with the booths and noise-excluding head sets on the audiometers, provide test conditions well within the current AS 1269 - 1976 values for 'Maximum Acceptable Background Noise Levels',[8] even when parked near a busy road and with the air-conditioners working.

5.3.5 Testing and Assessment

Ideally, testing is done before production starts, but testing is now carried out throughout the day on the condition that workers wear protection before their tests. This allows testing of approximately 100 workers per day and has posed no major assessment problems.

The audiometric tests are conducted by the nurses, who then examine and discuss the hearing protection being worn. All persons tested for the first time then see the medical officer who takes the personal history and does an E.N.T. examination. On subsequent tests, workers who show no loss and who have no problems return to work. Workers with losses or other problems see the medical officer and then return to work.

6. Recording and Reporting

Initially, record cards were supplied by the Commonwealth Acoustic Laboratories. As the workload increased our own records were developed and provide for a comprehensive history and continuous recording audiometric test results. The record cards remain in our custody and information on them is regarded as confidential.

Reports on the results of audiometric testing take two forms:-

6.1 To the worker at the time of the test. The test result is discussed and any abnormalities explained.

6.2 To management. Summary information is required to allow management to assess the effectiveness of noise control activities.

Initially summary reports were sent to management following on-site testing. The reports contained the names of persons tested for the first time, those showing losses, and any comments or observations to be made. This process was manageable when there were small numbers involved, but with increasing demands on our services, the point was reached where reports were being sent out months after the testing had been conducted. In addition, audiometry was being performed by other organisations mentioned earlier and the records filed with no reporting or summation of either the individual or collective results.

In addition to requiring a system for rapid recording and reporting, we have recognised the need for data for evaluating the effectiveness of the program. Reports of a computerized reporting system in the U.S.A. prompted an approach to C.S.I.R.O. Division of Mathematical Statistics for assistance in developing a computer aided reporting system to satisfy the following aims -

6.2.1 to lessen the clerical workload and eliminate the backlog;

6.2.2 to encourage uniform reporting;

6.2.3 to establish a data bank which could be used for statistical and evaluation purposes;

6.2.4 to provide a service for the use by other organisations.

7. Computer Program

After a lengthy development period, a program with the following characteristics has resulted.

7.1 Overview

The program accepts, checks and analyses data from the

routine audiometry carried out by the Branch. The data from the audiogram is analysed, the results of this audiogram are compared with the results of the previous audiogram, and with the first audiogram (called the reference audiogram), recommendations are made on the basis of the changes found, reports are produced and the data file is upgraded. Data from 34 different organisations (or parts of organisations) is at present being stored. Each separate organisation is called a site. Each site is identified by a unique site code.

7.2 Data inputted

The date on which the audiograms were done is inputted on a header record which identifies the site involved.

A single record per individual is then inputted, containing the hearing losses and other relevant information. There is no limit to the number of sites that may be processed in a single run.

As the program accesses the data in the form of a file a number of input media, such as punched cards, magnetic tape etc. are available.

7.3 Data Validation

Data validation is carried out in two stages:

7.3.1 The input data is checked for internal consistency. The checks performed are:-

(a) The year of birth must be such that the age of the person is between 15 and 65.

(b) The hearing thresholds given must be all multiples of 5, except for 99 which is allowable, and interpreted as 100+.

(c) The hearing thresholds must all be positive.

(d) The test date must be feasible (e.g. month should not be greater than 12).

(e) The sex should be coded as either M(male or F(female).

(f) The test status should be a number between 1 and 4.

(g) The hearing protection device code should be a number between 1 & 9.

(h) Column 80 of the card should be blank.

(i) Year of starting should be less than or equal to the year of the test, but not more than 50 years less than the year of the test.

(j) If the site is new, then all the test status's should be 1 (signifying a first, or reference test).

7.3.2 The existing file for that site is searched to find a previous entry for the person being processed. Both the person's name and their year of birth are used for identifying purposes in this matching operation. If a match cannot be found, and the test status is not 1, then an error condition exists and is reported on. Discrepancies in the sex recorded for the person are likewise reported on. Further processing is not possible until all the above errors have been eliminated.

The program also checks for changes in the recorded occupation and year of starting work for each individual. These changes are reported on, but do not stop further processing.

7.4 The Report

Two reports are produced. The full report is available on microfiche, via the C.S.I.R.O's Computer Output to Microfilm camera. The second report, printed on the conventional line printer, contains summary information suitable for the report to the employer, but does not contain the detailed personal diagnostic information and results which are included on the individual worker's record. The reports are laid out in three columns. Some sample reports are shown in Appendix B.

7.4.1 Column 1. This column commences with the name, sex, year of birth, occupation, date of starting work, and type of hearing protection worn for the individual being reported on. The status (whether reference, screening, special, or termination) of the test is stated,

and the number of tests now on file is shown.

The next section, analysing the results of this particular test, is the part omitted from the summary report. The employer thus is given no information about the state of the employee's hearing by the computer generated report, but is kept fully informed about the changes that may occur in his hearing. This procedure was adopted in order to strike a compromise between the need to keep the employee's medical record (the audiogram) confidential, and the need to fully inform the employer of the success or otherwise of the attempt being made to conserve the employees' hearing.

The frequencies 500Hz, 1 000Hz, 1 500Hz, 2 000Hz, and 3 000Hz are regarded as "speech frequencies" with 4 000Hz and 6 000Hz being called "high frequencies". The report comments on these groups and not on particular frequencies. In each group the worst result triggers off the corresponding message. The ears are commented on separately.

Table 1 shows the hearing thresholds that generate the various messages. In addition to describing the person's degree of loss, the program performs a simple test to decide whether or not the loss is probably due to noise. If $HL_{4\ 000Hz} - HL_{1\ 000Hz} \geq 15dB$, then the message "Loss probably due to noise" is printed; if otherwise, then "Loss probably not due to noise" is printed. We have reservations about this simple test, but as the message only appears on our copy of the report, we have not as yet attempted to devise a more accurate measure. Dissatisfaction with this measure is a further reason for not releasing this section of the report.

TABLE 1 - SCHEMA FOR REPORTING ON PRESENT TEST

Hearing thresholds (dB) needed to produce various messages

MESSAGE	Frequency						
	500Hz	1 000Hz	1 500Hz	2KHz	3KHz	4KHz	6KHz
Within normal limits	HL ≤ 15	HL ≤ 15	HL ≤ 15	HL ≤ 15	HL ≤ 15	HL ≤ 20	HL ≤ 25
Beginning loss	15<HL ≤ 25	15<HL ≤ 25	15<HL ≤ 25	15<HL ≤ 25	15<HL ≤ 25	20<HL ≤ 35	25<HL ≤ 35
Moderate loss	25<HL ≤ 45	25<HL ≤ 45	25<HL ≤ 45	25<HL ≤ 45	25<HL ≤ 45	35<HL ≤ 45	35<HL ≤ 45
Severe loss	45<HL ≤ 65	45<HL ≤ 65	45<HL ≤ 65	45<HL ≤ 65	45<HL ≤ 65	45<HL ≤ 65	45<HL ≤ 65
Very severe loss	HL > 65	HL > 65	HL > 65	HL > 65	HL > 65	HL > 65	HL > 65

7.4.2 Column 2. Column 2 describes any changes that may have occurred since the previous test, and also since the first (reference) test. The change description process is applied separately to the "speech" and "high" frequencies; to both ears; and the results of the present test are compared in turn with the previous screening test and the reference test.

Once again the message printed depends on the worst result achieved in the group of frequencies. If both frequency groups in both ears show little change, then the message "no significant change in either ear" is printed. Table 2 shows the threshold changes required to produce the various messages.

If the test being reported on is the reference test, then "Not applicable reference audiogram" is printed in this column.

TABLE 2 - SCHEMA FOR REPORTING ON CHANGES IN HEARING THRESHOLD (dB)

Change in Threshold (HL present test - HL previous test)	Message	
20dB	Mild adverse change	(speech frequencies / high frequencies
25dB	Moderate adverse change	(speech frequencies / high frequencies
≥30dB	Severe adverse change	(speech frequencies / high frequencies
-20dB	Mild improvement	(speech frequencies / high frequencies
-25dB	Moderate improvement	(speech frequencies / high frequencies
≤-30dB	Extreme improvement	(speech frequencies / high frequencies

7.4.3 Column 3. Recommendations for further action are made in the third column. The recommendation "schedule routine tests" is in effect a 'do nothing' recommendation, as this would occur anyway. This recommendation is printed whenever none of the following occur. The recommendation printed depends on the worst change reported on in the change column. For this purpose, improvements are

regarded as being "worse" than no changes. Table 3 shows the recommendations produced for the various changes.

TABLE 3 - RECOMMENDATIONS

Change	Recommendations
No significant change ($\leq$ 15dB)	Schedule routine tests
Mild adverse change (20dB)	Check suitability, use and condition of hearing protection device. Schedule retest within 30 days.
Moderate or severe adverse changes ($\geq$ 25dB)	Retest, if change confirmed, urge medical examination.
Improvements ($\leq$ -20dB)	Advise continued use of hearing protection device. Schedule routine tests.

7.5 Test summaries

The tests are reported on alphabetically within each site, and at the end of the reports from a site, the number of individuals reported on and the date of the test is printed. A similar summary from all sites is shown at the end of each computing run.

7.6 General comments

The program was written by officers of the C.S.I.R.O.'s Division of Mathematical Statistics. We have had full responsibility for running and maintaining the program since the end of February, 1978. The program was written for the C.S.I.R.O. Division of Computing Research's Cyber 76 computer, a very large computer located in Canberra. This computer is accessible via telephone lines and smaller communications computers from many parts of Australia, the whole system being called CSIRONET.

The program as it now stands is not without defects. A data validation check was inadvertently omitted and this has led to a small number of errors accumulating. In addition a routine to interrogate and change the information on file still needs to be written. The program was written in a way which takes advantage of the special features of the Division of Computing Research's system, and as a result it will only run on the CSIRONET system. The program

needs a considerable commitment to ongoing maintenance, and is somewhat complicated to run.

The development of the program was embarked on without the the involvement of a systems analyst or any computing professional. As a result, the system as it now stands has the undesirable features mentioned above; a considerable manpower commitment to running and maintaining the program has been forced upon us without prior planning; and the program is at present costing approximately 10 times the original estimate to run. Present costs are of the order of $0.50 - $0.80 per person per test, but may be considerably reduced in the future. Any organisation contemplating a similar large scale computing exercise could well learn from our experience in this area and consult a systems analyst while the program is still at the planning stage.

SUMMARY

The principal objective of the hearing conservation programs of the Public Health Department has been to conserve the hearing of noise-exposed persons in industry, and the various steps in their evolution have been intended to facilitate the achievement of this objective. As with many other industrial hazards, noise is potentially controllable and its effects can be ameliorated. Some sample long-term audiometric records are included in Appendix C.

It is noteworthy that the Department's objectives in monitoring the programs have not always coincided with those of the consumers of the services. This has been particularly evident in the years since noise-induced hearing loss has been a scheduled condition under the provisions of the Workman's Compensation Act. Although this provision has undoubtedly focussed more attention on noise and its effects than any other previous action, and has contributed greatly to the control of noise in South Australian industry, it has also profoundly affected preventive programs. Employees are interested in hearing losses because of their potential monetary value (as are employers), and these financial concerns have tended to override the goal of preventing disability, for, just as the employee perceives the short term discomfort of his hearing protection device as a greater liability than some future hearing loss, so the employer is more concerned with protecting his immediate rather than any long term liability. Some employers in South Australia have begun to require pre-employment audiometry and to offer employment only to those

without significant loss or to those who have already secured their pre-existing compensation entitlement. The social implications of this may be considerable, since job hunters with hearing losses have difficulty in gaining employment and may even become unemployable in certain trades. As a matter of policy, the Occupational Health Branch's programs have avoided direct involvement in compensation matters. Screening audiometry only is performed and pre-employment audiometry has never been provided. This policy may need revision eventually, but it is noteworthy that although these concerns have been present throughout the life of the program, there have been enough enlightened employers and interested employees to maintain the viability of a program which has prevention of disability as its primary goal.

Another important outcome of the experience with audiometry over the years has been an appreciation of the technical limitations of the procedure. It seems that there is relatively little understanding of the sources of variability in audiometry among both professionals and others involved in using the procedures. Although detailed analyses have not yet been performed on the data accumulated since controlled test facilities have been available, it is believed that the retest variability of the procedures are at least as great as those quoted by Burns and Robinson.[9] Moreover, the experience which technical staff have obtained with audiometers and their calibration suggests that calibration errors can often be a major source of inaccuracy in test results. Such factors are relatively unimportant in hearing conservation work, where screening results are used simply as indicators of adequacy of protection. They assume far greater importance, of course, when questions of compensation - or even livelihood - are at stake.

One significant deficiency in our past programs, which it is anticipated will be overcome by the availability of computerized data, has been the lack of data for evaluating the effectiveness and efficiency of the program. Evaluations have been largely subjective with program changes being largely dependent on the reactions of the staff and consumers of the service. Data on changes in hearing thresholds over time for individual employees has been available but the ability to examine the experience for the noise - exposed group as a whole has been limited.

A controversial matter which warrants comment in view of our experience is mandatory audiometry. The National Health and Medical Research Council's Model Regulations for Hearing Conservation provide for audiometry for all workers exposed to noise, and this provision was

seriously considered in South Australia before the decision was taken not to include it in the Noise Control Regulations. As has been mentioned earlier in the paper, our experience suggests that audiometry plays an important part in hearing conservation and is a useful monitor of the effects of noise exposure, but its real value is its contribution with the other elements of a complete hearing conservation program. It provides an opportunity for health personnel and employees to discuss hearing conservation measures and reinforces the need for workers to use protective equipment. Audiometric testing should not be viewed as an end in itself, and unless test results are interpreted and explained to both workers and management by competent persons experienced in industrial hearing matters, it is virtually useless and represents an unnecessary additional cost to industry. Similarly, enforced notification of hearing losses stands to contribute little per se. The costs of administering the notification requirement would be considerable and it offers little practical benefit.

In our opinion, if industrial audiometry is to be performed, it should only be in the context of a complete and continuing hearing conservation program.

Establishing hearing conservation programs in industry requires planning, resourcefulness, and competent, skilled personnel. The procedures and tests are apparently simple and yet, in reality, complex; noise control is achievable and yet often difficult and expensive, and the communication of results of audiometric testing to both employers and employees involves important issues of privacy and confidentiality. The latter is perhaps the most difficult and challenging aspect of the work. In our experience, employers are often deterred by the fact that employees are told the results of their tests and this has been among the reasons given by employers for refusing to introduce programs. On the other hand, the audiogram, like any other personal diagnostic information, should be confidential to the individual and his adviser, and the worker must be informed of his hearing status. Balancing the legitimate interests of the employer and employee, interests which are complimentary and yet potentially conflicting, has proved a complex and, at times, difficult process. We have attempted to strike a balance which respects the confidentiality of the worker's personal diagnosis and yet allows for the employer to know whether noise control measures are proving effective. This requires the informed consent of both parties and is an aspect of the hearing conservation process which is likely to become increasingly important in the future.

Our 15 years experience with hearing conservation programs has taught us that noise induced deafness presents a deceptively complex, important, and extremely challenging occupational health problem.

References:

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2. Ibid., P.150.

3. Ibid., PP. 151-153.

4. Industrial Safety Code Regulations, 1975, under the Industrial Safety, Health and Welfare Act, 1972, P.47.

5. Standards Association of Australia, Australian Standard 1269-1976. 'Hearing Conservation Code', S.A.A., Sydney, 1976.

6. National Acoustic Laboratories, 'Attenuation of Hearing Protectors', NAL, Sydney, 1978.

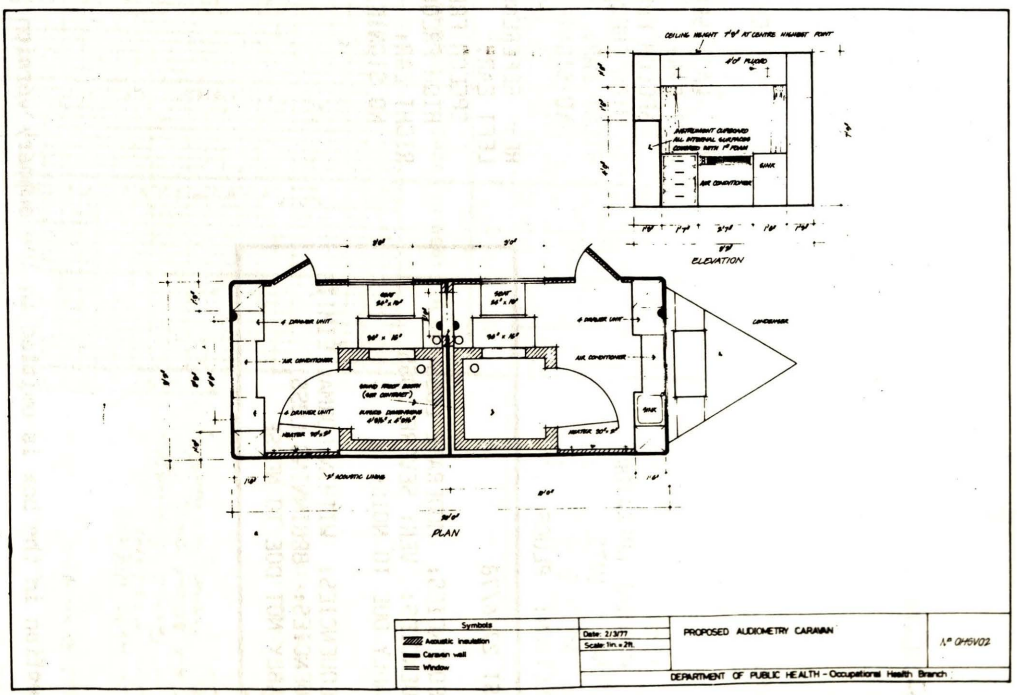
7. Standards Association of Australia, Australian Standard 1269-1976, 'Hearing Conservation Code', S.A.A. Sydney, 1976, P.28.

8. Ibid.

9. Burns, W., and Robinson, D.W., 'Hearing and Noise in Industry', HMSO, London, 1970.

APPENDIX A

External view of caravan



Plan of caravan

Sample Computer Report

PROCESSED ON 25-JUL-78

HEARING TEST REPORT FOR
ACME HEAVY INDUSTRY PTY LTD

NAME/
INDICATIVE DATA

BLOGGS J
SEX: MALE
BIRTH YEAR: 1940
OCCUPATION: MACHINE OPERATOR
YEAR OF STARTING: 1975
NO. OF TESTS: 4
TYPE OF PROTECTION: PLUGS

SCREENING TEST 27/6/78
LEFT EAR:
SPEECH FREQUENCIES: MODERATE LOSS
HIGH FREQUENCIES: VERY SEVERE LOSS
LOSS PROBABLY DUE TO NOISE
RIGHT EAR:
SPEECH FREQUENCIES: WITHIN NORMAL LIMITS
HIGH FREQUENCIES: BEGINNING LOSS
LOSS PROBABLY NOT DUE TO NOISE

CHANGE

RE: LAST SCREENING TEST 15/11/77
LEFT EAR:
SPEECH FREQUENCIES: MILD ADVERSE CHANGE
HIGH FREQUENCIES: SEVERE ADVERSE CHANGE
RIGHT EAR:
NO SIGNIFICANT CHANGE

RE: REFERENCE AUDIOGRAM 20/9/76
LEFT EAR:
SPEECH FREQUENCIES: MILD ADVERSE CHANGE
HIGH FREQUENCIES: SEVERE ADVERSE CHANGE
RIGHT EAR:
NO SIGNIFICANT CHANGE

RECOMMENDATIONS

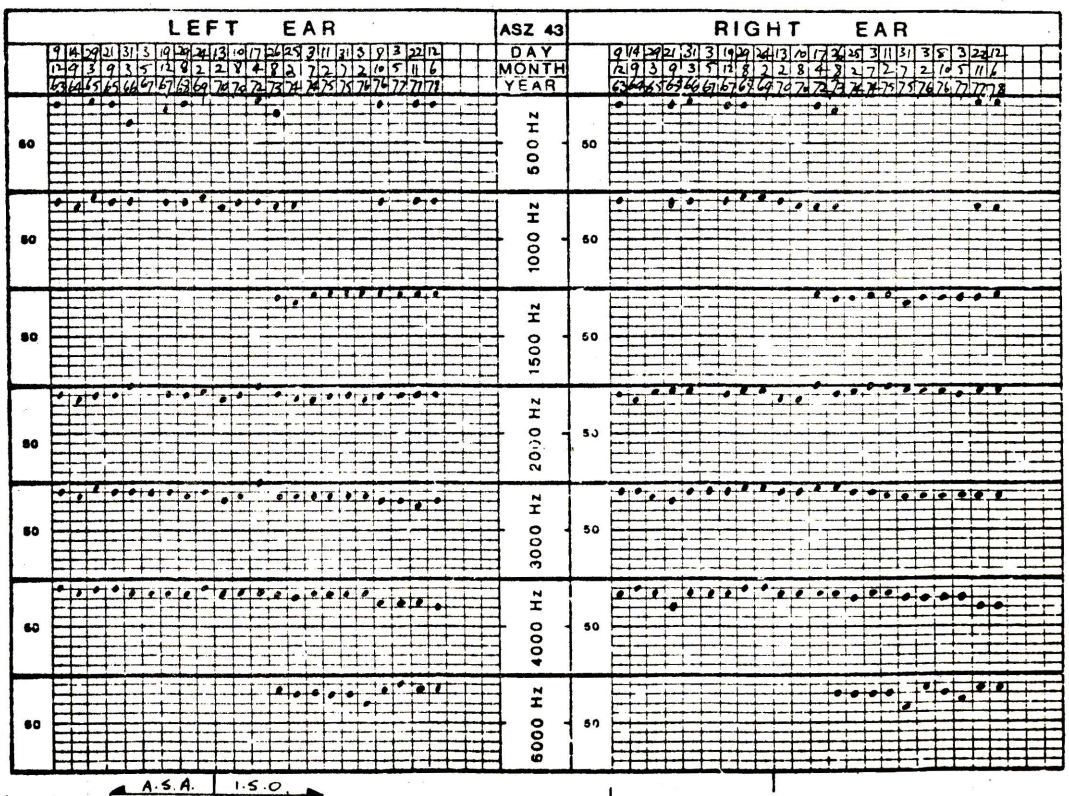
RETEST - IF CHANGE CONFIRMED
URGE MEDICAL EXAMINATION.

NOTE: The section in the box is omitted in the summary version

APPENDIX C

PERSONAL FILE

NAME: YEAR OF BIRTH: 1945
ADDRESS:
OCCUPATION: Boilermaker
EMPLOYER:
Period of present employment: From 1962
Previous Occupational History: —
Military Service: —
Medical History: Allergy.- Measles.✓ Mumps.✓ Whooping Cough.- Meningitis.-
Scarlet Fever.- Influenza.- Head Injuries.✓ Concussion 1962 — Motor bike accident.
Disease-E.N.T: —
Surgery-E.N.T: Tonsils removed — aet 5.
Recreational activities involving noise: —
Activities involving music: Plays piano — (own amusement)
Hearing impairments in family: —
Difficulty in hearing speech: .. in groups.. individuals.. telephone.. in noisy places..



PROTECTION	REMARKS
Plugs issued	T.M.D.
" "	Tested in quiet room
" Not worn	No change
Plugs worn	Satisfactory
Muffs issued	Loss @ 500cps. o/E-wax
" not worn	Improvement @ 500c.p.s.
Plugs worn	Holding own - muffs difficult
Muffs occasionally	Plugs fitted — M.S.A. Large
" " "	Improvement — Tested in Sound/Van
" " "	Loss @ 2K and 3K and 500
" " "	% conv 2a. Tested in booth.
" " "	Satisfactory
" " "	% conv 2a
" " "	Loss @ 6K.
" Now noisy	Improvement @ 6K. 10/8 lose 04K.
Ear Plugs	No change from last test.
"	" " " " "

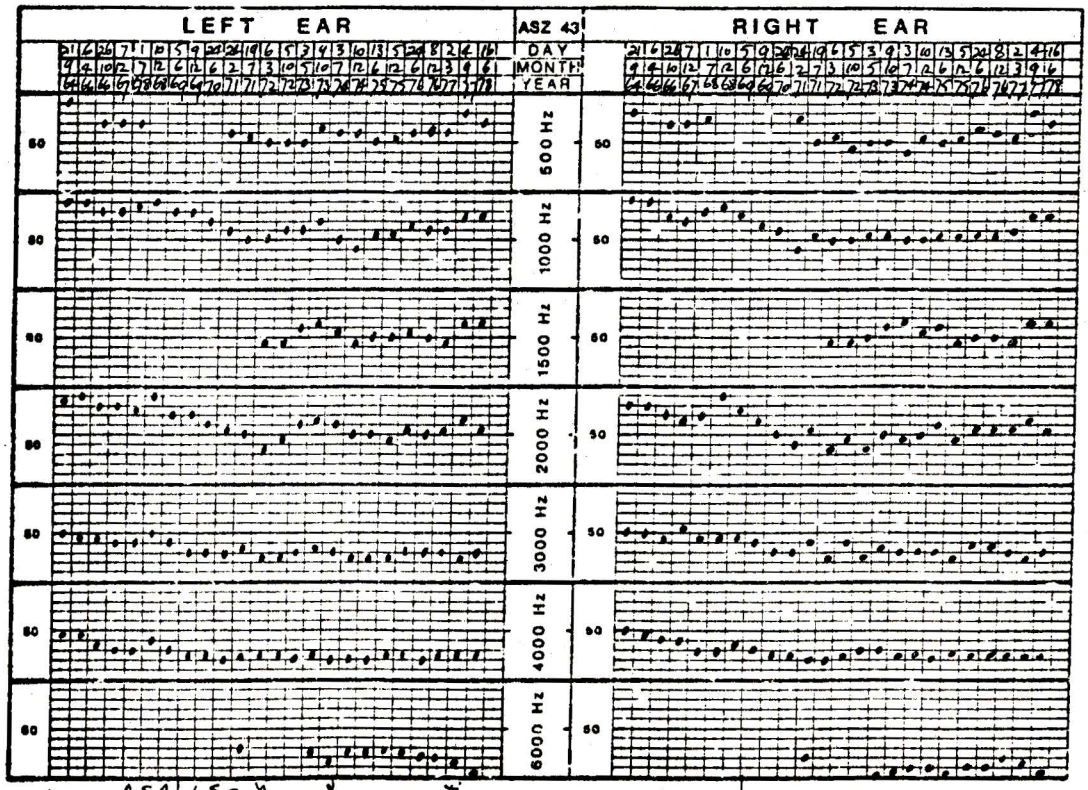
Summary

Started work as an Apprentice Boilermaker.
Noise levels fluctuated in Boilershop.
Has worn protection over 15 year period.
Periodic review shows very little change.

APPENDIX C

PERSONAL FILE

NAME: YEAR OF BIRTH: 1923.
ADDRESS:
OCCUPATION: Wood Machinist
EMPLOYER:
Period of present employment: From 1951
Previous Occupational History: Served Apprenticeship in a furniture factory.
Military Service: 5 years - Artillery.
Medical History: Allergy.- Measles.✓ Mumps.✓ Whooping Cough.✓ Meningitis.-
Scarlet Fever.- Influenza.✓ Head Injuries. Concussion.
Disease-E.N.T: Otitis Externa during war — no problems since.
Surgery-E.N.T: Tonsils removed - aet 20.
Recreational activities involving noise: —
Activities involving music: —
Hearing impairments in family: —
Difficulty in hearing speech: .. in groups.✓ individuals.- telephone.-
in noisy places.✓



PROTECTION	REMARKS	A.S.A.	I.S.O.
Nil - Engineering noise control	T.M's ✓ Tested in quiet room		
" "	Satisfactory		
" "	Loss in both ears		
" "	No change from last test		
Protection offered but refused	Further loss @ 4000cps R.ear		
" "	Slight improvement. ? Susceptibility		
" "	Downward trends		
Muffs continuously	Further loss. Referred to Otologist.		
" "	" Test in Sound/Van		
" "	No change in Lt. frequencies.		
" "	Downward trend continues @ 2K both ears		
" "	Improvement in some frequencies.		
" "	Tested in Sound/Proof booth.		
Plugs requested but refused	Now Leading Hand. — not on one reading		
" "	Satisfactory		
" "	"		
" "	"		
Ear Plugs issued and worn	New Foreman — moving job.		
" "	10dB loss @ 6K both ears		
" "	Machine out of Calibration — disregard test.		

Summary

Wood Machinist with established noise-induced hearing loss found at first test - aged 41 years.

Extensive engineering noise-control measures completed in Machine Shop - no protection worn.

Progressive deterioration in hearing levels.

Protection worn - hearing levels stabilised.

Discussion:

Mr. Murphy: What was the reaction of workers when they were told about their hearing loss. Was there any alarm or anxiety?
Sr. Parker: I must repeat that we don't give numbers. Workers are told generally of their loss: you have some loss, or your hearing levels are satisfactory, or keep wearing protection to keep your hearing levels where they are. We don't say you have a 50 decibel loss which is worth $2000. I think that the amount of alarm has increased over the last year or two and I think that that has got other factors bearing upon it. With the downturn in industry workers are seeing opportunities to claim their rights or their compensation entitlements. As I said in the paper the way we use the information on the hearing loss of an employee is in association with the protection which he wears.
Mr. Crehan: I was most interested in your use of the mobile facility. Firstly, I wasn't quite sure from your description whether the two booths were completely independent with two audiometrists in operation, and secondly is this a service that you provide to industry at large or is it aimed more specifically at smaller industries who don't have the economic justification in their own right to establish in-house audiometry?
Sr.Parker: There are two separate rooms, two separate booths, two separate audiometrists. There is no connection between the two rooms in the caravan. There is a lot of audiometry going on in industry in South Australia, in the large industries. We consider our role is to provide for small industries who aren't large enough to have their own facilities.
Mr.Patrick: In the data recorded have you given any consideration to the type of noise exposure, or some indication of the level of noise exposure of the employee concerned?
Sr.Parker: That is established in the very first instance with the noise level survey. We don't initiate a hearing conservation programme without a noise level survey.
Mr.Patrick: Yes I understand. You only include those over 85. Do you make any other distinction, if someone is subjected to very high levels, over 100, for instance?
Sr.Parker: Yes, all of that's taken into consideration in deciding who we'll include in the programme and the type of protection recommended.
Mr. Rose: You mentioned that with your six-monthly retests you sometimes find changes in only six months and then later I noticed that the changes that are recorded in the computer print-out are fairly large.

Is that the sort of change you are finding in six months?

Sr.Parker: Yes we do find those. Some of the changes are in the high frequencies and some are in the speech frequencies only, which is indicative of something going on other than the noise exposure. I think it's been difficult to present the computer programme in the time allowed, I think there is more value in reading the written paper.

Mr. Cracknell: You said that you told the employee the result of his test. This test is a screening test, not a diagnostic test. Could I ask you if you get an employee for his first ever test do you tell him that result straight away or do you wait a certain period if you find that he has a hearing loss. Do you give him another test before telling him or do you tell him on his initial test?

Sr. Parker: The first test is a reference test and we have a medical officer on site and he tells all employees the results of their first test in general terms. In the change column you may have noticed that there is an opportunity for changes of 20, 25 or 30 or more decibels to be reported and corresponding recommendations for those changes: in all cases of 25dB or more we retest and if the retest shows that the change is maintained then they are referred off to their own doctor.

Mr. Castleman: In regard to the problem for people with existing hearing loss who are required to wear hearing protection and thereby lose their means of communication and become isolated and the like - would you have any comment on this, particularly whether you have found any successful approaches to this problem?

Sr.Parker: I don't think I'm telling you anything new when I say that there are problems with all forms of hearing protection. There is a problem with people who have existing losses. In one case I know the workers complained they couldn't hear the knock-off bell. It was a fairly high frequency sound and people with losses in that region were in trouble so the bell was changed to a low frequency ring which they heard very easily.

Mr. E. Williams: Can you tell me how much education is being performed in the acceptance of hearing conservation programmes? It seems to me that this is a central factor in getting people to wear hearing protection.

Sr. Parker: In the paper I spoke about the introductory sessions and we regard those as vital. But some of our programmes have been continuing for years and there probably aren't too many left who had that initial introductory session, so that it is quite common for education sessions to be set up again, perhaps for a new group of apprentices in

a particular plant. Plants that have their own health staff doing this work have the added advantage of being able to do that with captive groups. But the way we work is that we come in twice a year and if there seems to have been a deterioration in wearing patterns or losses then quite often additional education sessions are set up.

MONITORING AUDIOMETRY: PROTECTION FOR WHOM?

William G. Noble
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Tonal threshold audiometry has long been advocated to monitor the hearing of people exposed to potentially injurious noise. The rationale follows from a general model of biological monitoring of hazardous environments. Also, people vary in their reaction to injurious noise, so direct observation of performance is seen as necessary in conservation of hearing in industry. Unfortunately the practical realization of the exercise has been shown to have little chance of success. Uncontrollable variability in serial estimates of thresholds in individuals means that no intelligible picture can be made of any person's audiometric "career", even when the most rigorous procedures are used. Only in retrospect can a clear view of a noise hazard be gained from auditory threshold estimation.

Despite this, monitoring audiometry continues to be used in industry and one answer to the question about why this should be, is that the procedure is a device for protecting management from compensation claims. A case study is described to support this assertion.

While it might be argued that such a motive cannot help but also provide the conditions for protection of hearing, that argument fails in light of the gross damage to hearing that is sanctioned by "legal limits" ("low fences") of the sort typical in the United States. A reform of this situation is potentially available in Australia through the more stringent system of assessment recommended by the National Acoustic Laboratories.

A clearer grasp of the issue at hand is advocated: watching people going deaf seems particularly unproductive as a way of tackling the problem of industrial noise.

Introduction: Audiometric surveying in industry

The tonal, air-conduction threshold audiogram is a test used in a variety of contexts, though probably its most successful application has been in retrospective epidemiological investigation of populations exposed to harmful agents. Most notable among such agents is noise

arising from various industrial processes. Within clinical settings the test is of course still part of the armament of the audiologist and otologist, but its one-time central role has been usurped, most obviously by tests of middle ear function. A claim that continues to be strongly made about tonal threshold estimation is that, while other non-verbal tests may have equal utility in regard to diagnosis, only the tonal test gives some measure of the extent of a person's hearing difficulty. In circumstances where assessment of degree of impairment is required, as against diagnosis of type of disorder, tonal threshold estimation is taken to be the most useful gauge.

Arguments have been made for a long time (see, for example, the American Medical Association Council on Physical Medicine and Rehabilitation, 1955) that tests using speech ought to complement, at least, the tonal test in assessment of degree of hearing disturbance. At most, however, speech testing has typically been undertaken to support a rather debatable claim that tonal threshold can validly predict speech hearing ability. The Veterans Administration in the United States seems to be the only agency that relies on speech test results as well as tonal test results in making assessments of degree of impairment.

I stated that the most successful application of tonal threshold testing has been in large-scale population work. I think this assertion can generally be assented to. Among several such studies I would mention that by the United States Public Health Service (1938); that by Hinchcliffe (1959); by Corso (1959); by Glorig and Nixon (1960); by Burns and Robinson (1970), as examples of the kind of thing I mean. The report by Burns and Robinson (1970), of a large-scale prospective and retrospective industrial survey, is particularly notable in virtue of showing what is able to be extracted from data obtained about the acoustical nature of occupational environments in relation to the audiometric status of persons exposed to those environments.

Burns and Robinson (1970) make it clear in their report that it was always their intention to make the keystone of their survey the prospective, serial testing component (undertaken over a 5-year period). The other element, retrospective assessments that rely on reported noise histories as the acoustical-environment data, was seen by them as intrinsically less sure than a method that follows noise-exposed individuals through their environmental-audiometric "careers". The philosophy underlying a prospective design derives from a generalization of the environmental-monitoring model of any hygiene programme. The

argument runs that if monitoring devices can be "attached" to environments to provide continual sampling of relevant physical features (temperature, carbon monoxide, or ionizing radiation levels, for instance), then in principle such devices can be permanently or temporarily attached to persons operating in those environments. Indeed, in the case of ionizing radiations, personal dosimeters are vital to allow monitoring of inter-individually variable amounts of exposure to such dangerous energy. This is still environmental monitoring of course, but refined to account for individual patterns of exposure.

In the case of noise, environmental levels can be monitored directly by attaching sound level meters to environments, or by personal noise dosimeters attached to environments via persons therein. But as neat a solution as any, it would be thought, is the temporary (occasional) attachment of an indirect monitoring device to persons exposed to noise, namely standard telephone receivers for the delivery of pure tones. Such indirect monitoring of the acoustical environment is at once, however, taken to be a direct monitoring of the exposed person's reaction to that environment. And this is arguably a much better procedure than direct environmental monitoring because of the problem of interindividual variability in reaction to noise. That's to say, even direct environmental monitoring using personal dosimeters does not cope with the problem of variable reactions to the same sound energy dose.

At one time it was the hope of audiologists that this variable longer-term susceptibility to noise between persons could be predicted from short-term assessment, namely, degree of temporary threshold shift following one working day's exposure to the noise in question. And investigation of this hope was also a critical feature of the Burns and Robinson (1970) study. Such predictability had been demonstrated at the group level by a number of investigators, but no successful method of prediction had been lighted on at the individual level. This meant that the "at-risk" people in a working group could not be reliably identified at the start of employment. Were a reliable "early-warning" measure of individuals' susceptibility to be found, there would be little need for ongoing audiometric monitoring of a whole group. This hoped-for outcome remained unrealized in the Burns and Robinson (1970) study. Exhaustive analyses of all conceivable measures and transforms failed to yield any correlation that could be relied on to identify people at risk in the long-term from assessment in the short-term.

The other, much more disappointing outcome for these investigators

was the highly erratic results of the prospective element of the survey. This, the intended crux of the investigation, was shown to be ongoingly yielding unintelligible data. The reason for that, quite expectably, was the inherent unreliability of standard audiometric testing in the individual case. The ideal of being able to monitor an individual's environment by periodic application of tests of his performance inevitably foundered on the rocks of "random" fluctuation in individual test outcomes. Despite the most careful and rigorous procedures, no intelligible progression at the individual level was discernible from serial audiometric assessments. I quote later from Burns and Robinson (1970) to underscore this point.

It was only the results from large numbers of participants in a retrospective design that finally prevented the investigation by Burns and Robinson from becoming a scientific disaster. From a series of extensive computer analyses a fairly coherent reduction was achieved of the reports of acoustic-environmental histories alongside present-day audiometric data. This data analysis allowed articulation of a general relationship between noise dose ("sound immission level") and population threshold distributions.

From the time of earliest emergence of the "sound immission level" theorem (Robinson, 1968) it was recognised (for example, Noble, 1970) that a basis now existed for intelligible assessment of the hazardousness of many noisy working environments, based on careful acoustical sampling. And with Atherley and Martin's (1971) finding that the theorem could be extended to cover impulsive sounds as well as more continuous ones, its general applicability to industry was greatly enhanced. The use of monitoring audiometry was regarded as virtually unnecessary, because, while an individual's susceptibility could obviously be no more predicted by this system than by audiometry, at least the risk to populations as a whole could be.

Argument in reply to this point has been that monitoring audiometry can surely still be useful in making certain that direct (sound level) monitoring is indeed valid. While such an argument has appeal, it also has a fatal flaw in it. Ongoing audiometric monitoring (as against retrospective surveying)was the procedure that precisely failed to yield intelligible results in the Burns and Robinson (1970) study. Why should the expectation be different, therefore, in any future context? It is quite clear that the inherent unreliability of audiometric testing, particularly at the (high) frequencies likely to be the first ones to

show the result of injury, makes ongoing monitoring a fruitless exercise. Only in the very longterm, in effect when monitoring turns into retrospective surveying, can useful results accrue. By then, however, it can truly be said that one may have been engaged in the exercise of carefully witnessing a population going deaf.

Monitoring audiometry: Protection for whom?

In spite of all the foregoing points, points that are well-known in audiology and occupational health, monitoring audiometry continues to be advocated and practised. Why?

I have no doubt that all kinds of reasons may be offered, some more plausible than others. I want to address myself to one reason that I suspect is quite powerful, and that I know is generally unacknowledged. Monitoring audiometry is used in industry, not to protect the hearing of people exposed to noise, but to protect owners and their insurance carriers from compensation claims. Acoustic environments can be known to be potentially hazardous on the basis of sound level monitoring, but the concern will be not toward verifying that potentiality at the earliest time, but toward early identifying of those in whom the extent of damage to hearing is appearing to exceed the "legal limit". (I return later to a consideration of legal limits.)

In parts of the United States the practice of monitoring audiometry for the protection of management is of course vital, because employers can be sued for the whole of a claim for damages by an employee even though most or part of the injury might have been sustained by the claimant prior to current employment. The most recent employer, therefore, could be liable for damages in compensation for injury that was only partly that employer's fault. Hence, the pre- and per-employment audiograms may become the evidence that employers rely on to limit their liability. There can be no denial in that sort of context, therefore, that monitoring audiometry has as part of its purpose the limitation of claims responsibility.

But the point could surely be made that even though an important motive behind routine audiometric monitoring may be claims limitation, an inevitable outcome will be the conservation of hearing. For surely, to allow people's hearing to be injured is to put oneself at risk of being sued? Well, of course, the answer to this point is that quite a degree of injury can be allowed to occur in an exposed population without liability for damage. This is what I mean by the legal limit. And a further question, that must be asked in reply to the above point, is

what becomes of persons whose reaction to injurious noise seems to be extreme?

Let me exemplify what I have discussed so far in relation to my assertion that monitoring audiometry is conducted with an eye to claims limitation, not to help protect people's hearing. High and Gallo (1963) reported an analysis of data from 444 employees of an aviation missile research organization. These people had been employed for an average of 4 years 10 months and had each undergone 6 tonal threshold tests spaced at roughly 8-month intervals. By the time the sixth test had been administered the average age of the group was just over 36 years. High and Gallo stress that the highly variable sound levels and discontinuous exposure patterns of this employment context would have made it almost impossible to obtain a purely acoustical appraisal of the noise hazard. And at that time (1963) this was indeed the case. Hence monitoring audiometry was a necessary procedure to ensure the conservation of employees' hearing. How this was effected is best described by High and Gallo themselves:

> "Since the primary purpose of the audiometric program was to protect the employees' hearing, the technician was instructed to check for changes in the hearing levels of employees each time they presented themselves for testing. In the event the most recent test results showed a shift of 15 db or more for one or two frequencies over the pre-employment audiogram, the standing instructions required that the employee be given a short rest and then retested at the affected frequencies. If the change in hearing level was verified on the second attempt, a report was to be made to the appropriate authority for action. [pp. 17-18]."

It is not stated what form of "action" would be taken by the "appropriate authority" upon discovery of extreme changes in individuals' audiograms, but presumably something was done. And presumably whatever was the action, it was visited upon the "extreme" persons, rather than upon these persons' environments. The sample size (444) is not reported to have changed in this retrospective analysis by High and Gallo of a prospective monitoring programme. This could mean either, that the N = 444 represents a final figure from which extreme cases were removed from the job (i.e. that might have been the "action" taken), or it could mean that extreme cases remained in the sample (that the "action" taken by an appropriate authority was, say, to do no more than note the

identities of extreme cases), or it could mean that no such extreme cases were ever noted. The last outcome is of course essentially implausible since "random" changes of at least 15 dB at any frequency would be readily observed in so large a sample.

The third outcome is also rendered implausible by a factor that I wish now to lay stress upon, which is, that a steady deterioration in average thresholds for the whole group was noted over the six test occasions (see Figure 1). This must mean that "real" changes of at

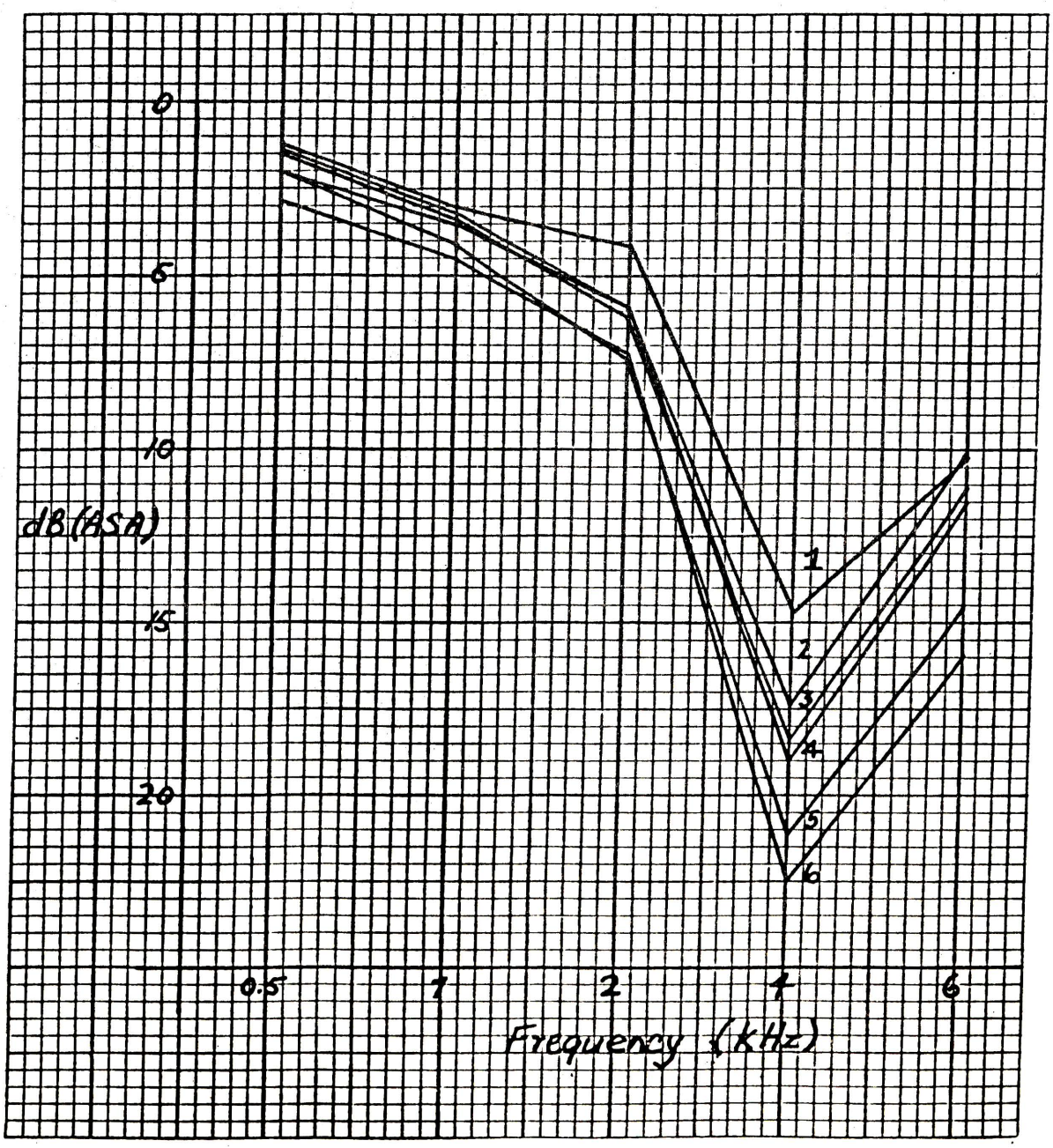

Figure 1. Mean auditory threshold levels of 444 listeners tested about every eight months on 6 successive occasions (numbers 1 to 6 identify results from each occasion) over a five-year period (data from High and Gallo, 1963, Table I).

least 15 dB at any frequency (particularly higher frequencies) were shown by some members of the sample over the test period.

While High and Gallo's primary purpose was simply to observe intertest reliability of serial audiometry in an industrial context, they do take time out to remark upon the change in average threshold in this comparatively young sample of people.

> "The medians for 4000 and 6000 cps indicate that the sample H[earing] L[evel] was slightly elevated at the time of the first test and grew progressively worse during the five-year test period. The amount of change ... was greater than would be expected on the basis of aging alone ... The change was most likely the result of occupational noise trauma ... The mean H[earing] L[evel]s for the higher frequencies showed a small but statistically significant increase. [pp. 19-20]."

It is possible to explore these observed changes in mean threshold levels in more statistical detail by the fact that High and Gallo provide coefficients of correlation between results from successive test series. From these, plus estimates of the pooled variance over each successive pair of serial tests, the standard deviation of differences between successive sets of results can be calculated. Using these, plus the mean differences observed in threshold levels from one occasion to the next, t-tests for correlated means can be applied. The most obvious changes in thresholds in High and Gallo's study were observed at 4 kHz. It turns out that only one t value of the 5 calculated, namely, that for the change in 4 kHz threshold between test occasions 3 and 4, fails to reach significance. This outcome confirms what is clear from Figure 1, that consistent deterioration in hearing in this population was occurring right from the first occasion of test and continued throughout successive occasions during the five-year period of observation.

Recall here that, "the primary purpose of the audiometric program was to protect the employees' hearing [High & Gallo, p.17]." But in view of the above findings it is rather hard to see in what way the hearing of employees was being <u>protected</u>, as against its deterioration simply being monitored. It would have been evident from the first and again from the second retest that injury to hearing <u>on a population level</u> had indubitably taken place. The great value of such large-scale retro-

spective observation is precisely to allow the general trend to be witnessed, even if, as Burns and Robinson (1970) found, the true course for any individual cannot be reliably mapped. Furthermore, in the light not only of Burns and Robinson's (1970) findings, but also of High and Gallo's (1963) analyses of intertest variability, the policy of noting extreme individual changes (leading to some unstated "action" being taken) is quite ill-advised because changes of this kind are wholly expectable by chance.

Burns and Robinson (1970) comment on serial monitoring thus:

> "[A] more deep-seated problem exists, however, ... This is the influence of random errors in the audiometry which all but swamp the noise-induced part of the threshold shifts. Even with the safeguards of precision equipment and impeccable control of the testing, these errors must be regarded as ineradicable in the practice of pure-tone audiometry as it is today ... [I]t is important to note that the serial results by themselves would certainly not have permitted the determination of well-defined trend curves in the way that was found to be possible with the retrospective data.
>
> "In practice an apparent improvement in hearing is observed almost as often as a loss. The former can reasonably be dismissed ... The same cannot be done with apparent losses since these may well be genuine. Though it is clear in some cases that apparent losses are unreal, in the great majority there is no sure way of telling true from false. [Burns & Robinson, pp. 21-22]."

These authors later observe that, in considering results from serial tests, "No amount of statistical sophistication can conceal the fact that the vast majority of the observed threshold shifts are more illusory than real due to the limitations of accuracy inherent in conventional audiometry. [Burns & Robinson, p.165]." They go on to remark that some sort of meaningful conclusion can yet be drawn from the data, but in making such a conclusion the authors re-emphasize the point that, "it in no way assists the interpretation of the meaning of an individual measurement of threshold shift from serial audiometry. [Burns & Robinson, p.179]."

So what is going on in programmes of auditory threshold monitoring in industry? What is going on, as I have already said, is monitoring to ensure that only non-extreme damage is taking place. It should be made

clear that whether an extreme response reflects actual or illusory change is no deterrent in principle to such a policy. The meaning of a non-extreme change, however, is guided by what is legally permitted. It is time to treat this issue in a little more detail.

The "low fence" or "legal limit" of damage

When Albert Wojcik finally won his suit for damage to hearing brought against the Green Bay Drop Forge Company in Wisconsin, the spate of claims that followed unnerved the metal-working industries of Milwaukee, because they had accumulated no reserves of cover with compensation insurance carriers to meet such costs. A team of medical consultants was convened, and among other recommendations, this team asserted that the then current system of assessment of impaired hearing (American Medical Association Council on Physical Medicine, 1947) should be replaced by a "simpler" scheme that involved averaging the threshold levels at 0.5, 1 and 2 kHz only. Also, a "low fence" of 15 dB (ASA) should be instituted such that compensation was only payable to those whose 0.5, 1 and 2 kHz average thresholds exceeded this value (Nelson, 1957). Additionally, and in conformity with a previous manoeuvre by industry in New York, a 6-month waiting period following cessation of a person's employment was invoked before such a person could sue his former employer.

While voices were loud in proclaiming the scientific and biological validity of the 0.5 to 2 kHz threshold formula (the American Academy of Ophthalmology and Otolaryngology and the American Medical Association adopted it wholeheartedly), the plain fact (as everyone knows) is that very little change occurs in threshold in this region in people with hearing impairment caused by noise (Figure 1 illustrates the classic appearance of noise-induced hearing disorder). Commenting on the apparent diminution of the problem of noise injury in recent time, Sharrah (1966) pointed out that this was an appearance only, not necessarily a real reduction in the problem. This was for the reason, he goes on to state that, "two basic safeguards ... have kept claims experience in the noise field at a fairly low rate. The two safeguards are: (a) The six-month waiting period; (b) The hearing measurement formula recommended by the American Academy of Ophthalmology and Otolaryngology and the American Medical Association. [Sharrah, 1966, p.276]."

I have shown in two extensive reviews (Noble, 1973, 1978, Ch.6) that the validity of the above formula for assessing degree of hearing impairment can be seriously questioned, but of course I cannot disagree

with the fact that one of its features is precisely to limit claims by people with noise disorder. The virtue or otherwise of that feature is not my present concern, the effect it has had in hearing conservation very much is my present concern. A legal limit for injury has been sanctioned by the utterance of this formula so that, in apparent good conscience, the hearing of people exposed to noise can be permitted to go on being injured to a point where average threshold just reaches 15 dB (ASA), or 25 dB (ISO) across 0.5 to 2 kHz. I can assure you that for many people with injury to hearing due to noise trauma, an average of that magnitude usually tokens a severe injury at higher frequencies and is thereby likely to be associated with considerable hearing handicap in everyday life (Atherley & Noble, 1971; Noble & Atherley, 1970).

Conclusion and recommendation

The recent hearing assessment system recommended by the National Acoustic Laboratories (1974) goes a fair way to dealing with the sort of problem presented for conservation policy by the United States and derivative systems of assessment. In particular the recommended "low fence" in the NAL system of 15 dB (ISO) across 3 and 4 kHz, as well as across 0.5 to 2 kHz, could ensure that industrial owners and insurance carriers become more vigilant in protecting the hearing of employees, in order to protect themselves. Of course, the lightish weight accorded in the NAL scheme to higher frequency threshold change in the calculation of overall percentage of impairment will allow actuarial adjustments that produce "optimum" profiles of hearing damage - cost liability. We could thus find that it is still economically unthreatening to allow people to suffer injury to hearing in Australian industry, though probably a lesser degree of injury will be tolerated than at the present time. Also, the acceptance by individual Australian States of the recommendation (by a Federal agency) is presumably not guaranteed.

Probably the most worriesome feature of monitoring audiometry is the question thrown out by High and Gallo's (1963) report. What happens to people who present the appearance of an extreme downward change in threshold? This is a particularly pressing question in light of the knowledge that such a change is just as likely to be spuriously gross as really so, and with the corollary point that a nonextreme change is just as likely to be spuriously mild as really so. What kinds of action might management take in industry as a result of these possibly bogus assessments?

In conclusion I would like to make a positive remark about

audiometry in industry. I mention earlier that a reasonable prediction of a population's likely future auditory status can be obtained from assessment of temporary threshold shift. Hence, where occupational conditions permit (a large enough workforce engaged in sufficiently homogeneous activity), pre- and post-exposure testing of auditory thresholds under the usual conditions of a TTS study design may help in evaluating the hazardousness of an environment. However I would see such a procedure only as the complement to a fullscale sound level measurement survey. Incidentally I would mention that in circumstances where work patterns are inconstant, hence exposure to noise is variable through the working day, "activity sampling" (Currie, 1963) can offer a useful adjunct or alternative to personal noise dosimetry. Such a technique was successfully applied by Atherley, Else and Noble (1972, unpublished) in a noisy work environment that entailed nonconstant exposure to hazardous levels.

The final point that needs stressing is the one that we always (ritually) stress at the end of such gatherings, but in falling in with tradition I am going to be consistent in my "economics" approach to the issue of hearing damage. Once an occupational pursuit in a given environment has been shown to be associated with risk of hearing injury it is quite clear what then needs to be done. The noise has to be reduced so as to be noninjurious, and by noninjurious I mean, "causes no injury". I do not mean, "causes less than the legal limit". And my reason for insisting on that is because I don't see why one should tolerate a risk of injury to hearing in one's occupation when one would not tolerate such a thing otherwise in society. As regards the economic angle I seek indulgence to quote from a recently published and rather seditious work.

> "As an ordinary citizen, I join the rest of society in paying compensation costs in the price I pay for goods produced under dangerous conditions. Frankly, I would prefer to pay the cost of making these conditions nondangerous. [Noble, 1978, p.51]."

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Discussion:

Mr. Satory: I would like to comment in a way that is not intended to detract from the importance of other papers but I consider this personally to be the most important paper that has been presented to date.

Mr.O'Keeffe: When Dr. Noble came to his concluding remarks it just left me with a bit of a question mark. I find it hard to explain but I think it was this way - that he was certainly having quite a crack at industry and perhaps about what society should or shouldn't be doing about occupational hearing loss. But then it suddenly ran through my mind about all the noise that goes on in discotheques, shooting clubs and so on. I wonder if he has given any thought to what society ought to be doing in relation to noise outside the occupational area as well as within it.

Dr. Noble: I don't think that I want to take up too much time in answering that question. I think that it's an important question but I don't think it is one that directly addresses itself to the kinds of issues that I have been trying to consider. I have learned quite a lot at this conference this afternoon about the conditions which are facing Australian industry in regard to spates of claims of the sort that faced American industry 25 years ago. I can understand that industy is feeling the pinch in this country but I would stress that the Americans felt that pinch a quarter of a century ago and I think that Australian industry has probably had sufficient time to put its house in order. So yes I have had a bit of a crack at industry. In regard to what people do outside their occupational pursuits I think that people are free to do what they will. It's where people are engaged in the business of damaging other people's health that the rest of society must adopt some concern.

Mr.O'Keefee: Could I just make another point. From what you said it is possible that there are other methods of testing what is going on in relation to noise in the industrial situation apart from testing the individuals concerned. Would a combination of noise monitoring and audiometric monitoring be of value, especially for distinguishing occupationally and non-occupationally caused hearing loss?

Dr. Noble: I do appreciate that I had to go rather fast in my presentation because time was getting on but that was one of the points that I stressed within the paper; the hope that by combining direct environmental monitoring and indirect environmental monitoring (i.e. periodic

performance testing) one could surely get some kind of overall picture. But that is exactly what Burns and Robinson set out to do in the most rigorous programme on industrial surveillance that has been carried out to date, and it was precisely that programme that yielded "unintelligible data", and these are their words, not mine.

Dr. Southgate: I don't think we should knock in any fashion the audiometric testing because it's a very valuable instrument in the hands of all people interested in the prevention of hearing loss, because at least you have a piece of paper with some symbols on it, as the gentleman here said, which you can show the person concerned and point out the fact that he has lost part of his hearing and indicate the need for protection in order to prevent any further hearing loss.

Dr. Noble: One of the things that has disturbed me that I have heard this afternoon is that potential employees are being denied employment in this country precisely because a piece of paper with symbols on it, the validity of which is questionable, is being used to discriminate one set of persons from another. Now that disturbs me profoundly. I recognise that there is a legislative change required in this country to protect the employer from liability for damages that potential employees acquired before they came to their present employment. I think it is entirely unreasonable to expect the present employer to cover all the costs of compensating for something for which a previous employer should be responsible. But I simply challenge, as I have challenged for a number of years, both the reliability and the validity of that famous piece of paper with its famous symbols on it.

Mr. Castleman: I believe that you have made the point very well for a complete hearing conservation programme. I wonder if you would comment on how you believe this should be co-ordinated, particularly as to the qualifications of the person co-ordinating the programme, who that person should report to in the organisation and what regulatory controls should apply in the area.

Dr.Noble: That sounds like the content of my next paper! That's a fairly large issue and I wouldn't even care to begin, but certainly properly qualified acoustical-environmental engineers need to be much more in the picture than they presently are. Work analysts, job analysts and work study specialists need to be very much more involved than they are.

SECOND PANEL DISCUSSION:

Anon: Are you saying, Dr. Noble, that to your mind there is no satisfactory means of establishing a hearing loss of a worker in industry if he is subject to excessive noise?

Dr. Noble: In the long term it is possible to do that on an individual basis, probably.

Anon: You don't accept that the audiogram is a satisfactory technique.

Dr. Noble: Not in the short term.

Mr. Serradura: Would you please elaborate on that? - not in the short term? - a little more please.

Dr. Noble: In the short term, in a good group study, under the right kind of conditions, it would be possible to use audiometric measures of temporary threshold shift to back up a noise survey in order to evaluate the hazardousness of an environment. In the long term, that is to say over a period of a few months, such as in High and Gallo's study, the pure tone audiogram can be used on a population basis to demonstrate that the environment is hazardous, that is to say that very tiny changes in average hearing level are sufficient to be statistically significant, even though individuals within that very large population may have wandered all over the place. But both in the short term, and in the longer term, that is to say for a period of probably up to five years, I think that no real reliance can be placed on the individual audiogram.

Anon: If you can achieve statistical significance by taking a large population, couldn't you also achieve that for an individual by taking a greater number of tests?

Dr. Noble: Yes. But then of course you've got the question of costs.

Mr. Satory: I would like to address my question to Dr. Bulteau. Is there some other information that we can get that may be more important that isn't being collected during these tests. For instance, I am suggesting that there are other things that we could look for in the people who are going deaf, e.g. that hard rather than soft wax within the ear could give less damping and be instrumental in causing the deafness.

Dr. Bulteau: I know of no evidence that would correlate with the type of wax or any other factor in the external auditory meatus.

Mr. Satory: That was my point. But let's collect the data.

Dr. Bulteau: Well mostly before any testing is done wax is removed anyway for otosocopic examination. But I don't know that you could

require every worker in every industry to have his ears examined and the wax taken out.

Mr. Satory: I'm not suggesting that the wax be taken out. Examine the wax condition.

Mr. Wyndham: I notice that in Sister Parker's testing there is provision for improvement as well as deterioration. How commonly do you get improvement and do you think these are just errors of the testing technique?

Sr.Parker: We haven't done validation tests over the whole group as yet. We do find that improvements occur. The accuracy of the first test is absolutely vital. It can be undermined if there has been a language problem, or any of the other problems associated with audiometry mentioned in this last day and a half, that could have upset the validity of the first test, and you can then get apparent improvements. However even in our controlled test conditions we still get improvements.

Mr. Murphy: I'd like to ask Dr. Howe: do you have any comments on some of the practical aspects put forward by Sister Parker in relation to your scheme?

Dr. Howe: I'm sure Dr. Bowmaker would agree with me that one of the things we did see in repeat monitoring audiometry was this improvement as well as a loss of hearing and this did not appear to be restricted to any particular frequency. It was quite variable, and I guess this is some support for Dr. Noble, although I disagree with him violently. If we had adopted his attitutde to audiometry, it would have saved the company up to this time about a million dollars and we could have spent that million dollars, which would have been money well spent, on noise reduction. But let's not get ourselves sidetracked in this whole issue. We talk of monitoring audiometry, not to see how much damage the noise in industry is doing but how we are going in reducing that noise. If you are doing nothing about noise you may as well not do monitoring audiometry. It's fundamental, it's no different to testing people for lead exposure where you are supposed to comply with certain regulations, but even though you are within the regulations you still have to test people to make sure the regulations are working. So I make a plea - let's not talk about monitoring audiometry as though it's the beginning and end. It is purely a check, good or bad it doesn't matter. I don't care what people's views are on it but it is probably as much as anything the thing which keeps stimulating industry to improve the noise situation within their particular industry. I don't believe that any industry would be so silly as to continue spending

money on audiometry and not spend the right amount of money on noise reduction, which is the ultimate thing we are working for.

Sr. Parker: I just want to add a further comment about the frequency which does shown variability and that is 6000Hz. The test retest variability at that frequency is greater than at any other.

Dr. Noble: I would like to comment on something Dr. Howe said. I felt increasingly irrelevant to the whole enterprise as I listened to the papers this afternoon, especially Dr. Howe's, because it is clear that monitoring audiometry needs to be scrapped in Australian industry for quite different reasons than the ones I have been arguing for. It needs to be scrapped in order to save Australian industry all that money. As soon as monitoring audiometry is included in an industry that is precisely the signal for the payment of compensation. I think that the uses of monitoring audiometry for all the kinds of reasons that have been brought forward are indeed reasonable but please let us not pretend they have any reliability or validity to the task of protecting people's hearing. The way that people's hearing is protected is by making the noise non-injurious. Measuring the hearing does not protect it.

Dr. Gibson: I have found this one of the most interesting sessions of the conference. There is nothing better than a bit of conflict to stimulate discussion. As an experimenter, not involved in measuring hearing, I first of all deplore the idea of rejecting data that says improvement because my hypothesis is that improvement can't occur. My hypothesis may well be wrong because as Sister Parker said, I might be testing after a period of hay fever. As an experimenter I would say it is a very bad experiment if I am going to reject half my data just because I didn't expect it. However, I am very pleased to hear what Dr.Noble says. I too believe that is a very important statement and it should be an encouragement to the academics amongst us to look at a populations of non-exposed persons and study the statistics of their hearing over a period of time, and give those people working in industry some guidelines as to over what period you have to test to get a reasonable average. It seems to me that there may well be seasonal effects, there may well be correlations with effects that have not been considered and I would be pleased to hear any speaker's comment.

Dr. Howe: Just for what it's worth, Bethlehem Steel in America, which have probably had their programme going for about 25 years, were doing monitoring every twelve months. They had looked at their results over a long period and decided that they couldn't get significant results in

less than three years. Just when they decided that in came the OSHA regulations requiring it every twelve months but that was their impression of the type of results they got: you couldn't get anything that looked valid under a three-year period. I guess these fluctuations that Dr. Noble talked about are probably happening.

Ms. Hinch: Dr. Noble, would you care to comment on any correlation between the variation shown in the studies that you have mentioned and electrophysiological tests which are presumably not subject to certain fluctuations we commonly associate with pure tone threshold variation.

Dr. Noble: Do you mean like averaged evoked response? I'm not aware, but then I'm not thoroughly familiar with this literature, of studies of the serial reliability of evoked response threshold determination and I would ask for help from my psychoacoustical colleagues here. That leads me to comment on something I heard earlier this afternoon, which was that we don't really understand what this variability in threshold determination is about. I would challenge that: we know very well what it's about. What we also know is that it is uncontrollable, but we know what it is attributable to and part of its attribution is indeed to changes in level of adaptation of the auditory system from time to time as well as possible familiarisation effects, learning effects, this kind of thing. Now as to how much of the variability is attributable to familiarisation with the signal type as against how much is attributable to adaptation of the auditory system, that would be a matter of some debate. One very interesting but little-known piece of research that was done by some engineers and statisticians in the north of England many years ago was to study the degree of quiet threshold shift - that is to say the quiet adaptation of the auditory system that is left to its own devices in anechoic conditions - for about an hour. They found a reasonable correlation between the extent of such quiet threshold shift in the short term, over an hour, and the extent of test retest variability in the longer term, which suggests that there is individual susceptibility to small changes in environmental noise levels, apparently of a physiological character. That's uncontrollable, as are all the other features of audiometric unreliability. Sister Parker has mentioned the greater variability at 6KHz. This is entirely due to the fact that when you replace earphones on a listener's head a year later they are obviously not going to go quite on the same place that they went the year before. Hence you set up a different acoustical field in the outer ear of the listener, especially at higher frequencies, and it doesn't require much of a change in the

positioning of the earphone on the ear to produce dramatic changes in apparent threshold at 6KHz and above.

Mr. H. Weston: It's obvious that there's a lot of difficulties in this are and I very well realise that there are extreme difficulties in industry in reducing noise. It's pretty obvious also that there are difficulties in carrying out audiometry and that it costs a lot. I'd like to mention that for very many years a lot of State Health authorities and the National Health and Medical Research Council have stated that 90dB(A) for 8 hours is a reasonable starting point for industry but they have also recommended that over a period of 5 or 10 years efforts be made to reduce it to 85dB(A). NH & MRC recommend that this should be done in Model Regulations, and I think that industry is perhaps very unwisely lobbying to have this taken out of regulations. As a result it has been taken out of all State regulations (as a mandatory requirement). This means that there is no goal for the future to actually achieve what everybody is trying to achieve which is the elimination of this problem. I feel that we should all try a bit harder to at least set some goal for the future so that this problem will be eliminated from industry.

INDUSTRIAL DEAFNESS - A TRADE UNION VIEWPOINT

by

The Hon. H.B. French, M.L.C., President, The Federated Rubber and Allied Workers Union of Australia,

and

Mr. T. Reynolds, Compensation Officer, Labor Council of New South Wales.

As many of you here today will know, the Trade Union movement has been concerned for some years now about the growing trend and incidence of industrial deafness. In fact over the last few years my union, the Federated Rubber and Allied Workers Union, has as a service to its membership provided on a regular basis screening hearing tests to determine whether members have in fact sustained a hearing loss due to noise at work. I might say that the results of these surveys have disclosed a surprising number of union members with this problem. Indeed, the number of claims that we have made as a result of these tests has returned many thousands of dollars to our membership.

The whole subject of noise induced deafness, as I've said, is a matter of increasing concern to the trade union movement - so much so that recently Unions affiliated with the Labor Council met and discussed the subject and as a result of that meeting have carried resolutions in the following terms:-

"That in the light of current medical and other opinion, this meeting of Unions considers that the most desirable level of noise at the workplace should be no greater than 85dB(A), and so far as the proposed draft hearing regulations to be introduced by the NSW government are concerned, it is reluctantly accepted that the noise exposure limit be 90dB(A) for eight hours a day, but we require a reduction to the 85dB(A) level for the same period within five years. Further, we believe that new factory premises should be designed to comply with the 85dB(A) level.

Furthermore, Unions seek from the Government inclusion in these regulations of a provision for the achievement of an 85dB(A) limit within five years and an ultimate reduction to

80dB(A) or such lower noise level as may be determined in the future as being non-deleterious to the worker."

Now while on the subject of these proposed noise regulations I might point out that unions affiliated with the Labor Council have, through the Council as the governing body of the trade union movement in this State, put a number of submissions to State Government concerning amendm ents which we feel are necessary to these regulations. Without detailing every submission that has been made, suffice it to say that we are concerned about such matters as the re-issue of hearing protectors. The unions believe that there should be minimum acceptable standards of cleanliness spelt out in the regulations and it is worth noting that a number of unions have insisted that hearing protectors not be re-issued to other persons in certain circumstances.

So far as the duties of the occupiers of premises are concerned the draft regulations in their present form place emphasis on the pre-employment hearing and medical examinations. It is certainly the view of my union so far as hearing tests are concerned that an employer should be bound to test every person prior to that employee leaving his service and be responsible for the cost of conducting audiometric and other tests necessary to determine whether or not that employee has a noise-induced hearing loss before he terminates his service. In this way I believe an employee will be able to lodge a claim under the provisions of the Workers Compensation Act against that employer before he proceeds to new employment. As we know, and I might add that this is a matter of some concern to me, a number of employers, when they have application for employment test their new employees and it is clear - and experience confirms this - that a number of employers are being unreasonable in refusing to engage employees for particular jobs because they are found to have a hearing loss. The compensation law on this subject presently requires an employee to lodge a claim against the last employer to which the nature of the decrease is due. This, as we know, means that if a claim is not madeagainst the previous employer and the prospective employer has an operation which by itself produces noise sufficient to cause industrial deafness, then the moment the employee starts at the new place he is entitled under the law to lodge a claim against the new employer. The suggestion that I have made, namely that the employee be allowed the privilege and benefit of having audiometric tests done at the employer's expense, and be allowed to claim against

that employer, if necessary, before he leaves that employment, will in my view overcome a lot of the difficulties that we and, I suggest, employers now face.

Workers Compensation, as most of us now realise, is an ever-increasing burden on our community. The costs of premiums of course rises when the legislation is amended and the benefits improved. I am proud to say that as a member of the Legislative Council I had occasion to speak in support of the amending bill that came before the chamber in December last cocerning this area. The situation now is that following the amendment to the Workers' Compensation Act here in NSW as from the 9th December, 1977, under Section 16 of the Act the sum of $6,850 is payable for total loss of hearing in one ear and the sum of $14,450 is payable for loss of hearing in both ears. These figures are, I suggest, substantial amounts to pay to members of unions and others employed in the workforce who unfortunately find themselves with this problem. I'd like to state at this point, however, that if industry is as concerned about this subject as I believe some sections of it are, that once the Government introduces its new noise regulations it is not unreal to suggest that the trade union movement may have to make claims for damages at common law against those employers who not only do not comply with the regulations but who because of their neglect in providing safe means of work - by this I mean an establishment where noise can be reduced - will be sued for damages. If and when it occurs I think it fair to say that employers will find that the costs to them will be much greater than the amounts presently prescribed under the Workers' Compensation Act. I make these observations because I fear that a number of employers who have reasonably large establishments have not yet taken steps to reduce the noise problem. Perhaps they feel that they can afford to pay the premiums and have the claims made against them under the Workers' Compensation Act. If that be so - and there are certain employers who adopt that thinking - then I invite them to think again.

Far too many factory operations are noisy and are not conducive to good worker health. Often I find that, to offset the headaches and pains, a number of members of unions have sought to buy analgesics in the factory canteen and at nearby shops. The medical profession in many instances has a tendency to prescribe Valium instead of looking at the root cause of the problem. Many employees are not told about the health and safety hazards in their jobs. Employers, in my view, could make greater use of modern means of communication

such as audiovisual equipment to help introduce new workers to the job. Office machinery is a problem; frequently we find that photo-copiers and duplicators are noisy and when they are set up in the store room, the tea room or other confined space without adequate ventilation in some cases the noise problem is quite severe. Now while it is true that some companies have adopted stringent safety programs and certain companies require workers to wear earmuffs or respirators as the case may be, rather than take the more costly step of removing the source of the hazard or redesigning plant layout, the situation as I have said will cause discontent and promote the prosecution of Common Law actions for damages in due course against those employers who fail to recognise the problem and do something about it.

The Trade Union Movement has always been directly involved and concerned about the health and welfare of its members and indeed we are now finding that right across the spectrum our members are suffering poor health. Far too many have back troubles, tension headaches, arthritis, rheumatism, high blood pressure, hearing and visual defects as well as respiratory problems, which I suggest can and must be rectified. Many of these health problems may be attributable in part to worry of job security and lack of job satisfaction but when you go into many factories these days and look at the conditions under which many people work and take into account the temperature, noise, odour, physical danger, ventilation, pollution and lighting, is it any wonder that there are the number of claims that are made each year under the Workers' Compensation Act? In fact in the state of New South Wales some 250,000 claims are made annually and this in effect represents one in six of the workforce in this state having to seek medical treatment in respect to some problem which has been caused or materially aggravated by the nature of their employment.

In conclusion may I thank you for your attention and to the Australian Acoustical Society and its officers responsible for convening this conference, might I say that I am glad to have had this opportunity to be present here today and to put forward some of the views I have and to listen to the views of others perhaps more expert than I in this most important area. Finally, I might say that Mr. Reynolds, who as you will see from the programme was to have presented this paper today, is on leave and is of course unable to be here but has asked me to convey his apologies to you.

Discussion:

Mr. Sponberg: Mr. French, as a member of the government would you be prepared to use your good offices to recommend that the limit which is now set at 90dB(A) in the current draft regulations be reduced progressively to 85. The reason I ask this question is that I understand that the limit of 90dB(A) could be compared to a person standing about 20 feet away from a jackhammer for 8 hours duration and that limit seems to me to be arbitrarily high.

Mr.French: That is easy to answer: yes. I think we all know that there is going to be a state election shortly and at the present time those people representing the trade union movement in the Legislative Council, I being one of them, haven't had the numbers to be able to get through a lot of legislation which we felt would be beneficial to the workers but we hope that that is all going to change within the next month or so.

Mr. O'Dwyer: You mentioned that you would like to see the noise problem eradicated and you went on to say that you want to see many other things brought in to reduce the noise level. However there was no mention of the union's role in this particular problem. Do you see the unions having any responsibility in solving the problem and if so in what way? I speak specifically of the reluctance of most members of the unions to wear their protective equipment, especially hearing protection. Do you see it as a union responsibility to see that there is some training given to the members of the union itself?

Mr. French: In the beginning, workers do not object to the wearing of earmuffs or any other protective clothing, as a general rule. You can find a minority who do I guess - but if one looks at the airports you can see it is one of the conditions of employment that earmuffs be worn by ground engineers working near jets. The same is true within our own industry where we have wire-drawing in the cable section of industry. There, protective glasses are part and parcel of the terms of employment and these are rigidly carried out. I don't believe that there could be more than a minority of people who are reluctant to wear earmuffs. The other question that arises from that is are they both original earmuffs, have they been cleaned properly, there is this hesitancy of course in re-using old muffs. In relation to the design of plant I believe that the government should invite the trade unions to collaborate with the designers of new industrial plants. We've found in our industry that there has been consulation but that is as far as it went. Our word wasn't accepted but I believe that in the near future there must be some greater involvement of those who are representing the workers in

the design and installation of new equipment.

Dr. Fricke: I'd like to follow up the first question with the comment that before the OSHA regulations were introduced in the United States a study was done of the cost to industry of these regulations and it was found that to set the limit at 90dB(A) was going to cost industry something like $4 billion and to set it at 85 was going to cost something like $40 billion. I wonder whether an equivalent study has been done in NSW and if it hasn't been done shouldn't it be done before we introduce this legislation?

Mr. French: We feel that money is one thing and hearing is another. At one time the trade unions' role was only to improve conditions and obtain more money. They were the traditional roles but now there is a greater involvement in seeing that other factors such as occupational health and safety are considered. In my own industry we are now conducting hearing screening tests twice a year which have come up with surprising numbers of people with hearing losses. We don't want to have the situation where people are going deaf because of the neglect of manufacturers. Now on the cost structure, it's purely money, and I suppose if you're going to improve any place, it's going to cost money but as far as we are concerned in the trade union movement our priorities are for our people to work in safe conditions.

Dr. Mather: I'd like to ask Dr. Fricke were you suggesting a study of, say, 90 versus 85 dB(A)?

Dr. Fricke: I think in the impending legislation that the level of 90dB(A) will be adopted initially and then it will reduce to 85 in five years time. What I'm mainly concerned about is is that 5 years long enough or is it too long.

Mr. French: We feel that this can be done in five years. As far as the costing is concerned, I'd like to know who are the people who really do the costing.

Dr. Fricke: Whether we like it or not, we do put a price on people's lives and disabilities. I don't know what the price is in Australia but for the UK it is something incredibly small for a life, something like £12,000. Surely if we are going to do it this way we have to take this into account.

Mr. French: The unfortunate part about Australia is that you have six states and each state has its own independent compensation act, each with different amounts of compensation, whether it be for loss of life or limb, hearing, sight and so on. This is a ridiculous situation. I believe that compensation should be approached on a national level

and that a person's life should be worth the same in Western Australia and New South Wales.

Mr. Kimpton: I'd like to dispute something Mr. French said in that he finds that there are very few workers who mind wearing hearing protectors. In our experience at the Board we find that, mainly with labourers, it's very hard to convince people to wear protectors. They just don't want to bother with it, and I think the main problem is education. What I'd like to know is whether the Union movement as a whole is making moves or is interested in educating its members and also its officers. We had a case recently where a Union officer came out on a job, refused to wear hearing protection which is mandatory for Board's employees, went back to the office and declared the machine black. He simply refused to wear protection, so I think we need education of the workers plus the union people themselves. While we are talking about occupational hearing loss here we've also got to consider the fact that some loss occurs in our so-called social life - discotheques or even the clubs that some of us go to. While it's not an occupational loss it must accentuate the trauma that does occur with occupational loss. So surely we need educational programmes, not only through the unions of course but through the government, perhaps at school level for the young people and in some other way for older people, to teach them that noise is not just a problem at work, it's elsewhere as well, so that they do protect themselves in some way or other.

Mr. French: I believe that certainly there should be an education programme and it should start at the school level. When there is a hazard most workers will wear protective equipment providing they are instructed that it is necessary for their well-being. A big problem for employers, and I guess for unions too, is the high proportion of migrants from non-English speaking backgrounds in industry at the present time. Some companies are printing information in other languages now and the Ethnic Affairs Commission here in New South Wales has introduced a booklet in about 10 languages advising workers of their rights in relation to compensation and so on. There should be proper interpreters on the job to instruct people in their own language, it's no good relying on another migrant who happens to be bi-lingual. We have found this difficulty in giving a viewpoint of what a stoppage is about because the particular person who does the translation will only translate his version and if you're not familiar with the tongue you don't know what he said.

Mr. Campbell: I'd like to ask Mr. French what is going to be the attitude of the trade union movement in a situation where the new noise

control regulations come into force requiring the mandatory use of hearing protection if some member of a union is disciplined for his failure to comply with that regulation?

Mr. French: I think I'd wait and see. I think that I have already spoken generally on this, that there will be the cooperation of the trade union movement. If it is made mandatory in certain jobs, I think that the majority of unionists are responsible people and are prepared to cooperate in their own protection. It's hypocritical of us to come along and agitate for certain things and then not be prepared to abide by what we're agitating for.

Mr. Hughes (TAA): Just one correction I would like to make; much as we would love to have wearing earmuffs on tarmac as a condition of employment, despite several attempts to get this worded into the awards during negotiations, it's always the union that rejects it. It's not a condition of employment to wear earmuffs on tarmac. We have an unwritten verbal agreement though that if we find an employee whose hearing has deteriorated since the previous test, then the unions will allow us to issue a letter to that individual, stating that the wearing of earmuffs is now a condition of employment.

Mr. Ruschena: This is more of a comment for noise reduction in the long term. Eventually industry will have to reduce the noise exposure of employees - I don't think that fact is disputed by anybody. However, noise reduction in certain industries usually involves such high costs that an employer or manufacturer will not look at it in isolation but will tend to bring it in as part of either an upgrading in process or some other such thing. There are certain processes which it is not possible to quieten, for instance you cannot hit a steel object with a steel hammer quietly, or break rock quietly. Therefore the obvious solution would be to isolate the worker in control rooms or other such devices. As I said you don't usually treat large jobs for noise control in isolation and therefore you look at your efficiency. The trend will inevitably be towards automation - one man controlling more equipment, and therefore in the long term I think it will inevitably lead to less employment in those industries.

Mr.E. Williams: Being in the aviation industry for the last 30 years I'd like to talk a little bit about why perhaps people don't wear earmuffs in marginal levels of say 85dB(A). In a very noisy area like on the tarmac near a jet engine, where the noise is over 100dB(A), we don't have very much problem in getting people to wear earmuffs. It's down around the 85 or below the 90 decibel range that education is

necessary to get people to understand that their hearing is in the long term being impaired. It has been suggested that this is a union problem, but I would suggest that industry provides the machines, they are the ones who will determine who is going to work near these machines, so I think industry has a responsibility to set up training programmes of their own to inform people of the need for protection. And industry has the responsibility to provide this protection. Because protection is the last line of defence, what we should be trying to do is to reduce the noise in the environment itself.

Mr. French: I couldn't agree more.

WORKERS' COMPENSATION LEGISLATION
PROVISIONS RELATING TO OCCUPATIONAL HEARING LOSS

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Relevant legislation

The workers' compensation laws in Australia that are relevant when considering occupational hearing loss are as follows:

N.S.W. - the Workers' Compensation Act, 1926.

Victoria - the Workers' Compensation Act, 1958.

Queensland - the Workers' Compensation Act, 1916.

S.A. - the Workmen's Compensation Act, 1971.

W.A. - the Workers' Compensation Act, 1912.

Tasmania - the Workers' Compensation Act, 1927.

A.C.T. - the Workmen's Compensation Ordinance, 1951

N.T. - the Workmen's Compensation Ordinance, 1949

Commonwealth - the Compensation (Commonwealth Government Employees) Act, 1971.

- the Seamen's Compensation Act, 1911.

In other words, there is separate workers' compensation legislation in each of the six States, the Australian Capital Territory and the Northern Territory and the Commonwealth has legislated separately in relation to its own employees and also in relation to seamen who are employed on Australian registered ships trading interstate or overseas.

There are some significant differences between these ten separate compensation laws. It is fortunate that, except for a few major difficulties which I will mention, most of the differences do not affect the situation a great deal in relation to compensation for occupational hearing loss. Some of the differences are rather technical, so I will deal with the subject in fairly general terms in an attempt to avoid making it over complicated. Indeed, it would be impracticable to do otherwise in the time available.

My direct experience has been confined to the Commonwealth legislation. I have acquired some knowledge of the State legislation, but I do not claim to be an expert in that field and this was the understanding upon which I agreed to prepare and present this paper.

Provisions in the legislation relating to the liability to pay compensation

When speaking of occupational hearing loss, we usually have in mind a hearing impairment caused by exposure to noise trauma over an extended period of time. This comes within the category of diseases that are contracted by gradual process and the condition is sometimes referred to as boilermakers deafness, industrial deafness or noise induced hearing loss. Occupational hearing loss can sometimes result from a single incident, such as an explosion, however, and this constitutes an injury. Indeed, I recall a case where a Commonwealth Officer was a passenger on a civil airliner and he was paid compensation for a loss of hearing which resulted from a noise blast from a jet engine when he was boarding the aircraft.

Under the Acts of N.S.W., Victoria, Queensland and South Australia and also under the Compensation (Commonwealth Government Employees) Act, the employer is liable to pay compensation when an employee -

- sustains personal injury arising out of or in the course of the employment; or
- suffers from a disease, or the aggravation, acceleration or recurrence of a disease and the employment was a contributing factor to the contraction or the aggravation, etc. of the disease.

In practical terms this means that, in the case of an injury, the claimant must show that it either arose out of the employment or that it arose in the course of the employment. In this regard, it should perhaps be mentioned that some causal connection with the employment must be established to show that an injury arose out of the employment, but a mere temporal connection is sufficient to show that an injury arose in the course of the employment. Thus, under the Acts of N.S.W., Victoria, Queensland and South Australia and the Commonwealth Act relating to Commonwealth employees, there is a liability for an injury if there was either a causal or a temporal connection with the employment. In the case of a disease, or the aggravation, etc., of a disease, however, it must be shown that the employment was a contributing factor and this requires a causal connection with the employment, somewhat akin to that meant by the words arising out of the employment.

The foregoing is a brief statement only of the provisions which apply generally in relation to injury and disease under the legislation to which I have referred. Since we are considering occupational hearing loss,

it is not really necessary to go into these provisions in greater detail, because a claimant suffering from this condition merely has to show that he has been exposed to excessive noise in his employment to establish both a causal and a temporal connection with the employment.

A further aspect which I should mention, however, is that the compensation cover under this legislation extends to travel between home and work and to certain attendances associated with the employment, such as the attendance of an apprentice at a technical college or trade school.

Apart from the general provisions to which I have referred, the South Australian Act also has separate provisions relating to industrial diseases which are due to the nature of the employment. Noise induced hearing loss is one of the diseases listed in a schedule to the S.A. Act and is deemed to be due to the nature of the employment, unless the employer proves the contrary, if the worker was employed in any process involving exposure to noise. Under these provisions, the last employer is liable to pay the compensation, but is entitled to seek contribution from any other employer who has employed the worker during the previous 3 years - in default of agreement, the amount of the contribution is determined by the Industrial Court of South Australia.

Although it does not have a schedule of diseases, the N.S.W. Act has provisions relating to diseases contracted by gradual process and the condition known as "boilermakers deafness" and any deafness of like origin is deemed to be such a disease. The last employer is liable to pay the compensation and he is entitled to seek contribution from previous employers. Since this is limited to another employer who has employed the worker during the preceding 12 months, however, I doubt whether this provision has much significance in cases involving occupational hearing loss.

The Victorian Act has special provisions relating to industrial diseases due to the nature of the employment. The last employer principle applies and, where the disease is contracted by gradual process, he is entitled to seek contribution from previous employers. Although there is no time limit in this regard, it is significant that these special provisions only apply where "a worker is suffering from a disease and is thereby disabled from earning full wages at the work at which he was employed".

Presumably these special provisions would therefore be limited in their application to the very few hearing cases that result in the worker being disabled from earning full wages.

Under the Queensland Act, loss of hearing caused by the condition known as industrial deafness is deemed to be personal injury. To be able to claim for loss of hearing, however, a worker must still be employed, or only temporarily unemployed, when he makes the claim and he must have been continuously resident in Queensland for at least 5 out of the previous 7 years and have been continuously employed during that period in an industry and at a location where the noise level caused or contributed to the condition for which the claim is made. The compensation is paid out of the Workers' Compensation Fund administered by the State Government Insurance Office of Queensland.

The Compensation (Commonwealth Government Employees) Act has special provisions relating to a disease, or the aggravation of a disease, where the employment was a contributing factor. The schedule of diseases does not include occupational hearing loss, but the general provisions, to which I referred earlier, apply and there is also a provision which deems the employment to have been a contributing factor, unless the Commonwealth proves the contrary, in any case where the incidence of a disease (or aggravation) among those who have engaged in the particular employment is significantly greater than among persons who have engaged in employment generally in the place where the employee was ordinarily employed. In other words, there is a presumption in favour of, say, a boilermaker at the Garden Island Naval Dockyard, if the incidence of noise induced hearing loss is significantly greater among the boilermakers at the Dockyard than it is among those in employment generally at the Dockyard.

Turning now to the remaining legislation, I will have to be brief and I will refer first to the Tasmanian Act. There is a liability to pay compensation under this Act if a worker suffers personal injury by accident, or is disabled as a result of a disease, arising out of and in the course of the employment. This requires both a causal and a temporal connection with the employment for both injury and disease and, by definition, the word "disease" means only those diseases that are specified in the second schedule to the Act. This means that this legislation could be more restrictive in relation to some types of injuries and it certainly has its limitations in relation to diseases.

Industrial deafness is included in the schedule, but the position in Tasmania has been in considerable doubt since a judgment of the Supreme Court of that State over a year ago in which it was held that the words "disabled as a result of a disease" mean that the worker must be incapacitat for work, before there is a liability to pay compensation. Since very few hearing cases involve incapacity for work, it seems that very few such cases are now receiving compensation in Tasmania. The cover under the Tasmanian A when it does apply, also extends to travel between home and work and to cert attendances associated with the employment, such as an attendance at a trade school.

It seems that the position in Western Australia in relation to occupational hearing loss may also have been thrown into some confusion in May of this year, when a decision of the Workers' Compensation Board of that State, awarding a worker $11,036 for 56.1% loss of hearing, was reversed by the State Full Court. Under the W.A. Act, there is a liability to pay compensation for personal injury by accident arising out of or in the course of the employment. There is a separate provision in relation to diseases wh states that, where a worker is disabled from earning full wages by reason of suffering from any disease mentioned in the third schedule to the Act and th disease was due to the nature of the employment, he shall be entitled to compensation as if the disease were a personal injury by accident arising ou of or in the course of that employment.

"Noise induced hearing loss" is included in the schedule of disease and, unless the employer proves the contrary, this condition is deemed to be due to the nature of the employment, if the worker was employed in "any process involving exposure to noise".

I have not seen a copy of the judgment of the State Full Court, but, from what I saw in a press report, I assume that the decision went against the worker on the grounds that he had not been disabled from earning full wages because of his loss of hearing and the disease provisions of the Act therefore do not apply in his case. I understand appeal proceedings have been instituted in the High Court.

I mentioned the same problem in relation to the Victorian Act, but the important difference in that Act is the general provision, which relates to both injuries and diseases and renders the employer liable to pay compensation for a disease where the employment was a contributing factor.

Under the Seamen's Compensation Act and the Workmen's Compensation Ordinances of the A.C.T. and the N.T. there is a liability

to pay compensation where a workman (or seaman) sustains personal injury by accident arising out of or in the course of the employment. The disease provision is separate. It states that, where a workman (or seaman) is suffering from a disease and is thereby incapacitated for work and the disease is due to the nature of the employment, the employer shall be liable to pay compensation as if the disease were a personal injury by accident arising out of or in the course of the employment.

The Act relating to Commonwealth employees was the same prior to September 1971 and we had no problems; there was no difficulty in showing that an occupational hearing loss was due to the nature of the employment and the Commonwealth did not attempt to take the point that an employee who suffered from this condition had not been incapacitated for work. I recognise, of course, that the expression "is thereby incapacitated for Work" is a little different to the expression "is thereby disabled from earning full wages" in the W.A. Act. If my assumption regarding the reason for the judgment of the W.A. State Full Court is correct, however, I suspect that the position under the Seamen's Compensation Act and the A.C.T. and N.T. Ordinances is not free from doubt in cases where the hearing loss has not, in fact, caused either total or partial incapacity for work.

In other respects, the Seamen's Compensation Act and the Ordinances of the A.C.T. and the N.T. are somewhat similar to the other legislation. The cover extends to travel to or from the employment and to certain attendances associated with the employment. The last employer principle applies in relation to occupational diseases and there is provision for him to seek contribution from previous employers.

Other matters relating to the liability to pay compensation

Under all of the legislation there is a general requirement that the onus rests with a claimant to prove his claim. I have mentioned special provisions in some of the legislation under which the onus of proof is reversed in relation to occupational diseases. I do not propose to go back over these exceptions to the general rule, but I think it appropriate to make some comment on the element of proof that is required, so that you may appreciate the basis for some of the questions which those administering the legislation sometimes ask - particularly in relation to the medical examinations with which you may be associated.

When it is necessary for a claimant to show that he sustained a personal injury arising out of or in the course of his employment or that his employment was a contributing factor to the contraction of a disease, he does not have to prove this beyond all doubt or by direct evidence. The standard required is that the matter in question be established on the balance of probabilities, as distinct from mere possibilities. The determining authority must not conjecture or surmise, but may, where necessary, draw a legitimate inference from the accepted facts.

While we do not necessarily expect a medical specialist to say that a disease was caused by the employment, we are left with an unsatisfactory situation if he has merely said that it is possible the employment was a contributing factor. Consequently, we generally ask for an opinion based on the balance of probabilities and, in my view, this means more likely than not.

The compensation that is payable for loss of hearing

For loss of hearing the compensation generally takes the form of a lump sum payment, but cases sometimes arise where weekly payments are made for total or partial incapacity for work. For example, I recall a fairly recent case where a Train Driver with the Australian National Railways Commission was being retired on invalidity grounds because of a hearing loss in excess of 50%. It seems that the relevant regulations or by-laws set a minimum standard in relation to hearing for this class of employee and the railway authorities had been unable to place him in suitable alternative employment.

A statement setting out the lump sum and weekly incapacity payments under the various legislation is attached to this paper and I will refer to this when speaking to the paper.

All of the legislation has a schedule or table of injuries or losses for which lump sums are payable and all of these schedules or tables include a lump sum for loss of hearing. Such a payment has been included in the legislation applying to employees of the Commonwealth Government since 1930, and I think it likely that the equivalent provisions have appeared in the other legislation for a somewhat similar period.

If weekly incapacity payments have been made prior to the payment of a lump sum of this nature - an unusual situation in the case of occupational hearing loss - the weekly payments already made do not affect, or are not recovered from, the amount of the lump sum. So far as I am aware, however, the N.S.W. Act is the only legislation

under which the entitlement to a weekly payment is not terminated by the payment of the lump sum. The Compensation (Commonwealth Government Employees) Act differs somewhat in this regard, as a lump sum payment cannot be made under this Act if the employee is likely to become totally incapacitated for work. Also there are two circumstances where weekly payments to a Commonwealth employee are resumed after the payment of a lump sum - if he subsequently needs medical treatment, weekly payments are made for any period of incapacity associated with the treatment and weekly payments are resumed on a slightly different basis if he becomes totally incapacitated for work and such incapacity is likely to continue indefinitely.

Perhaps I should also mention that, under the W.A. Act, the worker must elect to receive a lump sum payment and weekly payments (if any) made before the election are not deducted from the lump sum.

Under the Compensation (Commonwealth Government Employees) Act and the Acts in South Australia and Western Australia the lump sum is payable for total loss of hearing on a binaural basis. The other legislation provides a lump sum for total loss of hearing (both ears) and for complete deafness of one ear. Claims for occupational hearing loss that involve either total loss of hearing, or complete deafness of one ear, are rare but, in all of the legislation, there are provisions under which the lump sum payable for a percentage loss of hearing is the relevant percentage of the amount listed in the table or schedule for total loss of hearing, or complete deafness of one ear, as the case may be. In this regard I think you will all agree that we are indebted to the National Acoustic Laboratories for their achievement in providing us with an accepted uniform standard for assessing percentage loss of hearing.

When dealing with the liability provisions earlier, I mentioned that in N.S.W., Victoria, S.A., A.C.T., N.T. and in the Seamen's Compensation Act, the last employer is liable to pay the compensation and that there are provisions, some with time limits, allowing the last employer to seek contribution from previous employers. I expressed some doubt whether these provisions would be effective in Victoria. To complete the picture, I should mention that the last employer principle also applies under the W.A. Act and contribution may be sought from other employers who employed the worker during the preceding 12 months. I was unable to trace any similar provision in the Tasmanian Act, but did not make an exhaustive check. The Compensation (Commonwealth Government Employees) Act has a provision which has the effect of rendering the Commonwealth liable only for the loss of hearing which has occurred in

the Commonwealth employment.

There are specific provisions in the Acts of N.S.W., Queensland, S.A. and W.A. that authorise a deduction for presbycusis. These provisions are all similar and were obviously designed to negate a decision of the High Court in 1969 in the case of Sadler v the N.S.W. Commissioner for Railways. The deduction mentioned in the legislation is one half of a decibel for each complete year in excess of 50 years of age, this being the deduction provided for in the 1970 C.A.L. Tables for assessing loss of hearing. There is provision for this to be varied by regulation; no such variation has been made in N.S.W.*, but I have been unable to check with the other States.

Under the 1970 C.A.L. Tables an average hearing level was calculated in decibels and the deduction for presbycusis was made before the total number of decibels were converted to a % loss. Under the 1974 N.A.L. Tables now in use, however, there is a direct conversion to a % loss at each of the 6 frequencies and a Presbycusis Correction Table is provided that allows for a deduction considerably less than one half of a decibel for each year in excess of 50 years of age until about 80 years of age. Consequently, I am unable to say how the States of N.S.W., Queensland, S.A. and W.A. now make the deduction for presbycusis, though I understand that the N.S.W. and S.A. authorities have made separate arrangements and are using tables specially prepared for their purpose by the National Acoustic Laboratories. The N.S.W. authorities advised that action is being taken with a view to repealing the provision in the N.S.W. Act that allows the deduction for presbycusis and, as I understand the position, this is more in keeping with the present thinking on the subject at the National Acoustic Laboratories.

I am a little puzzled by several provisions in the Tasmanian Act that apply when a loss of hearing is due to "the condition known as industrial deafness". It seems that, when this is the cause of the hearing loss, the % loss for which payment is made is reduced by 15% if the claim for compensation is made after 31 December 1974 in relation to employment that was continuing at that date of commencing thereafter. In any other case, i.e., for employment prior to 31 December 1974, the deduction is 20%. I would be interested to know whether the current N.A.L. Tables are used for assessments under the Tasmanian Act and, if so, whether this could be a duplication of the "low fence" already incorporated in the Tables.

*or in Western Australia

In addition to excluding any loss due to factors other than industrial deafness, or for which compensation has previously been paid, the Tasmanian Act also excludes any loss shown to have been contracted outside the State.

The Acts of N.S.W., S.A. and W.A. contain specific provisions for taking into account a previous lump sum compensation payment for loss of hearing. Under the N.S.W. and W.A. Acts payment is made in respect of the increase in the % loss that has occurred since the previous payment was made. Under the S.A. Act, however, the lump sum payable is the amount currently payable for the total % loss less the amount previously paid. Both procedures would give the same result if the amount payable for total loss of hearing remained constant, but the South Australian procedure is more favourable to the worker if there has been an increase in the compensation rate after the date when the earlier payment was made.

You will have noticed from the attachment to this paper that seven out of the ten statutes still retain a separate lump sum payment for complete deafness of one ear. A quick look at the figures will show that there is no consistent relationship between these amounts and the amounts payable for total loss of hearing (both ears). The ratio monaural to binaural in the Seamen's Compensation Act and the Ordinances of the A.C.T. and the N.T. is the same as the 1970 C.A.L. formula for calculating binaural loss. As I understand the position, that formula $\left(\frac{5x \text{ better ear} + 2x \text{ worse ear}}{7}\right)$ was later discarded. I cannot recognise the ratio monaural to binaural in the other legislation and I suppose this prompts the question why all have not followed the binaural approach adopted in the Compensation (Commonwealth Government Employees) Act and in the Acts of S.A. and W.A.

Other deductions

I mentioned earlier that, under the Compensation (Commonwealth Government Employees) Act, the Commonwealth is liable only for the loss of hearing that has occurred in the Commonwealth employment. It follows from this that any prior loss is deducted if the extent of that loss is known. A lump sum payment for a % loss prior to entry into the Commonwealth employment would provide evidence of such a prior loss. In some Commonwealth establishments a pre-engagement audiogram is taken and, if this reveals a hearing loss, this also is evidence of a prior loss. Where the current audiogram shows a noise induced hearing loss and the employee has been exposed to excessive noise in the Commonwealth employment, we have

operated on the basis that there must be specific evidence, such as that to which I have just referred, before a deduction can be made on the grounds that part of the loss has occurred outside the Commonwealth employment.

Likewise, if the current audiogram reveals a mixed deafness and the component that is not due to noise trauma is non-compensable, we use the procedure indicated in the N.A.L. Tables for determining the % loss due to the compensable component. I do not know what other compensation authorities do in this regard, but I am not aware of any reason why they should not follow the same procedure.

When awarding compensation under the Compensation (Commonwealth Government Employees) Act for a compensable loss of hearing which has been added to, or superimposed upon:

- an earlier non-compensable loss; or
- an earlier compensable loss due to a condition which is separate from that for which compensation is now being paid (e.g. an earlier loss due to an infection, a car accident or a one-time exposure to a loud explosion),

the payment is based upon the % loss of the hearing the employee had before the second loss occurred. In simple terms, if the employee had previously lost 40% he, in fact had 60%. If he has now lost 70%, he now has only 30%. For the additional 30% loss of hearing he is paid on the basis of a 50% loss, because he lost one half of what he had. This applies to other losses, such as sight and a loss of efficient use of say a previously defective arm and the principle has been incorporated in the N.A.L. procedures - or at least, the procedures made available to our Office.

The foregoing does not apply when we are merely revising the payment for hearing loss due to what might be termed an on-going noise exposure. In this case, we have for years been doing what I now see is specifically provided for in the S.A. Act - namely, award a payment equal to the amount currently payable for the total loss of hearing less the amount paid on the previous occasion (or occasions).

Other provisions which may be of some interest

There are, of course, many other provisions in the legislation that are not of direct concern, when we confine the discussion to occupational hearing loss - particularly from the viewpoint of the audiologist and those responsible for the assessment of the loss of

hearing. Perhaps I should briefly mention, however, that all of the legislation makes some provision for a right of appeal to a Court or other judicial body (such as the Workers' Compensation Commission in N.S.W. and the Workers' Compensation Boards in Victoria and W.A.) if the worker is dissatisfied with the decision of his employer (or the insurer) or the other authority responsible for the initial determination of his claim.

Under the Compensation (Commonwealth Government Employees) Act, for example, a claimant who is dissatisfied with a determination of the Commissioner for Employees' Compensation may request a statement of the reasons for the determination and copies of the documents, including medical certificates and reports, that were relevant to the matters dealt with in the determination. A notice outlining the rights of the claimant is sent with every determination. If still dissatisfied, the claimant (or the Commonwealth) may request the Commissioner to reconsider the determination. Whether or not he has made such a request, the claimant (or the Commonwealth) may request the Commissioner to refer the determination to a Compensation Tribunal for reconsideration or apply to a prescribed Court for a judicial review of the determination. There is then a right of appeal from the Tribunal or prescribed Court to the Federal Court of Australia on questions of law and from that Court to the High Court.

Concluding personal observations

I return to the comment I made earlier to the effect that we are indebted to the National Acoustic Laboratories. I meant that with all sincerity and, frankly, I wonder how we could have administered this aspect of our compensation laws on a rational basis, had it not been for the procedures devised by N.A.L. for assessing the compensable loss of hearing. For practical reasons, however, these procedures are confined to 6 frequencies which are weighted to deal with the average situation or the norm. No doubt this is as fair as it is possible to be in relation to the vast bulk of workers - particularly those in industrial situations involving exposure to noise trauma.

There will, however, be the exception, on rare occasions, where there is a loss at 6000 and 8000 hz that is having an adverse effect. Personally I have only seen one such case, but I mention it so that it will not be forgotten. As I understand the position, most people would be unaware of such a loss, but we were satisfied that this particular employee was aware of this loss and was affected by it in his employment in a branch of the electronics industry. Consequently we made what was regarded as an appropriate adjustment to take the loss into account.

In conclusion, I regret that I was unable to give you a simple talk on workers' compensation. Perhaps I could have done so, if I merely had to cover the Act with which I am familiar. But with 10 separate statutes and so many variations between them, the picture is confusing and I was unable to conceal this. Personally, I would like to see some attempt made to achieve a greater measure of uniformity.

STATUTE	LUMP SUM COMPENSATION FOR LOSS OF HEARING		WEEKLY PAYMENTS FOR TOTAL INCAPACITY
	Total loss of hearing	Complete deafness of one ear	
Compensation (Commonwealth Government Employees) Act	17 500	-	Compensation equal to full sick pay during first 26 weeks of incapacity. Thereafter, weekly rates as follows- $80 employee, $21 spouse, $10 each child
N.S.W. Workers' Compensation Act	14 450	6 850	Weekly wage, excluding overtime etc. during first 26 weeks of incapacity. Thereafter, weekly rates as follows- $86 employee, $19.70 spouse, $9.80 each child
Queensland Workers' Compensation Act	10 020	4 340	Weekly award rate of wages during first 26 weeks. Thereafter, weekly rates as follows - $77.40 employee, $19.35 spouse, $7.75 each child
South Australian Workmen's Compensation Act	15 000	-	Average weekly earnings
Tasmanian Workers' Compensation Act	12 859	5 804	Average weekly earnings
West Australian Workers' Compensation Act	33 649.50	-	Weekly earnings
A.C.T. Workmen's Compensation Ordinance	21 177.89	6 050.83	Compensation equal to full sick pay during first 26 weeks of incapacity. Thereafter, weekly rates as follows- $86.22 employee, $22.69 spouse, $10.59 child
Northern Territory Workmen's Compensation Ordinance	17 500	5 000	Compensation equal to full sick pay (or weekly earnings) during first 26 weeks of incapacity. Thereafter weekly rates as follows - $80 employee, $21 spouse, $10 each child
Seamen's Compensation Act	17 500	5 000	For the first 3 months, full wages in accordance with the Navigation Act; for the next 3 months weekly compensation plus an allowance in accordance with the Maritime Industry Seagoing Award to raise total pay to 75% of daily salary; thereafter weekly rate as follows- employee $80, spouse $21, $10 each child
Victorian Workers' Compensation Act	15 090	4 660	Weekly rates as follows - $73 employee, $20 spouse, $7 child, or average weekly earnings, whichever is the less

Discussion:

Mr. Heggie: I have heard an interpretation with regard to the New South Wales Compensation Act that if the person has noise-induced deafness then all of that deafness is deemed to have occurred on a notional date of injury, which is usually the date of claim or the date of medical examination, and that the last noisy employer is liable for all of that deafness provided that a previous settlement has not been made. Could you comment on whether that interpretation is correct?

Mr. O'Keefe: That would be substantially correct, although I haven't got the legislation in front of me. I mentioned earlier that they did have problems, not only with the question of whether the employee did in fact go to work, but also what was the date of injury for something which had occurred over a longer period of time, and they arbitrarily legislated - and I think in most of the legislation it is on this basis - that the date of injury is deemed to be the date when you make the claim. Our Commonwealth one is a little different, there again I don't have the Act with me at the moment, but as I recall that under our Act it is the date of incapacity or the date of the loss that is deemed to be the date of the injury for the disease in the Commonwealth situation. It is an arbitrary thing that is put into the legislation to fix a specific date and of course the last employer principle does apply in the NSW legislation. The last employer pays, he can seek contributions from any other employer that employed the person in a noisy situation in the previous twelve months, but I don't think the twelve months would get him very far.

FUNDAMENTAL ISSUES IN THE AUDIOLOGICAL ASSESSMENT OF COMPENSATION CLAIMANTS

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Historians looking back on the evolution of noise hazards, hearing conservation programmes, and relevant compensation legislation will surely be baffled by the complexities and convolutions of the procedures, both recommended and adopted. In no area is this more apparent than in that of compensation legislation for hearing loss and the audiological interpretation of the legal requirements and precedents.

The audiological assessment of the compensation claimant depends fundamentally on the act of parliament under which the individual is seeking his compensation and the legal technicalities which have sprung up to surround that act. To broadly clarify this point it seems (Department of Social Security, 1977) that (a) in each Australian state and territory employment injury is covered by a piece of legislation. Additionally Commonwealth Government employees and seamen are covered by separate acts and (b) the amount of compensation payable to an injured worker is set down in the legislation. Beyond that considerable variation occurs. Certainly, at this stage, there appears to be no exactly parallel procedures amongst the State and Commonwealth methods of assessing and compensating the hearing impaired worker.

To demonstrate this variability several examples will suffice. Although the amount of compensation is laid down within each piece of legislation it is surprising to find that some statutes provide noticeably smaller amounts for lump sum compensation than do others. The result is that the amount of benefit for the same injury may vary from statute to statute.

Under a number of the legislations the onus of proof is on the claimant to demonstrate four issues. He must establish that he has suffered a particular degree of hearing loss, that it was the

result of noise exposure, that it arose out of the course of his employment and that it occurred when he was employed by a particular employer or employers. There is little problem proving this when loss of hearing occurs from noise exposure with only one employer, but when a claim follows a history of noise exposure with a number of employers problems arise. In some states (S.A., Tasmania and, in theory W.A.) noise induced hearing loss is a specified industrial disease, meaning that workers in certain occupations are considered at substantially higher risk than the general population and their hearing losses are usually automatically compensable unless it can be proved that the injury did not arise from exposure to noise or to their employment. The onus of proof then falls on the employer.

Under some acts the employer who is liable for the compensation payment is not clear cut especially where the work history indicates a number of employers could have contributed to the hearing loss which is apparent at the time the claim is made. To overcome this some statutes have had so-called "deeming clauses" inserted. On the basis of these clauses noise induced hearing loss is deemed to be a disease which is of such a nature to be contracted by gradual process but for the purpose of compensation is deemed to have happened at the time when such worker makes his claim for compensation. This is usually interpreted to mean the liability lies with the employer who at present employs, or last employed, the claimant in noisy conditions.

Despite this variability between the compensation legislations there is fortunately no statutory requirements to adopt any particular audiological procedure, except possibly in those acts which include a clause relating to the treatment of a presbycusis component. Furthermore, the variations which do exist, although they may bother the legal advisors, are not of serious significance to the development of a procedure for the audiological evaluation of claimants.

To develop a procedure which is generally applicable it becomes necessary to concentrate on the similarities between acts

rather than the differences. It was from this point of concentration that the National Acoustic Laboratories began reviewing the ways of improving the procedure applied in compensation cases since 1970. Since the relevant acts are the basic legal instruments from which all procedural decisions arise they were re-considered. The first fact to emerge was that all the acts lay down that employees are to be compensated for loss of hearing. The term "loss of hearing" is however no more exactly defined, especially not in audiological terms. Remembering that an audiometric statement of an individual's hearing impairment would be expressed in terms of frequency and intensity the term "loss of hearing" was initially defined as an impairment of an auditory threshold acuity in the range of audiometric frequencies 250 to 8000 Hz. At the time this definition was consistent with a decision handed down by a previous Compensation Tribunal.

Having defined the frequency limits between which the claimant's loss of hearing should be assessed it was necessary to decide the upper and lower intensity limits. Firstly, when looking at an audiogram, to say that an impairment of acuity exists there has to be a deviation of acuity for the worse beyond the range of normal acuity. The range of normal acuity was taken as three standard deviations from the mean threshold level of normal listeners as reported in the various studies on which the ISO-1964 reference zeros for pure tone audiometry were based. When rounded out to the decibel levels available on the attenuator of the audiometer the levels shown in Table 1 become the levels beyond which handicap is considered to exist. These levels appear to correspond to the degree of impairment at which the impaired judge handicap begins.

TABLE 1

Frequency in Hertz	250	500	1K	1.5K	2K	3K	4K	6K	8K
Standard deviation in dB	6	6	6	6	6	6.5	7.5	9	10.5
3 x standard deviation in dB	18	18	18	18	18	19.5	22.5	27	31.5
In terms of audiometer attenuator steps these were rounded out to:									
	20	20	20	20	20	20	25	25	35

At the other end of the scale individuals were considered to have a total loss of hearing if their impairment of auditory acuity was such that the useful sounds of everyday life cannot be heard. Several studies (Hood & Poole 1971, Macrae & Brigden 1973) have found that above an average hearing level of about 90 dB the capacity to hear and understand speech, the most useful everyday sound, is negligible. Therefore if a person has a hearing level of 95 dB or more at any of the test frequencies then those frequencies are considered to effectively contribute nothing to his discrimination of speech.

Of course, different audiometric frequencies are of differing relative importance to perception in everyday listening and, although not known for many everyday sounds, they are known for speech. (Fletcher 1953). The frequency weightings are apparent if one considers the maximum percentage loss of hearing at each frequency in the October 31, 1974 Table as shown in Table 2.

TABLE 2

RELATIVE CONTRIBUTION OF FREQUENCY TO EVERYDAY SPEECH

Frequency in Hertz	500	1000	1500	2000	3000	4000
% contribution	20%	25%	20%	15%	10%	10%

At this point it may be apparent that there was a reduction in the frequency range which was to have been adopted originally compared with the range which was finally used. In theory the original range from 250 Hz to 8000 Hz would be preferable but serious practical difficulties were found to be associated with the inclusion of 250, 6000 and 8000 Hz. Ambient noise levels in even sound treated testing rooms was often found to produce spurious "losses of hearing" at 250 Hz for both air and bone conduction. In the event of conductive and mixed hearing impairments the fact that bone conduction thresholds could not always be determined for 6000 and 8000 Hz made their inclusion problematic. These three frequencies were therefore eliminated from the procedure.

The remaining concept fundamental to the derivation of the procedure for calculating percentage loss of hearing is that which takes into account the relative contribution of each ear to an individual's loss of hearing when listening binaurally. The rationale for considering this factor is that binaural hearing is the natural situation and is significant because it is obvious that a person with, for example, a 50 decibel hearing loss in each ear is more handicapped than a person with a 100 decibel loss in one ear only. It is therefore necessary to account for the handicapping capacity of hearing losses on a binaural basis.

In previous procedures the relative contribution was determined by applying various weightings or better ear-worse ear ratio. From the Macrae and Brigden study (op. cit.) evidence suggested that the better ear was four times as important in day to day functioning as the worse ear. Therefore initially it was proposed to apply a formula in which, having calculated the percentage loss of hearing (PLH) for each ear separately, that for the better ear was multiplied by four, added to that for the worse ear and divided by five to provide the binaural PLH. In the final procedure published in October 1974 this principle, in which the degree of impairment of the better ear largely determines the overall degree of handicap, was maintained. However, instead of simply weighting the PLH of the better ear as a whole, consideration was given to the relative contribution of each ear at each frequency. This takes into account that at one frequency an ear may be the better ear, whilst at another frequency it may be the worse. To achieve this more truly binaural format the PLH appropriate to any pair of hearing levels in two ears at a certain frequency was obtained by using a complex method of averaging the relevant percentage loss of loudness level of above threshold sounds over the range 40-100 phons, this being the range of everyday loudness levels. Average effects of recruitment were also taken into account in deriving the PLH values.

The resultant tables show, for each frequency, the percentage loss of hearing associated with any pair of hearing threshold levels within the range from the point of impairment of acuity beginning to the point of total loss of hearing. An example of the table for one frequency is shown in Table 3.

Table 3.

HL — Worse Ear \ HL — Better Ear	≤15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	≥95
≤15	0																
20	0.3	0.7															
25	0.6	1.1	1.5														
30	0.9	1.5	2.0	2.6													
35	1.3	1.9	2.5	3.3	4.1												
40	1.7	2.3	3.0	3.9	4.9	5.8											
45	2.0	2.7	3.3	4.3	5.4	6.5	7.4										
50	2.2	2.9	3.6	4.6	5.8	7.0	8.1	9.0									
55	2.5	3.2	3.9	4.9	6.1	7.3	8.6	9.7	10.6								
60	2.7	3.4	4.1	5.1	6.3	7.6	8.9	10.1	11.2	12.2							
65	2.9	3.6	4.3	5.3	6.5	7.8	9.1	10.4	11.7	12.8	13.7						
70	3.1	3.8	4.5	5.5	6.7	8.0	9.3	10.6	11.9	13.2	14.4	15.3					
75	3.2	3.9	4.6	5.6	6.8	8.1	9.4	10.7	12.1	13.4	14.7	15.9	16.7				
80	3.3	4.0	4.7	5.7	6.9	8.2	9.5	10.8	12.1	13.5	14.8	16.1	17.2	17.9			
85	3.3	4.0	4.7	5.7	6.9	8.2	9.5	10.8	12.1	13.5	14.8	16.2	17.4	18.3	18.9		
90	3.3	4.0	4.7	5.7	6.9	8.2	9.5	10.8	12.2	13.5	14.8	16.2	17.4	18.4	19.1	19.5	
≥95	3.3	4.0	4.7	5.7	6.9	8.2	9.5	10.8	12.2	13.5	14.8	16.2	17.4	18.4	19.2	19.7	20.0

Calculation of the total percentage loss of hearing is then simply obtained by totalling the values for each frequency. This is demonstrated in Example 1.

Example 1.

Frequency	Hearing Levels: Right Ear	Left Ear	Better Ear	Worse Ear	PLH
500	40	10	10	40	1.7
1000	45	25	25	45	4.2
1500	50	40	40	50	7.0
2000	55	55	55	55	7.9
3000	60	70	60	70	6.6
4000	65	85	65	85	7.2
				OVERALL PLH =	34.6%

The procedure is now to a point which general application is possible, however, there is one further aspect which needs to be clarified before proceeding to apply it. The Compensation (Australian Government Employees) Act lays down, as a general principle, that claimants who have suffered an injury or disease prior to the compensable injury or disease should be compensated for the compensable element as if their residual capacities at the time of the injury or disease represented 100% of that particular ability. This principle, as it applies to hearing, is laid down in

Section 39 (9) of the Act.

In the case of injury resulting in loss of hearing by an employee whose hearing is already impaired at the time of injury, he is compensated for the percentage loss of the residual hearing he had immediately prior to the injury. Therefore, it becomes important to, as far as possible, establish the state of the employee's hearing immediately prior to the injury. This is often the pre-employment hearing levels. It is especially useful to know if there is more than one component; whether all, one or none is compensable; and what was the temporal sequence of occurrence of each. If there is insufficient evidence to make a firm decision the employee is given the benefit of the doubt so that, for example, (a) if the shifts in hearing thresholds due to a non-compensable component cannot reasonably be determined (even by estimation based on expert opinion) then the employee would need to be compensated for the entire loss or (b) if the temporal sequence of occurrence of the compensable and non-compensable components cannot reasonably be determined then the non-compensable component is assumed to have occurred prior to the compensable component.

The provision of expert opinion on such matters for claimants under the Commonwealth Act is the responsibility of the Consultant Otologist who, after carrying out the otological examination, provides a detailed report on these issues. The exact nature of the otological and audiological report will be discussed later. Suffice it to say that once the report is completed it is possible to calculate a compensable PLH for claimants with and without non-compensable components. Where there is no non-compensable component or a non-compensable component which occurred after the work caused component the calculation of PLH is as was shown above (Example 1). However where there is a non-compensable component which pre-existed the work caused component Section 39 (9) of the Act is applicable and the following formula must be used:

$$\text{Compensable PLH} = \frac{\text{Total PLH} - \text{Non-compensable PLH}}{100 - \text{Non-compensable PLH}} \times 100$$

In this way the compensable PLH is that part of the total PLH which is work caused expressed as a percentage of the PLH attributable to the residual hearing capacity existing immediately prior to the injury.

That then is the derivation of the procedure. It is now possible to consider the issues involved in the clinical use of it. The practical application of the procedure involves three discrete, but ultimately interrelated, steps. These are:

(i) a complete and thorough audiological examination,

(ii) an otological examination, and

(iii) completion of the form "Examination by National Acoustic Laboratories for Loss of Hearing".

It is worthwhile considering the practices adopted in the audiological and otological assessment of Commonwealth compensation claimants because this highlights the way in which the legal bases of compensation are interpreted in audiological and otological terms and techniques. Therefore, there follows a brief description and some examples of the actual procedure which is followed in the audiological and otological assessment of compensation claimants seen by the National Acoustic Laboratories.

By and large claimants are examined both audiologically and otologically on the same day. There are good reasons for adopting this practice. They relate mostly to cases in which there is evidence of some conductive component or there is a suggestion of, or potential for, the pure tone thresholds to fluctuate. Hopefully during the short time which elapses between the audiometric tests and the otological examination there will not be changes in the condition which might account for any problems in correlating the findings of one examiner with those of the other. Such changes could occur, however, if the two examinations were more widely separated in time.

It is usual for the audiological assessment to be carried out before the claimant is seen by the otologist. The reason for

this sequence of events is that the otologist has the responsibility of establishing if possible (a) all the pathological conditions affecting the claimant's ears and/or hearing, whether work caused or not, (b) the causation of each condition and whether any particular condition has been aggravated or accelerated through Government employment factors, whether the condition is work caused or not, (c) the possible form of medical or surgical treatment, if any, (d) the increases in hearing threshold levels effected by each condition and whether or not those increases are permanent, (e) the relative times of occurrence of the permanent increases in hearing threshold levels associated with each condition, or at least the sequence of occurrence. Furthermore, in giving an opinion on the causative factors for each condition the otologist is required to make his comments "on the balance of probabilities (as distinct from possibilities)". In providing opinions based on probability, particularly on conditions affecting the claimant's hearing, the increases in hearing threshold levels due to each condition, and in considering the likelihood of particular conditions being due to specific causes the otologist needs as much evidence as possible and therefore virtually always needs to take into account the findings of the audiologist.

So as to present a complete audiological picture of the claimant's auditory problems the audiological assessment will include a pure tone audiogram for both air conduction and bone conduction thresholds and speech discrimination tests for each ear. Naturally masking will be applied whenever it is considered appropriate. Should there be any evidence of a conductive component or any doubt about the validity of the bone conduction thresholds impedance audiometry - including both tympanometry and acoustic reflex threshold measures - would be administered. Where there is any suspicion that a sensorineural hearing impairment might be due to something other than a cochlear disorder, tests such as tone decay, loudness balance, short increment sensitivity index (SISI) and Bekesy audiometry are used to clarify the situation. In the case of malingering, procedures such as the Stenger test, Electric Response Audiometry or Psychogalvanic Skin Response Audiometry would be used

to ascertain the real threshold levels. With all the required testing completed the audiologist must provide a written interpretation of the results and the conclusions reached. A comment on the need and suitability for hearing aids is also required. Additionally the examining audiologist provides comments on the reliability and consistency of the test results and, in the event of the alleged cause of injury being exposure to noise, comments on the noise levels and exposure rates experienced by the claimant are required. Other than to state the total PLH and the PLH due to each component identified by the otologist, this completes the audiologist's contribution to the assessment. The audiological report - and the claimant - are then passed on to the consultant otologist.

Since the major concern of this paper is the audiological assessment of the compensation claimant detailed consideration of the otological examination is not in order. However, as it reflects the relevance of the audiological findings to the overall evaluation it is worthwhile to look at several sample cases.

The first case (Appendix 1) is an instance of a claimant whose bilateral high frequency sensorineural hearing impairment is considered due to his exposure to noise as a sheet metal worker with the Australian Navy over a number of years. The audiogram shows hearing within normal limits in the low and middle frequencies with a moderate, bilateral high frequency impairment. The speech hearing test results indicated good hearing at slightly elevated levels and were consistent with the audiogram. Since these results appear to be clear cut no further testing was carried out and the comments regarding a hearing aid suggest there might be limited benefit in quiet situations.

Moving on to the medical report it is seen that the only condition affecting this claimant's hearing is stated as noise trauma and that this condition is believed to have resulted from "continuous exposure to intense noise whilst working as a sheet metal worker with the Australian Navy". There is considered to be no medical or surgical treatment. To the question as to whether

the condition has resulted in increases in hearing levels and whether they are permanent, the answer is that yes, there are increased hearing levels and they are permanent. The increased hearing levels are, in this case, reported to represent a loss of hearing in terms of the NAL PLH tables.

In that part of the report which is concerned with the assessment of hearing loss it is necessary, if a loss of hearing is said to exist, to state the claimant's total PLH. Where there is only one condition resulting in the loss of hearing and it is attributable to employment by the Australian Government there is no need to go further into the report. There are however three possible situations which require further consideration. These are: (a) where the loss of hearing is due to one factor alone but only a part of that loss is attributable to employment by the Australian Government, (b) where the loss is attributable to employment by the Australian Government, and (c) where the loss of hearing is due to two or more factors but only some of these factors are attributable to employment by the Australian Government and some are not.

Of the above situations the first tends to most frequently occur when the claimant has an impairment resulting from exposure to noise but there is pre-employment evidence, usually in the form of an audiogram, showing that part of the impairment existed prior to the time of employment, that part is considered non-compensable and must be excluded when determining the PLH due to employment by the Australian Government. Additionally, it must be remembered, the Act requires that the claimant be compensated for the work caused component as a proportion of the residual hearing existing at the time he was employed. Similar, but somewhat more complex, processes apply in the event of the other two situations. These are considered in the following examples.

In the first of these examples (Appendix 2) a claimant with a history of Menieres disease claims compensation for a hearing loss due to noise exposure. As the audiogram indicates the left ear hearing is within normal limits at the low and middle frequencies

with a high tone sensorineural impairment consistent with acoustic trauma. The right ear shows a mild sensorineural impairment in the low frequencies which increases to a severe impairment in the high frequencies. All other test results support the view that the impairment of the right ear is one of cochlear origin.

Following the otological evaluation the medical report shows that two components have been identified - acoustic trauma affecting the high frequencies in both ears and Menieres disease which is present in the right ear. The noise trauma is considered to be work caused and the Menieres disease is considered a non-work caused, pre-existing condition which is expected to progress. In assessing the loss of hearing the total PLH is calculated as 20.3%. To calculate the PLH for each component requires the consultant otologist to state whether the increases in hearing level resulting from the different factors can be distinguished from one another and if they can, to state on what basis this opinion is made. In this instance the otologist states that the increases in hearing level in the right ear attributable to acoustic trauma are considered to be the same as the left and that the remainder is considered to be due to Menieres disease. On that basis the hearing levels for calculation of PLH for the acoustic trauma component are shown as the same for each ear whilst those for calculation of PLH for the Menieres component are shown as the difference between these and the threshold levels obtained for the right ear.

For the final calculations it is also necessary to know if one component occurred in time before the other. If the noise trauma occurred before the Menieres disease Section 39 (9) of the Act would not apply and the PLH for this work caused component would be 12.6%. In this instance the Menieres component is believed to have pre-existed the noise trauma component so Section 39 (9) is applicable and the PLH for the work caused component becomes 16.2%.

In the second example (Appendix 3) an agricultural pilot working with the Commonwealth Department of Agriculture claims compensation for hearing loss after an incident in which he recently

suffered what is now considered to have been Barotrauma. On examination he is also found to have a sensorineural loss consistent with exposure to noise. This loss is also attributed to his work. The audiometric test results indicate that the claimant has a mild bilateral conductive impairment in the low frequencies with a moderate bilateral sensorineural impairment in the high frequencies. Speech hearing test results and impedance audiometry are consistent with the pure tone audiometry results.

The otological examination identifies the two components as noise trauma and barotrauma affecting the middle ear. Both are attributed to work causes - the medical report stating that the noise trauma was caused by noise exposure over a period of time whilst flying light aircraft for the department and the barotrauma occurred subsequent to an incident on 3rd September 1974 whilst flying for his department. In the Assessment of Hearing Loss section of the report the total PLH is given as 16.9%. For this claimant the process for calculating the PLH for each component is basically the same as for the previous example even though the whole of the loss is attributed to work causes. The reason is that should Section 39 (9) of the Act be considered appropriate the claimant would be entitled to somewhat more compensation than if the total PLH is used as the basis for assigning a monetary value to the handicap.

Firstly, the consultant otologist states whether the increases in hearing levels resulting from each factor can be distinguished from one another and on what basis. In this case the low frequency conductive component is considered due to the barotrauma and the high frequency sensorineural component due to the noise trauma. Therefore the bone conduction thresholds are taken as the noise trauma loss and the air-bone gap as the loss due to the barotrauma. Next the otologist comments on the temporal sequence of the two components. In this case routine hearing tests for civil aviation medicals prior to 3rd September 1974 indicate that the noise trauma component pre-existed the barotrauma. Therefore Section 39 (9) is applicable. On this basis the PLH resulting from acoustic trauma is 14% and, using the formula

mentioned earlier, the PLH resulting from barotrauma is 3.4%. This latter is 1% higher than it would have been had Section 39 (9) not been applicable. Should the two components have been shown to have occurred simultaneously the claimant would have been compensated for the total loss.

It may not have escaped the observation of some that the procedure outlined does not include any correction for presbycusis. This is so because legal precendent decreed that such a correction should not be applied. In any case there is considerable difficulty in differentiating how much of a claimant's impairment is due to presbycusis and how much is work caused since the interactions of age and noise exposure appear fairly complex. Nevertheless, some Workers' Compensation Acts contain a clause to the effect that, in ascertaining the percentage of the diminution of hearing in respect of noise induced hearing loss of a worker over the age of 50 years, it shall be conclusively presumed that his loss of hearing is, to the extent of one half of a decibel for each complete year of his age in excess of 50 years, attributable to presbycusis. Since the NAL procedure is not based on average hearing levels from which such a correction could be subtracted a Presbycusis Correction Table giving the correction per year of age over 50 as a percentage to be subtracted from the calculated PLH has been provided.

This however is still not sufficient for some Workers' Compensation Acts where either there is a statutory requirement to compensate the loss in each ear separately or to apply the 0.5 dB for every year over 50 correction to the hearing levels for each ear before calculating a binaural percentage loss of hearing. To accommodate these acts a set of monaural tables for determining PLH were published (February 16, 1976). From these a PLH for each ear can be obtained and where necessary the statutory presbycusis correction can be applied to the threshold levels before conversion to PLH. To determine a binaural PLH from the monaural tables the following formula is used:

$$\text{Binaural PLH} = \frac{4 \times \text{PLH(better ear)} + \text{PLH(worse ear)}}{5}$$

The PLH for the better ear is multiplied by four, added to the PLH for the worse ear and the sum divided by five. Excluding correction for presbycusis it is believed that the binaural PLH obtained by this method will, in about 90% of cases, be within 2% of the PLH obtained by means of the binaural tables. The example shown (Appendix 4) is of a hypothetical claimant with a bilateral sensorineural hearing impairment, who because he is 62 years old attracts a presbycusis correction of 6 dB. Both monaural and binaural PLH values are shown.

Finally there are a number of practical factors relating not so much to the audiological principles of dealing with compensation claimants but with the basic audiometric assessment which are worthy of comment. Basically they can be subsumed in the statement that the audiological issues, and to a lesser extent the otological issues, in compensation assessments are of little value if the audiometry, the measurement of the claimant's auditory capabilities, is not valid and reliable. Those factors which ensure validity and reliability, such as correct equipment calibration, control of ambient noise levels, careful test techniques, ensuring there is no temporary threshold shift at the time of test or that the claimant is not exaggerating his impairment, have all been dealt with elsewhere and in other respects. They are however the most fundamental issues in the audiological assessment of compensation claimants.

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Fletcher H. Speech and Hearing in Communication. Van Nostrand New York. 1953.

Hood J.D. and Poole J.P. Speech audiometry in conductive and sensorineural hearing loss Sound 5:30 1971.

Macrae J.H. and Brigden D.N. Auditory threshold impairment and everyday speech reception. Audiology 12:272 1973.

Macrae J.H. A procedure for classifying degree of hearing loss. J. Otolaryngological Society of Australia 4:1 1975-76.

N.A.L. 10

APPENDIX 1

N.A.L. Hearing Centre
....SYDNEY.....
Date .30/.2./.78.

COMPENSATION (AUSTRALIAN GOVERNMENT EMPLOYEES) ACT 1971-73

EXAMINATION BY NATIONAL ACOUSTIC LABORATORIES FOR LOSS OF HEARING

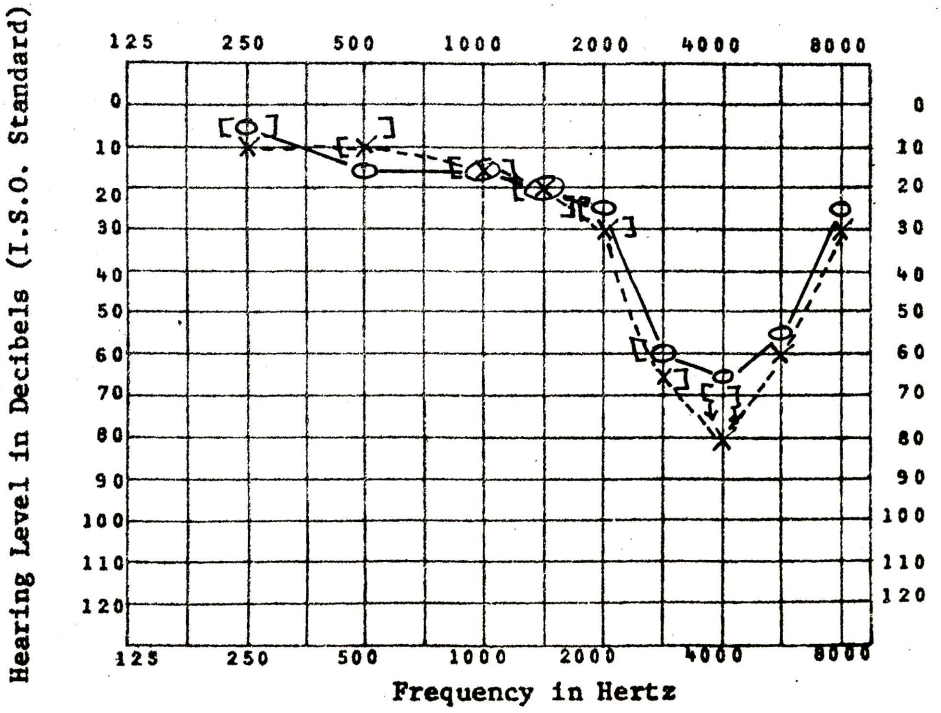
Claimant .....Mr. WILLIAM FRASER.....

Residential Address .....22..MACQUARIE..STREET
.....WEST LAKES.....
.....

The abovenamed claimant for compensation under the Compensation (Australian Government Employees) Act was examined by the Consulting E.N.T. Specialist .Dr F.A.R. HALL..... on .29./.2./.78. and N.A.L. Audiologist ..Miss..L..SMITH.. on .29./.2./.78. and their report is attached.

AUDIOLOGICAL ASSESSMENT

Below is a copy of the audiogram obtained from the claimant during the audiological examination by ...Miss..SMITH..... on .29./.2./.78



AIR: Left X Right O BONE: Unmasked ⊓ Left Masked ⊐ Right Masked

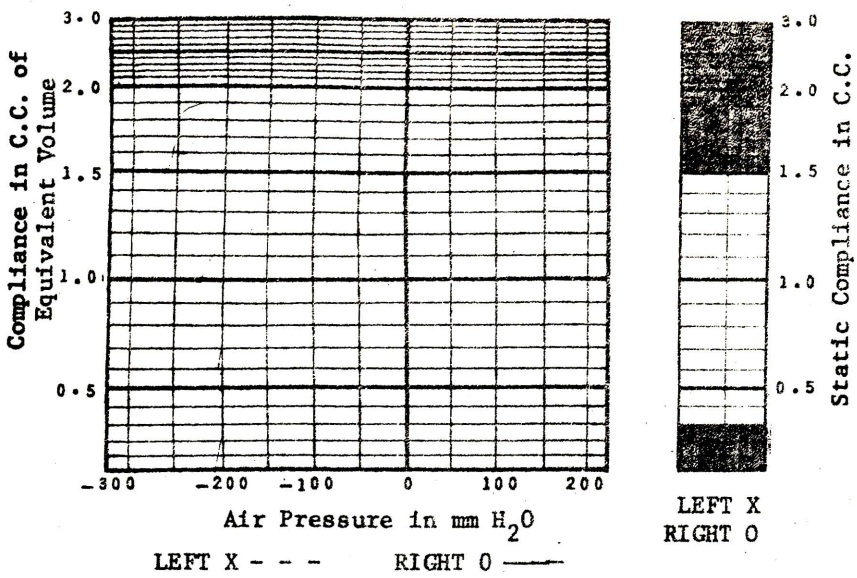
SPEECH AUDIOMETRY

WORD LIST	PBM1	PBM2	PBM3			
L, R, F.F.	L	R	L			
LEVEL (S.P.L.)	80	80	90			
% CORRECT	72%	88%	84%			
MASKING						

STENGER

PASSED ☐ FAILED ☐

TYMPANOMETRY



REFLEX THRESHOLD

FREQUENCY in Hz	PHONE ON RIGHT EAR	PHONE ON LEFT EAR
500		
1000		
2000		
4000		
	LEVEL IN dB ISO	

BEKESY

EAR	C/F	TYPE

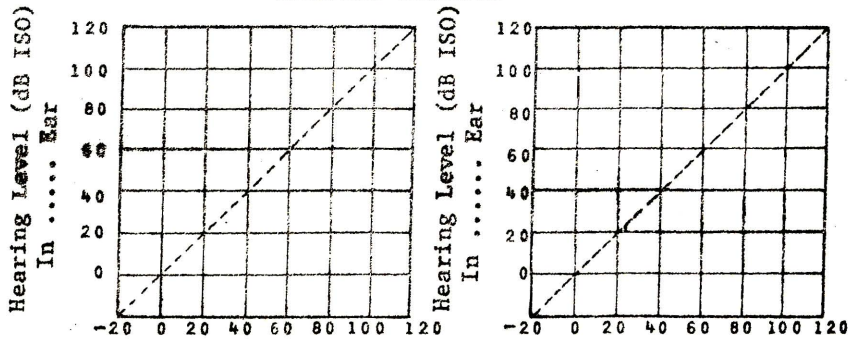
TONE DECAY

EAR					
FREQ					
DECAY					

S.I.S.I.

EAR					
FREQ					
%					

LOUDNESS BALANCE



ERA: .....

PGSR: .....

DAF: .....

AUDIOLOGICAL INTERPRETATION AND CONCLUSIONS: HEARING WITHIN NORMAL LIMITS IN LOW AND MIDDLE FREQUENCIES WITH A MODERATE BILATERAL HIGH FREQUENCY IMPAIRMENT CONSISTENT WITH EXPOSURE TO NOISE.

.....

COMMENTS BY NAL AUDIOLOGIST RE HEARING AID: MAY GAIN LIMITED BENEFIT FROM THE USE OF A POST AURICULAR AID IN QUIET SITUATIONS.

.....

.....

All of the following questions are to be completed by the Audiologist.

(1) Are all the test results reliable? (YES or NO) .....YES.....

(2) Are all the test results consistent with one another? (YES or NO) .....YES.....

(3) Are the test results consistent with all previous tests? (YES or NO) ..N/A.....
If your answer is no, how can the inconsistencies be explained?

.....

.....

.....

.....

(4) Are the test results consistent with the claimant's report of his injury and its audiological effects? (YES or NO) ...YES.....

(5) In the event of the alleged cause of injury being exposure to noise, were the noise levels and rates of exposure in excess of the criterion of 90dB(A) for 8 hours a day or its equivalent? (YES or NO) ....YES.....

If your answer is no, please comment on the noise levels and exposure rates involved .....

.....

.....

.....

Any additional comments: ..HAS BEEN USING EAR PROTECTION OVER THE .....
....LAST FOUR YEARS ONLY.....

.....

.....

.....

NOTE: 1. Please refer to the attached statement before answering the following questions.

2. For the purpose of these questions, employment by the Australian Government includes employment by an authority of that Government.

3. The following questions to be completed by the Consulting E.N.T. Specialist except where indicated.

PART A - MEDICAL REPORT

QUESTIONS:

1. From what condition (or conditions) affecting his ears and/or his hearing does the employee suffer (e.g., effects of noise trauma, otosclerosis, otitis media, etc.)?

NOISE TRAUMA.

2. Answering separately from each condition, on the balance of probabilities (as distinct from possibilities) has the condition resulted from:

(a) Causation - A particular event or occurrence in the course of, or attributable to, the employment by the Australian Government or the contraction of a disease to which that employment was a contributing factor?

YES.

(b) Aggravation, etc.- The aggravation, acceleration or recurrence of a pre-existing injury or disease due to a particular event or occurrence in the course of, or attributable to the employment by the Australian Government or to which that employment was a contributing factor?

NO.

(c) Progression - The natural progression of some pre-existing or underlying condition not associated with the employment by the Australian Government?

NO.

(d) Other factor - Some other factor and, if so, what is that factor?

NO.

3. If you have answered Question 2(a) or 2(b) in the affirmative, what was the particular event or occurrence that caused or aggravated the condition or the employment factor which contributed to the contraction or aggravation, etc., of the condition? (Note that this factor could be some characteristic of any work the employee performed for the Australian Government or the conditions under which such work was performed). CONTINUOUS EXPOSURE TO INTENSE NOISE WHILST WORKING AS A SHEET METAL WORKER WITH THE AUSTRALIAN NAVY.

4. What form of medical or surgical treatment, if any, is indicated? (A separate answer for each condition please).

NONE.

5. Have any of the conditions to which you have referred in your answers to the foregoing resulted in increases in hearing levels, as shown on the audiogram on page 1 and, if so, are these increases permanent? (Separate answers for each condition please).

YES AND THEY ARE PERMANENT.

6. Is the employee suffering from a loss of hearing in terms of the NAL procedure for determining percent loss of hearing? (Please answer YES or NO) ..YES...

PART B - ASSESSMENT OF HEARING LOSS

PREAMBLE

If, in answer to Question 6 in Part A above, you have said that the employee has a loss of hearing, please proceed to assess the hearing loss, making no deduction for presbyacusis. It will be necessary to answer Question 1 below in all cases. In cases where your answers in Part A have indicated that all of the hearing loss is attributable to employment by the Australian Government and is entirely due to one factor only, and also in cases where none of the hearing loss is attributable to employment by the Australian Government, only Question 1 need be answered. In cases where only part of the hearing loss is attributable to employment by the Australian Government, and also in cases where all of the hearing loss is attributable to employment by the Australian Government but has been caused by more than one of the factors set out below, one of the remaining questions (2 to 4) will also have to be answered. In asking Questions 2-4, it is assumed that the hearing loss will be due to one or more of the following factors:

* Noise trauma by gradual process;
* Noise trauma due to a single exposure, such as an explosion or rifle fire over, say, a few days;
* Diseases such as otitis medica, otosclerosis or Meniere's disease, etc.;
* Physical injury to a part or parts of the hearing mechanism; or
* Any other factor (e.g., effects of medication).

QUESTIONS:

1. What is the employee's total percent loss of hearing? (To be answered by NAL Audiologist)

15.7 %

N.A.L. Hearing Centre
....SYDNEY.....
Date .31/.5./.76

APPENDIX 2

COMPENSATION (AUSTRALIAN GOVERNMENT EMPLOYEES) ACT 1971-73

EXAMINATION BY NATIONAL ACOUSTIC LABORATORIES FOR LOSS OF HEARING

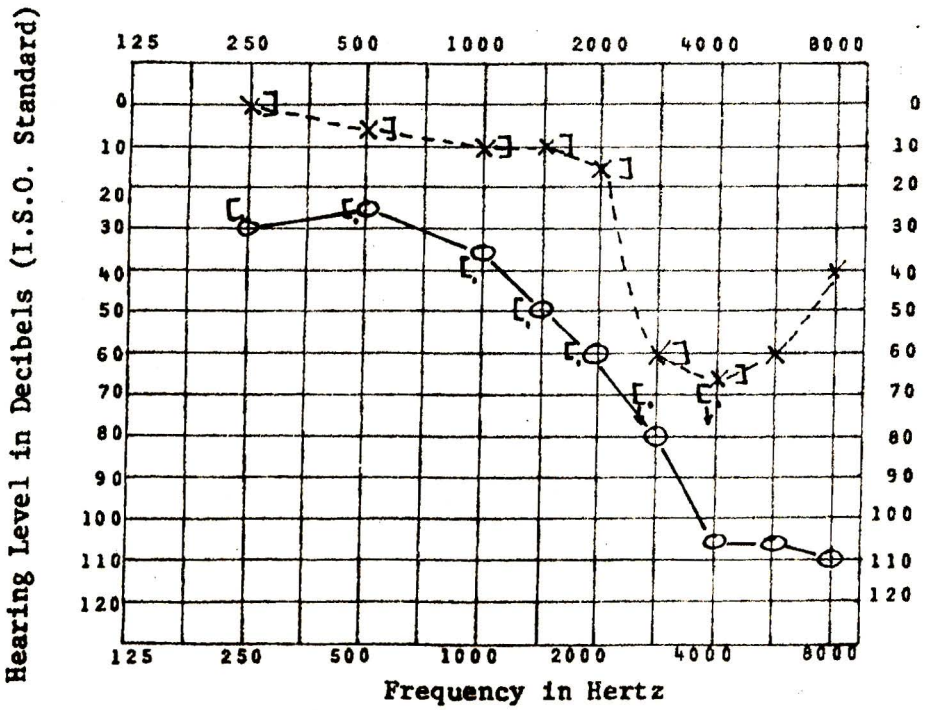
Claimant ....MR....AL...SORAN.....

Residential Address .....53..GREENWAY.ROAD
.....AINSLIE...A.C.T.
.....

The abovenamed claimant for compensation under the Compensation (Australian Government Employees) Act was examined by the Consulting E.N.T. Specialist ..DR..R..WITHERS.. on .29/.5./.76 and N.A.L. Audiologist MR..ANTHONY.DOUGLAS on .29/.5./.76 and their report is attached.

AUDIOLOGICAL ASSESSMENT

Below is a copy of the audiogram obtained from the claimant during the audiological examination by ....MR.DOUGLAS..... on .29/.5./.76



AIR: Left X Right O BONE: Unmasked ⊓ Left Masked ⊐ Right Masked

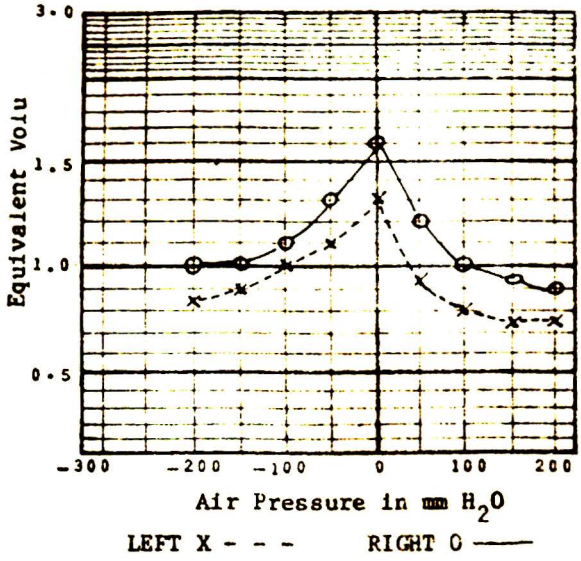
SPEECH AUDIOMETRY

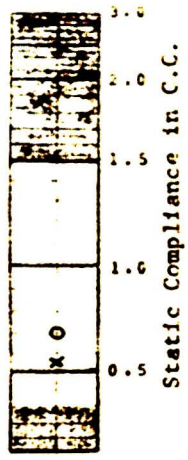
WORD LIST	PBM7	PBM8	PBM9			
L, R, F.F.	L	R	R			
LEVEL (S.P.L.)	70	90	100			
% CORRECT	88%	64%	76%			
MASKING		90	90			

STENGER

PASSED ☑ FAILED ☐

TYMPANOMETRY





REFLEX THRESHOLD

FREQUENCY in Hz	PHONE ON RIGHT EAR	PHONE ON LEFT EAR
500	100	85
1000	105	85
2000	120	95
4000	125+	115
	LEVEL IN dB ISO	

BEKESY

EAR	C/F	TYPE
R	C	II

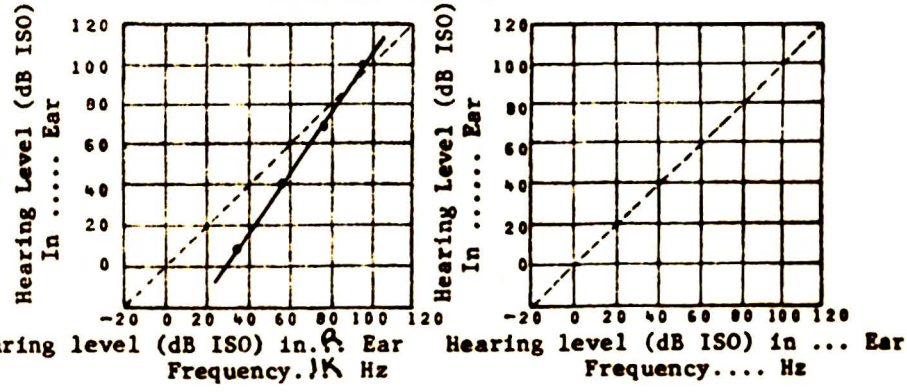
TONE DECAY

EAR	R	R		
FREQ	.5K	2K		
DECAY	5	15		

S.I.S.I.

EAR					
FREQ					
%					

LOUDNESS BALANCE



ERA: .....

PGSR: .....

DAF: .....

AUDIOLOGICAL INTERPRETATION AND CONCLUSIONS: LEFT EAR HEARING WITHIN NORMAL LIMITS AT LOW AND MIDDLE FREQUENCIES WITH A MODERATE HIGH FREQUENCY S/N LOSS. RIGHT EAR MILD S/N LOSS AT LOW FREQUENCIES INCREASING TO A SEVERE HEARING IMPAIRMENT AT HIGH FREQUENCIES.....

COMMENTS BY NAL AUDIOLOGIST RE HEARING AID: WOULD BENEFIT FROM USE OF HEARING AID IN RIGHT EAR.....

.....

.....

All of the following questions are to be completed by the Audiologist.

(1) Are all the test results reliable? (YES or NO) ...YES.....

(2) Are all the test results consistent with one another? (YES or NO) ...YES.....

(3) Are the test results consistent with all previous tests? (YES or NO) ..N/A.....
If your answer is no, how can the inconsistencies be explained?

.....

.....

.....

.....

(4) Are the test results consistent with the claimant's report of his injury and its audiological effects? (YES or NO) ...YES.....

(5) In the event of the alleged cause of injury being exposure to noise, were the noise levels and rates of exposure in excess of the criterion of 90dB(A) for 8 hours a day or its equivalent? (YES or NO) ....YES.....

If your answer is no, please comment on the noise levels and exposure rates involved .....

.....

.....

.....

Any additional comments: .....

.....

.....

.....

.....

NOTE: Although 90dBA for an 8 hour day exposure is a frequently applied damage risk criterion, it is important to recognize that, on available evidence, there may exist some probability that hearing loss due to exposure to noise levels less than 90dBA could occur. In view of this, a negative answer to Question 5 does not necessarily infer than the claimant could not have suffered an injury from noise exposure. However, as the levels and rates of exposure decrease below the criterion the probability of the hearing loss being attributable to noise exposure would be expected to diminish accordingly.

NOTE: 1. Please refer to the attached statement before answering the following questions.

2. For the purpose of these questions, employment by the Australian Government includes employment by an authority of that Government.

3. The following questions to be completed by the Consulting E.N.T. Specialist except where indicated.

PART A - MEDICAL REPORT

QUESTIONS:

1. From what condition (or conditions) affecting his ears and/or his hearing does the employee suffer (e.g., effects of noise trauma, otosclerosis, otitis media, etc.)? MENIERES DISEASE OF RIGHT EAR.
HIGH TONE ACOUSTIC TRAUMA BOTH EARS.

2. Answering separately from each condition, on the balance of probabilities (as distinct from possibilities) has the condition resulted from:

(a) Causation - A particular event or occurrence in the course of, or attributable to, the employment by the Australian Government or the contraction of a disease to which that employment was a contributing factor? YES - THE NOISE TRAUMA COMPONENTS ARE WORK CAUSED.
THE MENIERES DISEASE IS NOT WORK CAUSED.

(b) Aggravation, etc.- The aggravation, acceleration or recurrence of a pre-existing injury or disease due to a particular event or occurrence in the course of, or attributable to the employment by the Australian Government or to which that employment was a contributing factor?
No.

(c) Progression - The natural progression of some pre-existing or underlying condition not associated with the employment by the Australian Government? YES - THE MENIERES DISEASE IS A PRE-EXISTING CONDITION AND EXPECTED TO PROGRESS.

(d) Other factor - Some other factor and, if so, what is that factor?
No.

3. If you have answered Question 2(a) or 2(b) in the affirmative, what was the particular event or occurrence that caused or aggravated the condition or the employment factor which contributed to the contraction or aggravation, etc., of the condition? (Note that this factor could be some characteristic of any work the employee performed for the Australian Government or the conditions under which such work was performed).
SEE BELOW.

4. What form of medical or surgical treatment, if any, is indicated? (A separate answer for each condition please).
NONE.

3. THE LEFT EAR CONDITION APPEARS TO BE SOLELY ATTRIBUTABLE TO NOISE EXPOSURE EXPERIENCED OVER A NUMBER OF YEARS WHILST WORKING FOR THE AUSTRALIAN GOVERNMENT. THE ACOUSTIC TRAUMA COMPONENT OF THE RIGHT EAR CONDITION IS ALSO ATTRIBUTABLE TO NOISE EXPOSURE IN THE WORK SITUATION.

5. Have any of the conditions to which you have referred in your answers to the foregoing resulted in increases in hearing levels, as shown on the audiogram on page 1 and, if so, are these increases permanent? (Separate answers for each condition please).

YES. INCREASES IN HEARING LEVELS FROM ACOUSTIC TRAUMA COULD BE EXPECTED TO BE PERMANENT. THOSE FROM MENIERES DISEASE COULD BE EXPECTED TO ALTER.

6. Is the employee suffering from a loss of hearing in terms of the NAL procedure for determining percent loss of hearing? (Please answer YES or NO) ..YES...

PART B - ASSESSMENT OF HEARING LOSS

PREAMBLE

If, in answer to Question 6 in Part A above, you have said that the employee has a loss of hearing, please proceed to assess the hearing loss, making no deduction for presbyacusis. It will be necessary to answer Question 1 below in all cases. In cases where your answers in Part A have indicated that all of the hearing loss is attributable to employment by the Australian Government and is entirely due to one factor only, and also in cases where none of the hearing loss is attributable to employment by the Australian Government, only Question 1 need be answered. In cases where only part of the hearing loss is attributable to employment by the Australian Government, and also in cases where all of the hearing loss is attributable to employment by the Australian Government but has been caused by more than one of the factors set out below, one of the remaining questions (2 to 4) will also have to be answered. In asking Questions 2-4, it is assumed that the hearing loss will be due to one or more of the following factors:

* Noise trauma by gradual process;
* Noise trauma due to a single exposure, such as an explosion or rifle fire over, say, a few days;
* Diseases such as otitis medica, otosclerosis or Meniere's disease, etc.;
* Physical injury to a part or parts of the hearing mechanism; or
* Any other factor (e.g., effects of medication).

QUESTIONS:

1. What is the employee's total percent loss of hearing? (To be answered by NAL Audiologist)

20.3%

4. If your answers in Part A have indicated that the loss of hearing is due to to two or more of the factors set out in the preamble to Part B above and some of these factors are attributable to employment by the Australian Government and some are not -

(a) Can the increases in hearing level resulting from the different factors be distinguished from one another? (Please answer YES or NO) ..YES..

(b) If yes -

(i) On what basis can the increases in hearing level resulting from each factor be distinguished from one another?
INCREASES IN RIGHT EAR ATTRIBUTABLE TO ACOUSTIC TRAUMA ARE CONSIDERED TO BE THE SAME AS LEFT. REMAINDER CONSIDERED TO BE DUE TO MENIERES.

(ii) What are the increases in hearing level resulting from each factor and which of these factors are attributable to employment by the Australian Government?

FACTOR	EAR	500	1000	1500	2000	3000	4000
MENIERES	RT	20	25	40	45	20	40
	LT	0	0	0	0	0	0
ACOUSTIC TRAUMA	RT	5	10	10	15	60	65
	LT	5	10	10	15	60	65
	RT						
	LT						
	RT						
	LT						

(iii) Is it possible to determine the approximate times or periods of time at which the increases in hearing level produced by each factor occurred? (Please answer YES or NO) ..NO..

(iv) If the answer to Question 4.(b) (iii) is yes, what were those times?

(v) If the answer to Question 4.(b) (iii) is no, is it possible to determine the order in time in which the increases in hearing level produced by each factor occurred and, if so, what was that order?

YES - THE MENIERES COMPONENT IS CONSIDERED TO HAVE FUNDAMENTALLY PRE-EXISTED THE NOISE TRAUMA COMPONENT.

(vi) What is the percent loss of hearing resulting from each factor? (To be answered by NAL Audiologist)

PART C

If there is any additional information or comment which you consider relevant in this case that has not been brought out by the foregoing, please give it below.

MENIERES FACTOR = 4.9%

NOISE FACTOR = 16.2%

.....
Audiologist

.....
Consulting ENT Specialist

N.A.L. Hearing Centr
SYDNEY
Date 31/4/7

APPENDIX 3.

COMPENSATION (AUSTRALIAN GOVERNMENT EMPLOYEES) ACT 1971-73

EXAMINATION BY NATIONAL ACOUSTIC LABORATORIES FOR LOSS OF HEARING

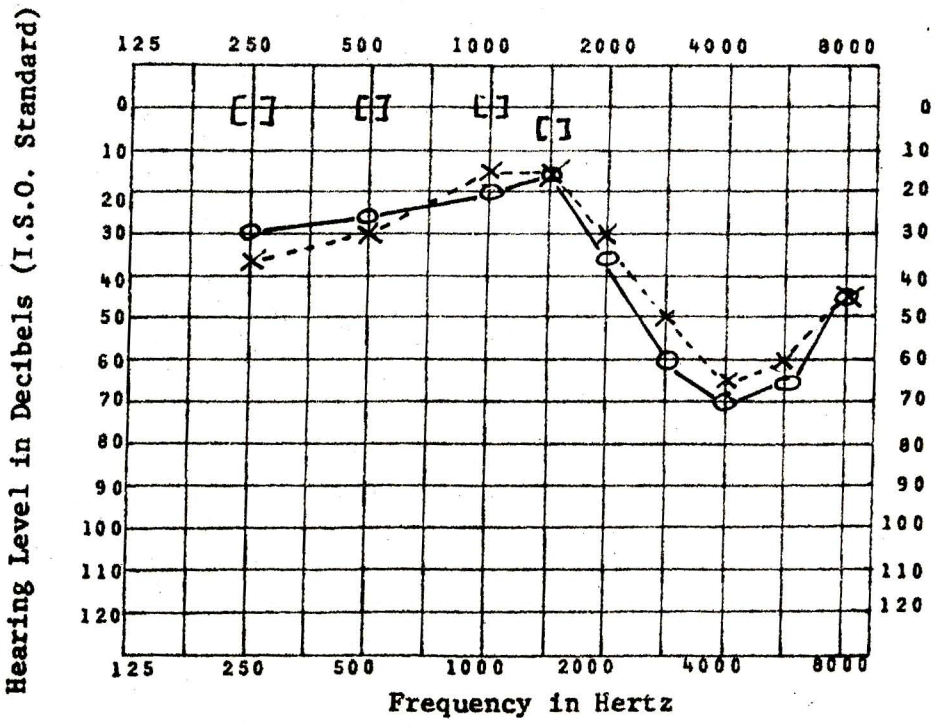
Claimant ...MR. MALCOLM HAYDEN...

Residential Address ..3 PETERSEN ROAD.....
...KNOXVILLE.....
....QUEENSLAND.....

The abovenamed claimant for compensation under the Compensation (Australian Government Employees) Act was examined by the Consulting E.N.T. Specialist ..DR. S. LOVE..... on 24/12/74. and N.A.L. Audiologist ...Ms. A. CHRISTIE.. on 24/12/74 and their report is attached.

AUDIOLOGICAL ASSESSMENT

Below is a copy of the audiogram obtained from the claimant during the audiological examination by ...Ms. CHRISTIE..... on 24/12/74



AIR: Left X Right O BONE: Unmasked ⊓ Left Masked ⊐ Right Mask

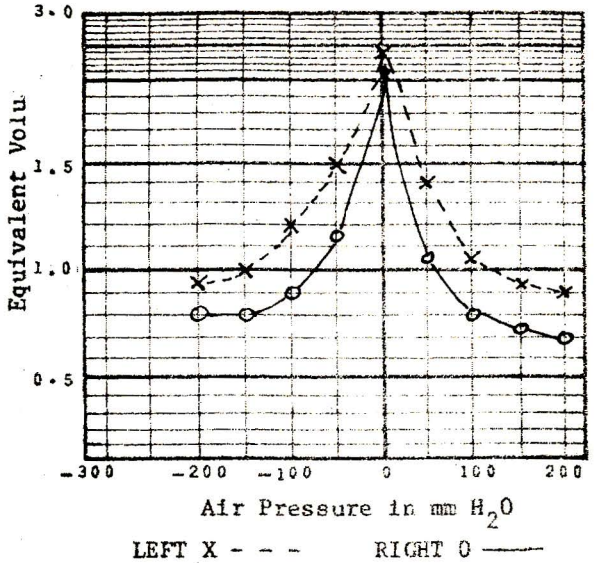
SPEECH AUDIOMETRY

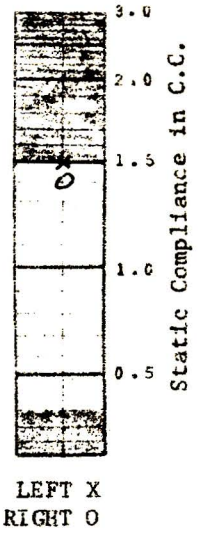
WORD LIST	PBM1	PBM2	PBM3	PBM4		
L, R, F.F.	L	R	L	R		
LEVEL (S.P.L.)	70	70	80	80		
% CORRECT	72%	76%	80%	84%		
MASKING						

STENGER

PASSED ☐ FAILED ☐

TYMPANOMETRY





REFLEX THRESHOLD

FREQUENCY in Hz	PHONE ON RIGHT EAR	PHONE ON LEFT EAR
500	120	125+
1000	115	125+
2000	120	125+
4000	125+	125+
	LEVEL IN dB ISO	

BEKESY

EAR	C/F	TYPE

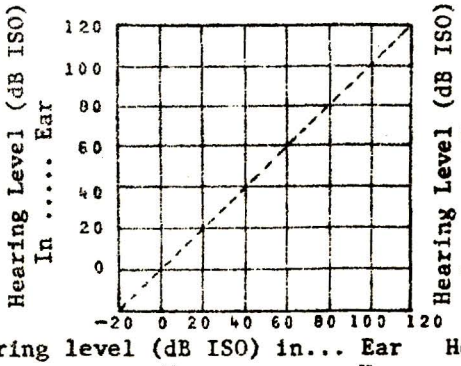
TONE DECAY

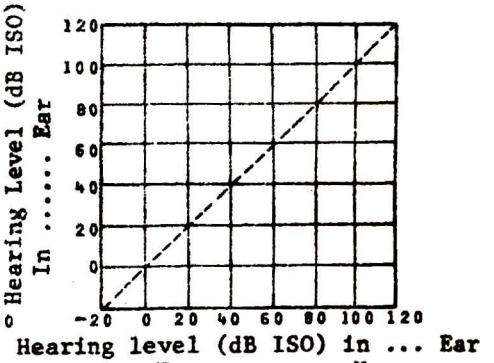
EAR					
FREQ					
DECAY					

S.I.S.I.

EAR					
FREQ					
%					

LOUDNESS BALANCE





ERA: .....

PGSR: .....

DAF: .....

AUDIOLOGICAL INTERPRETATION AND CONCLUSIONS: MILD BILATERAL CONDUCTIVE LOSS IN THE LOW FREQUENCIES WITH A MODERATE BILATERAL HIGH FREQUENCY SENSORINEURAL LOSS. SHOULD BE RETESTED AFTER ANY TREATMENT THAT MAY BE INDICATED.....

COMMENTS BY NAL AUDIOLOGIST RE HEARING AID: HEARING AID TO BE RECONSIDERED AFTER TREATMENT.....

All of the following questions are to be completed by the Audiologist.

) Are all the test results reliable? (YES or NO) ....YES.....

) Are all the test results consistent with one another? (YES or NO) ....YES.....

) Are the test results consistent with all previous tests? (YES or NO) ..N/A.....
If your answer is no, how can the inconsistencies be explained?

.....

.....

.....

.....

) Are the test results consistent with the claimant's report of his injury and its audiological effects? (YES or NO) ....YES....

) In the event of the alleged cause of injury being exposure to noise, were the noise levels and rates of exposure in excess of the criterion of 90dB(A) for 8 hours a day or its equivalent? (YES or NO) .NOT KNOWN

If your answer is no, please comment on the noise levels and exposure rates involved .....

.....

.....

.....

Any additional comments: .....

.....

.....

.....

.....

NOTE: Although 90dBA for an 8 hour day exposure is a frequently applied damage risk criterion, it is important to recognize that, on available evidence, there may exist some probability that hearing loss due to exposure to noise levels less than 90dBA could occur. In view of this, a negative answer to Question 5 does not necessarily infer than the claimant could not have suffered an injury from noise exposure. However, as the levels and rates of exposure decrease below the criterion the probability of the hearing loss being attributable to noise exposure would be expected to diminish accordingly.

NOTE: 1. Please refer to the attached statement before answering the following questions.

2. For the purpose of these questions, employment by the Australian Government includes employment by an authority of that Government.

3. The following questions to be completed by the Consulting E.N.T. Specialist except where indicated.

PART A - MEDICAL REPORT

QUESTIONS:

1. From what condition (or conditions) affecting his ears and/or his hearing does the employee suffer (e.g., effects of noise trauma, otosclerosis, otitis media, etc.)?

   NOISE TRAUMA OF THE INNER EAR.

   BAROTRAUMA AFFECTING THE MIDDLE EAR.

2. Answering separately from each condition, on the balance of probabilities (as distinct from possibilities) has the condition resulted from:

   (a) Causation - A particular event or occurrence in the course of, or attributable to, the employment by the Australian Government or the contraction of a disease to which that employment was a contributing factor?

   YES.

   (b) Aggravation, etc.- The aggravation, acceleration or recurrence of a pre-existing injury or disease due to a particular event or occurrence in the course of, or attributable to the employment by the Australian Government or to which that employment was a contributing factor?

   NO.

   (c) Progression - The natural progression of some pre-existing or underlying condition not associated with the employment by the Australian Government?

   NO.

   (d) Other factor - Some other factor and, if so, what is that factor?

   NO.

3. If you have answered Question 2(a) or 2(b) in the affirmative, what was the particular event or occurrence that caused or aggravated the condition or the employment factor which contributed to the contraction or aggravation, etc., of the condition? (Note that this factor could be some characteristic of any work the employee performed for the Australian Government or the conditions under which such work was performed).

   SEE BELOW.

4. What form of medical or surgical treatment, if any, is indicated? (A separate answer for each condition please).

   THERE APPEARS TO BE NO TREATMENT FOR EITHER CONDITION.

3. NOISE EXPOSURE OVER A PERIOD OF TIME WHILST FLYING LIGHT AIRCRAFT FOR HIS DEPARTMENT.

   BAROTRAUMA OCCURRING SUBSEQUENT TO AN INCIDENT ON 3.9.74 WHILST FLYING FOR HIS DEPARTMENT.

5. Have any of the conditions to which you have referred in your answers to the foregoing resulted in increases in hearing levels, as shown on the audiogram on page 1 and, if so, are these increases permanent? (Separate answers for each condition please).

NOISE TRAUMA PRODUCED HEARING LEVEL INCREASES WHICH ARE PERMANENT.

BAROTRAUMA PRODUCED HEARING LEVEL INCREASES WHICH MAY FLUCTUATE

6. Is the employee suffering from a loss of hearing in terms of the NAL procedure for determining percent loss of hearing? (Please answer YES or NO) ...YES...

PART B - ASSESSMENT OF HEARING LOSS

PREAMBLE

If, in answer to Question 6 in Part A above, you have said that the employee has a loss of hearing, please proceed to assess the hearing loss, making no deduction for presbyacusis. It will be necessary to answer Question 1 below in all cases. In cases where your answers in Part A have indicated that all of the hearing loss is attributable to employment by the Australian Government and is entirely due to one factor only, and also in cases where none of the hearing loss is attributable to employment by the Australian Government, only Question 1 need be answered. In cases where only part of the hearing loss is attributable to employment by the Australian Government, and also in cases where all of the hearing loss is attributable to employment by the Australian Government but has been caused by more than one of the factors set out below, one of the remaining questions (2 to 4) will also have to be answered. In asking Questions 2-4, it is assumed that the hearing loss will be due to one or more of the following factors:

* Noise trauma by gradual process;
* Noise trauma due to a single exposure, such as an explosion or rifle fire over, say, a few days;
* Diseases such as otitis medica, otosclerosis or Meniere's disease, etc.;
* Physical injury to a part or parts of the hearing mechanism; or
* Any other factor (e.g., effects of medication).

QUESTIONS:

1. What is the employee's total percent loss of hearing? (To be answered by NAL Audiologist)

16.9%.

3. If your answers in Part A have indicated that the loss of hearing is due to two or more of the factors set out in the preamble to Part B above and the whole of the loss is attributable to employment by theAustralian Government -

(a) Can the increases in hearing level resulting from the different factors be distinguished from one another? (Please answer YES or NO) ..YES..

(b) If yes -

(i) On what basis can the increases in hearing level due to each factor be distinguished from one another?

THE HEARING LOSS ASSOCIATED WITH THE BAROTRAUMA IS THE LOW FREQUENCY CONDUCTIVE COMPONENT.

THE HEARING LOSS ASSOCIATED WITH THE NOISE TRAUMA IS THE HIGH FREQUENCY SENSORINEURAL COMPONENT.

(ii) What are the increases in hearing level resulting from each factor?

FACTOR	EAR	500	1000	1500	2000	3000	4000
BAROTRAUMA	RT	25	20	10	5	0	0
	LT	30	15	15	5	0	0
NOISE TRAUMA	RT	0	0	5	30	60	70
	LT	0	0	5	25	50	70
	RT						
	LT						

(iii) Is it possible to determine the approximate times or periods of time at which the increases in hearing level produced by each factor occurred? (Please answer YES or NO) ..YES..

(iv) If the answer to Question 3.(b) (iii) is yes, what were those times? ROUTINE HEARING TESTS FOR CIVIL AVIATION MEDICALS PRIOR TO 3.9.74 INDICATE NOISE TRAUMA COMPONENT APPEARS TO PRE-EXIST BAROTRAUMA.

(v) If the answer to Question 3.(b) (iii) is no, is it possible to determine the order in time in which the increases in hearing level produced by the various factors occurred and, if so, what was that order?

(vi) What is the percent loss of hearing resulting from each factor? (To be answered by NAL Audiologist)

ACOUSTIC TRAUMA 14.0%

BAROTRAUMA 3.37%

APPENDIX 4

A hypothetical claimant has a bilateral sensorineural hearing loss and is 62 years old, giving a presbyacusis correction of 6 dB.

AUDIOGRAM

	500	1000	1500	2000	3000	4000
LEFT EAR	30	40	50	60	70	75
RIGHT EAR	35	45	45	50	60	65

HEARING LEVELS AFTER CORRECTIONS FOR PRESBYACUSIS

	500	1000	1500	2000	3000	4000
LEFT EAR	24	34	44	54	64	69
RIGHT EAR	29	39	39	44	54	59

PERCENTAGE LOSS OF HEARING
(AFTER CORRECTION FOR PRESBYACUSIS)

	LEFT EAR		RIGHT EAR	
	HL	PLH	HL	PLH
500	24	1.3	29	2.3
1000	34	4.8	39	6.8
1500	44	7.1	39	5.4
2000	54	7.7	44	5.3
3000	64	6.7	54	5.1
4000	69	7.2	59	5.5
		34.8%		30.4%

BINAURAL PERCENTAGE LOSS OF HEARING = ((4 x 30.4) + 34.8)/5

= 31.3%

WORKERS' COMPENSATION & INDUSTRIAL DEAFNESS - AN INSURERS VIEWPOINT

B. D. Bennett. B.A.

Manager, Employers' Liability Division, State Insurance Office, Melbourne, Victoria.

Industrial deafness, as reflected in Workers' Compensation claims, is considered to be only of minor concern within the Insurance Industry although there is little published material from which to work. Claims handling is relatively easy and has helped create this attitude. Because the insurer is the observed agent for the payment of claims there is a tendency for employers to think that the insurer should assist in preventive measures and post-claim therapy but this could be to misconstrue his role.

The majority of deafness claims are lodged in Victoria and New South Wales and from statistics from these States some idea of the cost can be established and is seen to be a small part of total payout. It is considered this will change because of growing worker awareness, increased use of machinery and the introduction of Industrial Noise Legislation. This will eventually lead to an increase in premiums especially in classifications not normally considered noise-hazardous, but it will particularly affect insurers in States where most of the claim rests against the last employer, and insurer.

The purpose of this paper is to present a basic overall view of industrial deafness and Workers' Compensation today from the viewpoint of an individual insurer. The aim, in essence, is more exploratory than analytic and is intended to raise questions rather than exude confidence.

With the Industrial Revolution Man was presented with a new hazard - Noise and its companion - Occupational Deafness. We know this did happen.

After many years the implications were realised and much has been done to remedy the situation. There is a wealth of material now available to accelerate even further progress. But in the Insurance world such is not so. Here there is little published material and a paucity of facts, almost to the extent that Industrial Deafness is a "non-subject". It is in this context that I must thank my colleagues in the insurance industry who generously volunteered use of their private papers and other assistance.

I wish to emphasize that the problem of industrial deafness is at present a minor aspect of the overall insurance picture. But the gathering implications are clear and it would be foolhardy to ignore them. Even now, in many States, the individual insurer is in an exposed position. Industrial deafness is not to be underestimated.

Can noise be controlled or minimized and either way what is it's bearing on the Insurance Industry? Can we merely charge a premium, underwrite the risk, or does our role also extend to include a more comprehensive responsibility to society?

That insurance premiums bear a direct correlation to claims is fundamental. To define insurance more precisely, it is "a system whereby a number of people agree to share the cost of a loss which may be suffered by any of their members. The insurance office or insurer acts as an intermediary or clearing house in that it collects the appropriate payments (premium) from those wishing to participate and disburses payments to those who have suffered a loss". (1)

The insurer simply shares cost. And whose money does he share? Who else but the employer's. Industrial deafness isn't just a worry to the worker or the insurer, it must be of concern to employers generally.

I said just a little earlier that this subject is not considered a major one by insurers. This feeling is engendered by the comparative ease of claims handling which I feel has so clouded our view that insurance fundamentals have been ignored. To have a look at claims

handling. Nothing basically complex, for the noise existed or it didn't. The claimant suffered loss of hearing or he didn't. The tests are run, they do determine whether he is incapacitated, and in many States, where work is responsible it is generally assumed that this is primarily related to his last job. At all events the court determination establishes a percentage loss of hearing and the position is resolved. That this is a far cry from the complexity and lack of certainty of the greater part of Workers' Compensation claims is an understatement, and such being the case an attitude of complacency is excusable. The claim is made, a loss of hearing is determined, and the claim is met.

But what of the human side? Can restitution be accorded for new uncertainties, a discovered isolation, an inability to cope in once familiar surroundings, and a reduced defence against day-to-day hazards? Money serves to make amends, but does it really? The insurer helps defray the immediate hurt and moves on. Certain segments of the public would have it that the insurer be responsible for preventive measures and that he administer post-claim therapy, but this is to misconstrue his role. Harking back to our definition of insurance the insurer's role is an economic one and his contractual obligation is to the employer. The insurer's obligations do not exceed the legal obligations of the employer but the insurer must carry out those obligations to the full. This is what the Insurance Policy is all about.

I think it would be opportune to go into a brief explanation of the rudiments of Insurance before moving onto the specifics of what industrial deafness is costing. To start with the Insurance premium - how is this set?

We have seen that insurance is the sharing of loss but how is this done? There is some variation between States but the broad principle is that the whole of commerce is divided into a number of industry classifications. Each classification effectively stands on its own. The total premium received in respect of that classification is

compared with incurred claims, plus on-cost for management expenses and an amount for profit, then the classification rate is adjusted accordingly. Incurred claims put at its simplest is a combination of claims paid plus the amount estimated still to be paid on claims not finalised.

There are different premiums for different risks - the differential comes from the incurred claims component which is assumed to represent, in total, the relative hazards in that industry classification. There is no selectivity as to the nature of hazard, the economic indicator for pay out being the only criterion. For example, the Boilermakers' classification is a high rate because a large amount is paid out in this classification - not because it is known that there is a high incidence of industrial deafness claims. No dissection is made of the amounts paid. It is assumed that there is a normal distribution of non-specific claims e.g. injuries sustained on journeys to and from work. All other claims are assumed to be due to factors specific to that classification.

This is a valid assumption over the long term but in the short term we are left with only a series of crude indications - with nothing like the precision of measurement of the physical sciences.

The public in general and employers in particular have lost the view of the insurance company as the co-ordinator of risk sharing and see it as an organisation with a strong element of gambling in its business. You put your money in and wait and see what you get out. This is understandable in view of the size and complexity of insurance companies which have grown so large as to appear to present visual proof of their success. This sort of image can be readily pilloried and leads people to demand of insurers actions quite outside their proper scope. Most of you here today will be asking the question, "What is the insurance industry doing to help stamp out industrial deafness". I will pose the question back, "Why should the insurance industry be worrying about industrial deafness, in itself?"

Because it administers the payment of claims it is not liable for the factors which precipitate claims.

Let us move to examine the fundamental question in respect of industrial deafness. What is the cost in monetary terms? -And remember that the money terms are a measure of human loss. I know that this conference would appreciate a firm figure as to the annual cost of industrial deafness. Regrettably this is not possible as most of the larger insurers do not keep separate records of hearing loss claims - they are mixed in with all other claims.

After having talked with insurers in all States it is clear that the very great majority of industrial deafness claims arise in New South Wales and Victoria. It was not possible to obtain full statistics but the number of claims made in the other States would appear to be insignificant. The New South Wales situation is good in that the Workers' Compensation Commission does extract statistics on noise claims and figures to 1974/75 are available.

NEW SOUTH WALES - BOILERMAKERS DEAFNESS (2).
Year ended 30th June

	1968/69	1969/70	1970/71	1971/72
Payments ($000)	950	1,200	1,400	1,300
Total Cases	2,347	3,100	3,617	3,117
New Cases	____	2,036	2,201	1,812
	1972/73	1973/74	1974/75	1975/76
Payments ($000)	1,900	1,780	1,350	N O T
Total Cases	3,689	3,403	2,792	Y E T
New Cases	1,557	1,568	1,764	A V A I L.

The Claims come under the heading of BOILERMAKERS DEAFNESS, a somewhat quaint and out moded expression in these time when, with increasing use of machinery, workers in all kinds of trades are subjected to an almost incessant cacophony of whistles, toots, buzzers etc. If we look at the three years prior to 30/6/75 then the number of cases, in round figures, was 3,700, 3,400 and 2,800. We do not know if the decline continued in 1975/76.

The cost of claims for the same years, again rounded, was $1.9 million in 1972/73, $1.8 million the following year then dropping to $1.4 million. On the rounded figures we thus have an average cost of $513, $529, $500 - a remarkably stable pattern - too stable.

The answer would seem to lie in the true claims costs being distorted by the number of repeat claims, which involve far less money. In fact the number of new claims over the last three years did not decline but actually rose. It was the repeat claims that dropped. Another possibility could be that the new claims were getting lower in cost because they were being lodged earlier. We do not know.

Projecting these last three years forward we have an expected cost of $1.7 million in 1975/76 - not a large amount in a heavily industrialized State.

At this stage let us look at the Victorian experience in this field and then compare it with New South Wales. In Victoria the Workers' Compensation Board has released statistics as to the number of deafness claims handled. Unfortunately they do not detail costs. Over the past four years the number of industrial deafness claims coming before the Board has risen sharply in Victoria although they are still considerably lower than in New South Wales. The figures are slightly more recent - 1974-384, 1975-604, 1976-871, 1977-1080.

Thus there has been a 180% growth between 1974 and 1977. More importantly the number of claims now handled by the Board is comprised of 10% hearing claims compared with 4% 4 years earlier.

YEAR	HEARING CLAIMS	TOTAL CLAIMS
1974	384	9245
1975	604	9283
1976	871	10138
1977	1080	10898

From samples taken from the two largest insurers in the field in Victoria it is estimated that an average cost would be around $1,950. This would make the total cost for Victoria in 1976 $1.7 million and in 1977 $2.1 million.

Now it will be noticed that there is a remarkable divergence between the number of claims and the average cost per claim. There are more than twice as many claims in New South Wales as in Victoria yet the cost in Victoria is $1,950, more than twice the average cost in New South Wales. Let us see if we can explain some of these differences. Some reasons for the prominence of New South Wales claims over Victoria are:-

a) Work population is higher.
b) More heavier type industry - these are the industries which potentially lead to more deafness claims.
c) It is possible that New South Wales workers are more aware of their rights to claim industrial deafness. Unions have been active in conducting awareness campaigns for some time.
d) Many of the claims reported in New South Wales are actually second or third claims, the worker having received a partial claim in the past.

An interesting contra-point is that in heavy industry, especially in New South Wales worker education programmes for deafness have been going for some time but the effects of this will be long term.

One of the obvious reasons for Victoria's higher cost is the fact of

higher benefits: in 1975 $15,090 compared with $8,250 in New South Wales for total deafness. It is difficult to say precisely but it would also seem that Victoria is still very much in the stage of first claims which tend to be higher than later claims.

We have some very crude figures as to the monetary cost of industrial deafness in Victoria and New South Wales. They are not fully comparable but looking at a projected cost in New South Wales of $1.7 million in 1975/76, an estimated cost in Victoria in 1976 of $1.7 million, we would be reasonably safe in assuming that the total cost in 1975/76 Australia wide was a fraction under $4 million.

Is this significant?

Let us look at the amount paid in industrial deafness claims compared to total claims in the workers' compensation field. From the report of the Australian Insurance Commissioner for the year in question we find that total claims paid out in 1974/75 was $238.5 million (3) and in 1975/76 was $298.8 million. (4). Even allowing for crudeness of sampling the claims cost we are talking about for industrial deafness is obviously quite small compared to total claims pay out. In itself this would tend to make it low on the list of industry priorities.

This outlook reflects the fact that the insurance industry looks to the past for its data. The industry is a conservative one and prefers to work on observable long term trends rather than create new data of its own. There is thus no evidence to make the insurance industry look at industrial deafness as a matter of concern. This is re-inforced by the general assumption that the principal costs for industrial deafness are adequately reflected in the rates for noise hazardous industry groups.

Yet despite this seeming serenity almost every claims manager I spoke to - across various companies and in different States - had the distinct feeling that this was one type of claim that was going to escalate dramatically in the future. Very few had solid data

to support their view but one general observation was that workers claiming compensation for industrial deafness had started to appear outside the traditional heavy noise groups.

Past experience has shown that industrial deafness claims tend to come in batches from a particular employer - one successful case brings on a string of further claims. This is why claims managers view with some trepidation the fact that a worker in an industry not considered noise hazardous in the past now succeeds in a claim. The effects of the more active educational role being undertaken by unions in this field must also colour their thinking.

Thus the insurers are being caught because, by the very method of working from historical data, they are caught with the cost before they can recognise the problem and adjust premiums accordingly.

There is a further matter at present causing a problem to insurers and this is how to deal with an employer who has an adverse claims experience because of pay out on industrial deafness claims. Historically the insurance method of coping with an employer who had an adverse claims experience was to impose a special penalty loading onto his premium. This is good enough in a situation where claims can be directly controlled by the employer.

What is the situation in a State where industrial deafness is treated as a disease and the liability for the total claim falls against the last employer? He may only have been the employer for six months of a twenty year claim. Is it valid to impose a penalty loading on an employer in this case? You can see the dilemma in which the insurer is placed.

Whilst an insurer can generally be expected to act reasonably and not unduly penalise an employer for claims out of his control there remains the economic fact that the insurer cannot afford to be too altruistic. The only solution would seem to lie in the method being adopted by the larger employers in New South Wales and South Australia - audiological testing at the time of employment so that the claim can be put back against the last employer.

It should be noted that we have no problems of this nature in Victoria at present. Here industrial deafness is treated as an injury and not as a disease. Accordingly the worker joins his relevant previous employers in his claim to get full satisfaction. To simplify matters all insurers have signed an agreement to share the cost of claims according to the number of years the employer's policy was held by that insurer. Although there have been some slight problems in getting co-ordination between insurers this system has generally worked well. The most important point is that the cost is spread over all the insurers involved during the period covered by the claim.

Just a little earlier I mentioned the situation where the insurer had to determine whether to load an employer with a penalty loading because of an adverse claims experience where the total cost of a claim had just landed against one employer and one insurer. We were looking at it then from the employer's angle but let us also look at it from the insurer's point of view.

In States where the legislation lets the claim rest in full or almost in full against the last employer and/or insurer the question has been ignored as to whether the insurer's stability could be jeopardized becaused of heavy unforeseen payments in a short period. I think such arises from the view that industrial deafness is a relatively minor part of claims and special provisions need not be taken. While industrial deafness stays a minor problem no change is necessary. However if it is expected that the number of claims and the diversity of type of workers making claims would be expanding then it can be appreciated how dangerous is this attitude to an insurer.

One obvious answer is that the employer eventually will be locked in to one insurer as no other insurer will have him and he will eventually have to pay by means of penalty loading. We will thus have got right away from the basic principle of insurance - the sharing of risk and cost.

To make some predictions - looking at trends in industrial deafness I

would anticipate that there would be a steadily progressive rise in the number of claims reported and I say this because:-

Firstly the growing awareness amongst workers arising from union education and by the ripple effect - that is the more who are successful in industrial deafness claims the more claims will be lodged.

Secondly the tremendous expansion of the use of machinery with its concomitant noise problems.

And thirdly, the great unknown, the effect of Industrial Noise Legislation which is either in force or coming into force in all States. It is hard to foretell the effects of this legislation. Theoretically the incidence of industrial deafness claims should reduce but only in the long term and in the short term it will tend to make workers more aware of their rights and thus increase claims. More significant is the possibility of an increase in common Law claims as it will be easier to prove negligence against an employer.

A natural corollary of all of these points is that there will undoubtedly be a steady increase in premiums in all areas where industrial deafness claims occur and it is anticipated that much of this will be outside the traditional noise hazardous industries.

The impact on individual insurers will be more severe in those States where the last employer/insurer carries all or almost all of the claim as there is the likelihood that an individual insurer may have to carry a disproportionate load.

To conclude, industrial deafness has not been a matter of great concern to the insurance industry to date. It is smooth running and the cost not excessive.

We think it is changing but I underscore the lack of accurate statistics, of precise information.

There is a crying need for a detailed analysis of the problem so that Insurers can look to the future with knowledge, and can actively plan for proper and just action to meet claims in the interest of workers and employers as well as insurers.

REFERENCES

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3. Second Annual Report of the Insurance Commission for the year ended 30th June, 1976, Canberra, 1976. P.88.

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Discussion:

Mr. O'Keeffe: Perhaps I could make a comment in relation to the Commonwealth Act. I do not have the figures with me but I think I can remember them near enough. Our experience over the financial year that has just ended was that the average claim was about 15% Percentage Loss of Hearing, the average payment was about $2,500. I think there were 312 cases and a total payout of about $750,000. These figures will be in our annual report when it is presented to Parliament in a month or two.

Professor Lawrence: What concerns me about this is that there is absolutely no incentive for an employer who is going to try to reduce his noise levels. Is there a possibility of reducing premiums for an employer who reduces the number of hearing loss claims?

Mr. Bennett: In Victoria we give what we call a claims experience discount. If the employer can get the cost of claims down he gets rewarded with a discount of 35% of the total premium. You must remember this is based on his total claims payout, so he may have a perfect factory situation with everything controlled and yet he gets half a dozen death claims on behalf of people killed on the journey home. Now his discount has gone out the window.

Mr. O'Dwyer: Just some figures from Queensland: in the three months March 1977 to July 1977 we had approximately 80 claims at an average cost of $1,700. In the period August 1977 to February 1978 we had 160 claims at an average of $2,000 and from March 1978 to August 1978 we had approximately 160 claims for an average of $1642, bringing the payout in those 18 months to something like $726,000. So as an overall average our industrial deafness claims cost about $1,800 each. I'd like to comment also on the interest that insurers should have in industrial deafness and indeed in risk acceptance generally. We should be interested in providing employers with information about how their business is going because if we just depend upon turnover for the profit or the surplus, then we only provide service. Of course the insurance industry is simply and purely a service industry, but you will find I feel that if we rely solely on turnover and are not interested in keeping the claims down and doing a bit of risk management for the insureds, then we will price ourselves out of the market to such an extent that employers will, by necessity, have to become their own insurers, which will do away with the insurers' role completely.

Mr. Bennett: So far the situation revealed in your figures isn't very

far away from ours. About the need to give information to the insured it is significant to point out I think that at least half a dozen claims managers I spoke to were building into their computer systems the ability to get out detailed information on industrial deafness, something they don't have at the moment. There will be a growing tendency I think to provide information.

Mr. O'Dwyer: You could liken this situation that we have now to cardiac claims back in 1958-60. At that stage, cardiac claims were fairly unheard of and they grew and we didn't know what our component was for them. Now we have industrial deafness and I wonder if in ten years time it will be something else like silicosis or lung cancer or those types of things. So I think it is just a passing phase but of course statistically and actuarially we must prepare for it.

Mr. E. Weston: Would it not be in the insurers' interest to fund educational programmes in the interest of not pricing themselves out of the market?

Mr. Bennett: That gets back to the fundamental question. The insurer's got no interests except the employer's. Any money the insurer spends is the employer's money. Now the one who has got to be actively motivated to do something about it, I feel, is the employer.

Mr. Weston: Even though you are spending the employer's money, which they are going to be doing anyway, it should be in his interest for you to spend it on educational programmes.

Mr. Bennett: We spend his money under a firm contract. The insurance policy is quite specific. We are to settle his legal obligations. Now if he has a legal obligation, by all means we'd get in there and spend the money on it, but it is out of the question for us to embark on a fancy risk management campaign without the employers' approval. They might come to us and ask for help; that would be fair enough, we could do it then. In Victoria there are 60-odd companies in the workers' compensation field, over 50 groups setting up risk management; you would be far better off suggesting that the National Safety Council or somebody like that form a decent team of risk management funded by contributions, a levy on employers. That's the danger of having every insurer being his own risk manager.

Mr. Campbell: We have had some interesting situations with industrial deafness over the last few years. To the point about the notional date of injury, it might be interesting to know that we recently took on some new business at the 30th of June and by the end of the first week that we were on risk we had fifty claims for industrial deafness and

by the third day of the next week we had 71 claims for industrial deafness. The average cost of these claims was determined at about $3000. We happen to run an accident prevention department which provides services to our clients in accident prevention generally and we do some statistics now and again on hearing claims. We had another client recently and we assessed his cost over a year of claims to be in the order of $145,000. Of that figure, $100,000 was the cost and projected cost of his hearing claims. So I don't think the matter is one which is going to go away. It is a matter which is going to become worse. It is not only the employer who pays workers' compensation premiums, it is every member of society. So the more we can do to reduce claims through accident prevention the better off we'll all be.

Anon: A paper that was presented to a hearing conservation seminar in Grafton about a month ago by Ted Tobin lists fairly clearly the escalation of claims for hearing loss in his company. The company is actually pursuing the course of finding out people who have hearing loss and getting their claims processed as quickly as possible. It's a unique study I think and it does show this almost exponential growth in the numbers and amount of money paid out for hearing loss claims.

NOISE IN THE WORKPLACE - EDUCATIONAL PROGRAMS TO REACH SMALL INDUSTRY

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At least half of the workforce is to be found in so-called small industries, generally disadvantaged to date with respect to occupational health and safety services. If occupational hearing loss is to be minimised, ways of reaching this neglected part of the workforce must be found.

A general climate favourable to programs for small industry should be encouraged. Factors favourable to educational and other initiatives are appropriate legislation backed by adequate funding and trained manpower, together with educational activities designed to reach, in particular, young people before they join the workforce, or during the early stages of their vocational training. Group occupational health services and other projects and programs are briefly mentioned to show the variety of possibilities that exist to reach workers at risk dispersed throughout small industry.

The experience of occupational health (OH) professionals in most countries where new OH legislation has been proposed, or actually enacted, is being paralleled in this State at the moment with respect to noise in the workplace. While we are to talk on educational programs designed to reach small industry the substance of our paper will deal with the factors which favour, or are necessary for, the successful development and implementation of programs not only valuable for minimising occupational hearing loss but also for overcoming, or reducing the incidence of, many other work related problems.

Small industry can be variously defined as including those organisations too small to provide their own occupational health services, or depending on the country, as establishments with no more than 50, or up to 300 employees. These definitions are loose but do give some guidance to the upper limits of size of the establishment under consideration. Further, and equally roughly, one can safely say that more than half the workforce will be found occupied within such "small industry".

Health and safety experience is probably worst in medium-sized small factories, which at times are less likely to be prepared to maintain or update measures to improve on this poor health and safety experience. The size of the operation may not justify the particular minimum investment necessary to effect needed improvements, be these the acquisition of new plant and equipment, or the carrying out of repairs and modifications to existing facilities. However, some encouragement can be taken from experience which has adequately demonstrated that a thorough review of procedures and processes forced by some new legislative or other initiative generally results in greatly improved productivity with less hazard.

Unfortunately, no one seems to have satisfactorily solved the problem of providing satisfactory OH and safety services for the "smaller" small industries. Such establishments employ from just several to about 20 or so persons and account for many thousands of establishments. Little chance therefore exists for regular inspections or educational visits by governmental authorities. Even where plans for meeting their needs look good on paper there may be dissatisfaction on the shop floor, with apparently poor understanding of hazards and their prevention.

In Sweden, industrial safety representatives with basic (40 hour) training in OH and safety account for over 2% of the workforce. Most "small" small establishments are required to have at least one such representative, and beyond that size joint management/employee safety committees are required. Even with such a high proportion of employees aware of problems in their working environment and able to do something about them (protected by provisions of the law) it is not clear that Swedish experience is greatly superior to ours. Noise in industry continues to rank as one of the major

problems, as it does elsewhere.

Also, what has been well developed and found to be successful in one place may not be readily transferable elsewhere because of the particular political, cultural or socioeconomic milieu. Enactment of innovative Swedish work environment law has been facilitated by a long history of active management/worker consultation and a generally heightened public awareness of work related and environmental issues, if one can judge by their news value to the media.

So it is into a rather dismal local situation that we come to consider what climate may be necessary to encourage schemes and initiatives to promote hearing conservation in its many aspects in this country.

Rarely can attitudes be rapidly changed, and in the normal course of events one must accept that the time scale against which tangible improvements in industry as a whole can be expected to occur may be a decade to a generation. If this is so, the sooner worthwhile initiatives can be taken the better. There will be some listeners who will have practised or developed programs for their organisations which have already been shown to have been highly successful. By contrast many places of work have no idea about the fundamentals of a hearing conservation program.

A major ally in setting up such a program may be a new piece of legislation (OH and safety, or workers' compensation) providing the initial stimulus or motivation to do something. Why do we need such pressure to act ?....Employers and employees alike show increased interest in the provisions of new law in order to understand their "obligations" and "rights". One recognises that laws in themselves do not solve problems, and that it is probably in the first five to ten years after the enactment that the major changes in attitude will have to be effected - otherwise the advantages and potential for change offered by the law will have been greatly diminished.

It has been observed that people coming to understand the requirements of the legislation have been further motivated to see real value in the underlying OH and safety principles when they receive

not only answers to their specific initial questions but interestingly presented and clearly useful background information. Indeed, successfully dealing with an inquiry from an organisation may be the single most important factor allowing subsequent discussion of and dealing with other work-related matters, seen to be important by us but not perceived as such in the first instance by the enquirer. This is perhaps no different to saying that if you do a good job once the customer or client is likely to come back.

When legislation comes into effect one should see this as a demonstration of a government's intention to provide adequate funding for its implementation. As has been the case in overseas countries, an increase in adequately trained inspectors or compliance officers will also be needed, not to mention educational programs to raise both management and employee awareness. Where inspectors are to have an educational and advisory role in addition to their enforcement duties the upgrading of existing staff, and recruitment of new staff, have always been found to be key problems in effective implementation. Well trained staff can be used to monitor and review programs that industry may be required to develop.

Another fundamental aspect of legislation related to the workplace is the proportion of the workforce covered by its provisions. Current UK legislation includes "general duties" provisions which place a responsibility on individuals and organisations for the genesis, extension and perpetuation of problems, inasmuch that provisions apply to designers, manufacturers, installers, erectors, importers and/or suppliers of "articles and substances" for use at work to ensure that, insofar as they are responsible, risks to health and safety are eliminated and that the articles or substances are safe when properly used. Recognition of the need to engineer out noise problems before they even start, while well recognised as a principle, is a relatively slow process depending on plant and equipment replacement, unless a completely new process, department or factory is being set up.

One may interpose the comment here that some managements have found effective, even if not ideal, solutions to their OH problems by making the wearing of appropriate personal protective devices a condition of continuing employment in prescribed areas. This

approach has been particularly effective with eye protection, and has been used for hearing conservation, usually with a parallel attempt to improve the standard of equipment and its guarding, shielding, or isolation as appropriate. No law was required for these managements to take the initiative.

Generally speaking, very little time is given to the teaching of occupational health, safety, and ergonomics in the training of engineers, architects, and others who have design, planning and executive responsibilities. Until recently there has been little opportunity for medical students to develop an appreciation for the way in which workplace problems could affect health, and this of course includes a consideration of the development of noise induced deafness. Administrators also should learn about health problems at work during their training: in the long term, the senior executives with the authority to authorise and implement adequate training programs in industry and expenditure on equipment are drawn from the professional groups mentioned. No doubt competition for a student's time is intense nowadays, but surely there is sufficient evidence around us to demonstrate the high price being now paid for the neglect of inculcating preventative principles in the past.

Reaching experienced employees in industry and convincing them of the value of adequate hearing protection when such a measure has to be resorted to, can be no easy task in practice - how much easier might it have been to convince the worker or tradesman of the need for personal protective measures in those formative apprenticeship years, or during properly structured orientation/ induction programs? Where personnel policy is sound, and the enormous cost of high turnover and poor training is recognised, the incorporation of additional material on noise will not be difficult. Some will say that such induction courses are beyond the scope of the small industries we are supposed to be addressing ourselves to. This may be an appropriate point, then, to introduce the concept of group occupational health services which, very broadly, may be divided into the geographic or regional type, and the specific industry based type. A few examples of group services are only just being developed in Australia, but are seen to be of central importance for small industry in many European countries.

In the first, a number of "subscribing" firms come together to use the facilities of a well located occupational health centre, operating variously as a private service, as a co-operative, as part of an already established occupational health service of a large firm, as part of a hospital outpatient facility, or according to whatever viable basis one can devise.

With the second, a particular industry, often with one or more problems peculiar to that industry and requiring special expertise, can provide a shared service, where the common bond is the special problem rather than the convenience of proximity. In either type of service the properly trained occupational health nurse is a key person who can accept some responsibility in the education program, with screening audiometry and for noise measurement and assessment.

Perhaps working backwards from the concept of the group occupational health service, small industries in a particular location can group together on a temporary basis to make good use of private or government educational services. For example, while it is often not realistic to have someone skilled in noise problems moving from small factory to small factory, and repeating fundamental information on a "small tutorial" basis, it may be quite feasible to run the program for a group of 20 or 30 people representing a similar number of organisations with a much larger total workforce. In one sense this is already achieved through the operation of groups such as Productivity Groups, but some "common interest" programs or courses may be more successfully run on a "one off" basis, with different representatives attending depending on the subject.

Among educational initiatives being taken to prepare industry for the Hearing Conservation Regulation anticipated to be introduced under the New South Wales Factories Shops and Industries Act, a number of one day seminars on "Occupational Noise Measurement and Assessment" are to be held at the Division of OH and Radiation Control. Three such seminars are programmed for September 1978 and will be able to train twenty people at a time to become "competent persons" who would be able to carry out occupational noise measurement and assessment in their own organisations - a requirement of the new regulation. Divisional staff have also lectured and demonstrated on noise to several thousand apprentices. A private

organisation conducts a course in screening audiometry. Several commercial undertakings will be able to provide noise assessment, hearing testing and hearing conservation programs - one cannot at this stage comment on the educational aspects of these services being offered.

The initiatives mentioned to date depend on the activities of educational institutions and managements and governments; organised labour can do much to make its contribution to the health and safety of its membership through courses able to be run through the Trade Union Training Authority, and through trade union publications. A proven technique for the latter vehicle in the USA has been to have occupational health and safety professionals answer unionists' questions in a regular column. In one union publication the accumulated answers to questions over several years were gathered together and supplemented by new material to form an excellent, most readable text for workers on occupational health and safety matters.

Other ways in which the general level of awareness is raised in the general community to a particular problem area is through talks to service clubs, community special interest groups, and through the electronic media.

A dream that one day may come true is to see the appreciation for the significance of problems as universal as that of noise developing among primary and high school children, where the essential background information is woven into sections of the school program without overemphasis on OH and safety as a discipline in itself. Many principles affecting lifestyle, and touching on our health and well being, and our broader environment, could be allowed to develop across and throughout the more traditional subjects and courses in a natural way demonstrating primary prevention at its best. Up to the early years of high school we have the whole future workforce "captive" for this approach.

In conclusion, we return to the question of funding. Considerable cost may be involved in developing suitable courses and testing them, as well as the accompanying teaching materials. In New Zealand a portion of the compulsory levies paid to the Accident Compensation

Commission are being used to promote preventative safety and OH initiatives in education and research. In Sweden the well established Work Environment Fund has been able to provide a great deal of support for research, education and information dissemination. No monies from the Fund are available for providing services. Funding through joint union/management agreements may also find a place in this country to help sponsor educational programs for employees, particularly in some high risk industries.

To summarize what we need and what can be developed in a setting within which our limited resources of trained manpower can best be used: legislation encouraging a form of "compulsory self-regulation" where noisy industries have to develop solutions to their problems with guidance as necessary; adequate funding for manpower training to provide for proper advisory, enforcement and educational programs; educational initiatives that reach as many young people as possible before they start work; and, services of a group OH type which can disseminate information at any time, but particularly on employment and during periodic health reviews.

Discussion:

Mr. El-Issa: We all heard about the harmful effects of noise but our problem at the ABC is that we provide pleasant noise, ie music, and it is causing loss of hearing. Now how could we control it, how could we re-arrange the orchestra? It is impossible. How could we put a barrier between the player and his instrument? How could we stop the drummer from playing too hard? Is there any way we can combat this problem?
Mr. Weston: I'm not quite sure the question is in the correct session. I'm sure there is someone in the audience who may be able to provide assistance, but I'm not sure whether Dr. Simson would wish to comment?
Dr. Simson: Thank you very much Mr. Chairman for removing my problem. I suppose educationally speaking there isn't an answer to that question and I suppose really one ducks past it. Having some interest in this area myself, I can't really see how the matter could be resolved other than by some very sophisticated partial attenuation of the sound without removing some of the very characteristics that you want to retain. So I am very happy to duck past the question technically. But I think your point is taken that there are areas in which the solutions are not going to be too simple. I thought for a while that you were going to focus on the community noise aspect of this and perhaps I could say that this is an area of conflict, because on the one hand we are trying to teach people about noise reduction in industry, but on the other hand there seems to be a very real problem in having that appreciation carried over to a non-acceptance situation. As I understand it in some areas, and certainly with some young musicians playing with high amplification, there are very real problems. So I am not proposing an answer to that, I am simply saying that this is highly typical of a problem which spreads not just across people's work but actually spreads across community values and a host of other things.
Mr. Kotulski: Quite a few rock musicians already use earplugs because they suffer too much pain when they are playing at loud levels and in a lot of ABC studios they do have partial barriers. Often the problem is with the drummer, so they isolate him and ask him very firmly to play as quietly as possible and on top of that the control room operator cuts down the amplification on the drummer as well. I don't see how you can put a full size symphony behind partial barriers but I have seen it done with 20 piece orchestras.
Mr. Carter: Orchestral musicians are particularly affected by this problem because they cannot use earplugs. They have to play very softly

and hear very soft sounds immediately after hearing very loud sounds. I believe in many large overseas orchestras they have co-principals who divide the performing and rehearsing load. It would appear that only in that kind of administrative arrangement would there be any solution for orchestral musicians. On the question of training apprentices I'd like to support your comments very much. In a study of apprentices which we have done a large number came from small shops and there was only one apprentice, say, in the shop. Many of these apprentices knew nothing about hearing conservation. They are on day release to the Technical College and it is an ideal opportunity to teach them about all kinds of industrial hygiene. Until recently I don't think the Department of Technical and Further Education did much formally in this direction and I am very pleased to see that some initiatives might have been started from the Health Commission in that region.

Dr. Simson: One of the most exciting though very small programmes that I became involved in is at a High School where one of the teachers asked me to come in to try to translate into practical terms, in the workday world, the physiology they were doing which was relevant in this case to the heart and lung. It seemed that what was needed was some sort of transfer or translation of the material the students were assimilating into examples which had real meaning for them. At lunch I was talking with somebody who was talking about the awareness of young people in the area of environmental pollution and how by using the interest at a particular time that people have, one can modify attitudes by using that interest and saying "look, here is another twist that you mightn't have thought of, another aspect of this same problem", and infact using not a formal course of teaching but simply introducing relevant points at a time when it really means something to the person. There is a very big difference between forcing behavioural change and developing an attitude change.

Mr. Carter: If I could add one small comment. In our study we found towards the end that we might be getting through to them, because when we loaned a number of earmuffs out to people who had to do a practical class before being tested - a difficult situation in which we decided to lend them earmuffs to avoid any temporary threshold shift due to - the noise - we got only one out of six pairs of earmuffs back.

CLOSING REMARKS

Mr. R. A. Piesse

Director, National Acoustic Laboratories.

First of all I would like to congratulate all of the speakers for the excellent papers they have presented to this meeting. These papers have given us an enormous amount of practical information on hearing conservation and compensation and have provided us with many inspirations for further consideration. I believe their value to the understanding of the problems in this area are considerable.

I have been asked to make some brief remarks about the proceedings of this Conference which I will now try to do. To an extent they will summarise some of the things we have talked about over the last three days.

You all know that loss of hearing is being caused by noise with consequent effects on quality of life or social well being in very significant numbers of people. Hearing aids, although of assistance, do not restore normal hearing and consequently people who lose some part of their hearing from this cause will continue to suffer a loss of quality of life for the rest of their lives.

Legislation is attempting to reduce the problem but there are deficiencies in this area. Regulations are unclear in many respects, have problems of application and make no provisions for the future. They are limited through lack of resources and cost, etc., with the result that many workers will still suffer a loss of hearing by the end of their working life.

Means are available through noise surveys and work time patterns to establish noise exposures for individuals.

Hearing protection programs, including the selection and fitting of hearing protectors and monitoring audiometry, have been established often in the absence of any legislative requirement to do so. However, many problems remain to be solved in all of these areas. These problems include the difficulties and cost of providing these programs for a wide range of industries, a large proportion of which are small

businesses scattered over the country.

Doubts have been thrown on the usefulness of monitoring audiometry to protect individuals from loss of hearing and this will remain a contentious issue for some time. Its use for education and motivation of the worker and for the stimulation of industry to improve the sitatuion was maintained. The complexities of getting reliable audiograms are not fully appreciated by managements and authorities and there are difficulties in obtaining adequate training and guidance in this area. To overcome inadequacies there is a need for audiologists to make their presence felt in the hearing conservation field.

Unions have expressed an interest in worker education relating to noise and of course there is also an interest to the employer, particularly in view of the possibility of hearing loss occurring outside employment situations which are impossible to separate from work-caused losses. The provision of education programs amongst young people is probably one of the greatest needs at the present time.

Turning now to compensation. We have seen that legislation is complicated and there is incredible variability between the States. In two States compensation will probably not be paid unless there is incapacity for work.

The NAL tables for percentage loss of hearing are applied in most States. These tables are determined in such a way as to give a percentage which is directly related to the handicapping effect of a hearing loss on day to day functioning. In the application of these tables it is important to establish the hearing levels prior to injury, and for many Acts the relative times of occurrence of different components of the hearing loss. Thorough audiological and otological examinations are required to establish the types of hearing loss present and their probable causes. They also indicate the reliability and consistency of the audiometric results. It is evident, although it hasn't been stated, that standards being applied in many States to the assessment of compensation do not approach those being applied in the Federal Government. As hearing levels are usually exaggerated the result must be the payment of additional compensation where it is not justified. This may not be of great concern for many insurers at the present time but claims must increase. Unfortunately, compensation

payments at the present time do not seem to be of much concern to insurers and therefore do not force them to encourage employers to improve their efforts to protect workers.

I believe the conference has provided a very valuable opportunity for an examination of many of the activities related to a field in which there are still many challenges. It is evident that loss of hearing among workers and others in the community will continue to occur under present conditions and legislation. Positive moves must be made to educate young people to the dangers of over exposure to noise and to reduce noise exposure of individuals to increasingly lower levels if any great advance is to be made. Prevention must be the best answer if we are to preserve the best quality of life we can.

In conclusion I would like to make mention of the organising committee - R. Waugh, J. Macrae, G. Pickford, T. Paterson and P. Kotulski. We are very fortunate to have such an effective and competent committee which gave us a program permitting discussion in all important areas.