APPROVED CODE OF PRACTICE FOR THE

MANAGEMENT OF NOISE IN THE WORKPLACE

OSH
occupational safety & health service
te ratonga oranga

DEPARTMENT OF LABOUR
TE TARI MAHI

ACKNOWLEDGEMENTS

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Contents

Notice of Issue

I have issued this *Approved Code of Practice for the Management of Noise in the Workplace*, being a statement of preferred work practices or arrangements for the purpose of ensuring the health and safety of persons to which this code applies and persons who may be affected by the activities covered in this code.

J. M. Chetwin

Secretary of Labour

July 2002

Foreword

I have approved this statement of preferred work practices, which is an *Approved Code of Practice for the Management of Noise in the Workplace*, under section 20 of the Health and Safety in Employment Act 1992. When a code is approved, a Court may have regard to it in relation to compliance with the relevant sections of the Health and Safety in Employment Act. This means that if an employer in an industry or using a process to which an approved code applies can show compliance with that code in all matters it covers, a Court may consider this to be compliance with the provisions of the Act to which the code relates.

Hon. Margaret Wilson

Minister of Labour

August 2002

1. INTRODUCTION

1.1 Changes to this Approved Code of Practice from the 1996 Code

Since the publication of the original *Approved Code of Practice for the Management of Noise in the Workplace* in 1996, there have been changes in the standards that underpinned the code. These standards are:

- AS/NZS 1269-1998 *Occupational noise management*, Parts 0-4:
  - Part 0: *Introduction*
  - Part 1: *Measurement and assessment of noise emmission and exposure*
  - Part 2: *Noise control management*
  - Part 3: *Hearing protector program*
  - Part 4: *Auditory assessment.*
- AS/NZS 1270:2002 *Acoustics — Hearing protectors*.

The publication of these standards has included some significant changes to the "preferred work practices or arrangements" that a code of practice is intended to present. It has been necessary to update this approved code to recognise these changes.

The main changes are:

- AS/NZS 1269:1998 presents a more comprehensive description of practices in the areas of noise assessment, noise control, hearing protector selection and audiometric assessment than was possible with the 1996 code of practice.
- AS/NZS 1269.3 and AS/NZS 1270:2002 together provide an updated method of hearing protector selection, known as the "Classification" or "Class" method. This method supersedes the "Grade" method that has been in use in New Zealand for the last twenty or so years. The method which manufacturers use to test hearing protectors has also changed, providing a test that better takes into account the "real world" use of hearing protectors.
- The code recognises a new method of audiometric testing from AS/NZS 1269.4. The existing method, based on AS 1269:1989, continues to be recognised. The criteria for when noise-induced hearing loss is recognised as serious harm is unchanged.

The people with an interest in this code of practice include:

(a) Employers, principals and persons who control a place of work;

(b) Employees and self-employed people;

(c) Designers, manufacturers and suppliers of plant and hearing protectors;

(d) Professional health and safety practitioners, or people providing technical or "competent person" services to any of the groups listed in (a) to c) above.

As technical detail on different practices and methods is provided in the standards, there is no need to reproduce them in this code. The focus of this code is to provide information to people of their legal duties, and the steps they need to take to fulfil those duties.

It is expected that people providing a professional service such as noise assessment, control, and audiometric assessment will purchase and be familiar with the contents of AS/NZS 1269:1998.

1.2 Purpose of this Code of Practice

The principal objective of the legislation and this code of practice is to reduce the incidence and severity of hearing loss resulting from excessive noise exposure in workplaces.

The most effective and reliable way to prevent and control this significant hazard is to eliminate, or at least quieten the sources of noise to which employees are exposed. Measures such as job rotation and the use of hearing protectors are only acceptable as control options if:

- They are used as short-term measures while a more permanent noise reduction or isolation solution is being implemented; or
- All practicable steps have been taken to eliminate or reduce the noise output of a noise source, but this has not reduced noise exposure of employees to a level lower than the exposure limits; or
- All practicable steps have been taken to isolate employees from the noise source, but this has not been achievable, and they are still exposed to noise in excess of the exposure limits.

While this code aims to provide general guidance in accordance with AS/NZS 1269:1998, it is not possible to deal with every situation that may be found in the workplace. In using this code, discretion and judgement will be needed. In many cases, the consultation process will be able to deal satisfactorily with the issues relating to the application of this code and the standards. In other cases, it may be necessary to seek expert assistance.

1.3 Limits for Occupational Noise Exposure

The occupational exposure limits for noise are stated in Regulation 11 of the Health and Safety in Employment Regulations 1995. Regulation 11 requires employers to take all practicable steps to ensure that no employee is exposed to noise above the following levels:

(a) Eight-hour equivalent continuous A-weighted sound pressure level, $L_{Aeq,8h}$, of 85 dB(A); and

(b) Peak sound pressure level, L_{peak}, of 140 dB, —

whether or not the employee is wearing a personal hearing protector.

1.4 Health Effects of Occupational Noise Exposure

1.4.1 Noise Induced Hearing Loss

Noise-induced hearing loss occurs because excessive noise damages the delicate hearing mechanism of the inner ear. Initially, the excessive noise causes a temporary hearing loss, or temporary threshold shift (TTS), and hearing recovers to normal over a period of time.

A temporary threshold shift may occur when a person's exposure to noise exceeds the equivalent of 85 dB(A) for 8 hours, or a peak sound pressure level of 140 dB. However, repeated exposure to such excessive noise normally transforms this into a permanent loss, or permanent threshold shift (PTS).

Temporary and permanent threshold shifts may also be accompanied by ringing in the ears, called tinnitus. This can also become permanent, and may be extremely distressing to the individual.

The extent of noise-induced hearing loss (NIHL) depends on the intensity of the noise, its duration and its frequency (or pitch). Put simply, the more time a person's ears are exposed to excessive noise, the greater the degree of hearing loss. More time equals more acoustic energy and hence more damage. The damage that results is irreversible, and treatment is limited.

People suffering from occupational deafness experience a distortion of the sounds they hear, as they lose the ability to hear at some speech frequencies. In particular, the ability to hear consonant sounds such as t, k, s, sh and p is reduced, and people can no longer distinguish between some words, or indeed, hear what is being said. Hearing aids offer very limited benefit for some people with noise-induced hearing loss.

Humans suffer a deterioration in hearing naturally with age (presbycusis). Hearing loss from excessive noise adds to this natural problem but, unlike ageing, it is avoidable.

Some individuals are more sensitive to noise than others and will lose hearing more readily through noise exposure. The large variations in the susceptibility of individuals to hearing damage due to exposure to excessive noise means that the exposure limits set out in the regulations are therefore not in themselves guaranteed to remove all risk of noise-induced hearing loss. AS/NZS 1269.4 predicts a 10 dB hearing loss for 95% of a noise-exposed population if they are exposed for 40 years to the noise standard of 85 dB(A) for 8 hours per day.

The exposure limits do not apply to ultrasound or infrasound. Infrasound and ultrasound guidelines are noted in Appendix 5.

1.4.2 Non-Auditory Effects of Noise

Performance in reading, writing and listening tasks is affected by noise. These tasks, and those requiring a steady posture, are also disrupted, particularly by sudden bursts of noise. Performance in tasks demanding continuous attention (vigilance) may be affected by noise.

Noise diverts attention away from the less important elements of a task to those

that are regarded as being more important. Judgement may become more extreme in the presence of loud noise and more confidence is expressed in a decision, even where it may not be warranted.

Annoyance is determined by the intensity of the sound and by the attitude of the individual. Feelings of control over the source of noise reduce annoyance and improve performance.

Loud noise may make communication difficult. It may also mask warnings. These non-auditory effects occur at levels well below the exposure limits. Guidelines on appropriate noise levels that should largely prevent these effects may be found in the joint Australian/New Zealand Standard AS/NZS 2107:2000 *Acoustics — Recommended design sound levels and reverberation times for building interiors*.

Workers who suffer from noise-induced hearing loss may be reluctant to wear hearing protectors. Whether it is real or not, they sometimes perceive that it makes conversation and hearing warning sounds even more difficult. It may make them feel isolated and vulnerable to other hazards.

1.4.3 Vibration

Noisy processes are often associated with vibration. Intense vibration may be transmitted to employees who operate some vehicles, equipment and hand-held tools. Where employees are exposed to whole- or part-body vibration, the exposure must be controlled and maintained within limits that protect employees from adverse health effects. Guidance on these limits is contained in International Standards (e.g. ISO 2631 and ISO 5349) and other documents. (See Appendix J.)

2. Employers' Duties in Managing Occupational Noise

2.1 Employers Duties

Figure 1 (next page) summarises employers' duties under the Health and Safety in Employment Act (HSE Act) 1992 as it applies to noise in the workplace. A fuller description of the legislation and legal responsibilities is given in Appendix 1 of this code of practice.

2.2 Providing a Safe Place of Work

Section 6 of the HSE Act requires employers to take all practicable steps to ensure the safety of employees at work, and to provide a safe working environment. Regulation 11 of the Health and Safety in Employment Regulations 1995 states the levels of noise exposure that should not be exceeded. The regulation further states that hearing protection is only a valid means of control when all practicable steps have been taken to reduce noise to below the stated levels.

It is important for employers to note that the aim of the Act and Regulations, and this code of practice is to reduce noise exposure to below the "hazard criteria" stated in Regulation 11.

Use of hearing protectors in many situations is the only means of control that is left for employers. However, hearing protection in the form of earmuffs or plugs is often a misused control option. Its effectiveness in protecting employees' hearing depends on:

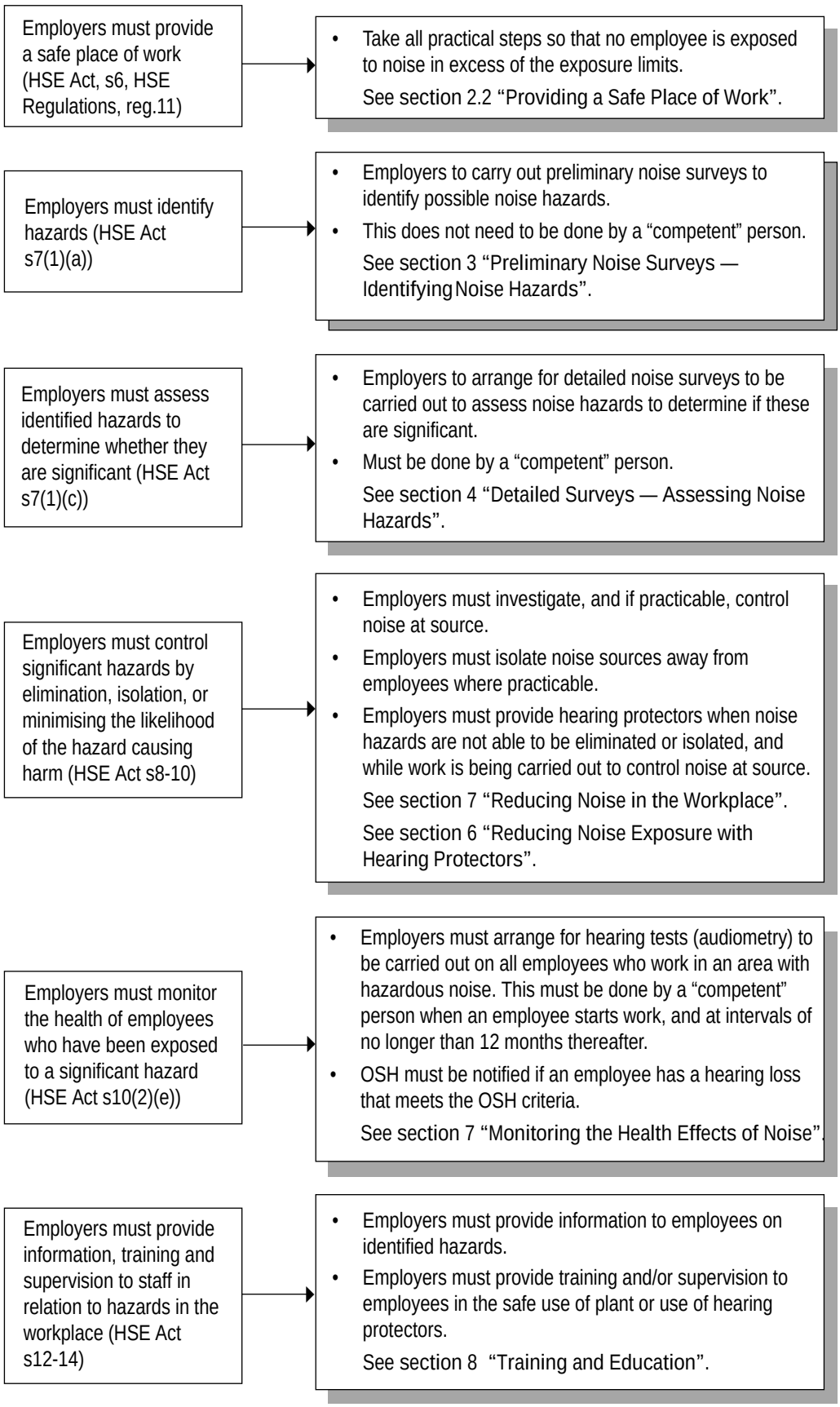
- Selecting the correct device;
- Having the device fit an individual properly; and
- The amount of time the hearing protector is actually worn while an individual is exposed to hazardous noise.

For these reasons, an employer is not meeting their responsibilities under Section 6 of the Act, or Regulation 11 if they provide hearing protection without taking all practicable steps to reduce noise exposure to a level below the hazard criteria.

Much of the activity surrounding noise measurement and audiometry is technical in nature, and confusing to many employers. This is not an end in itself, but should ultimately lead to knowledge of the noise environment, and control of hazardous noise exposure to employees.

When planning a new workplace, or any alteration to work activity, employers should consider the effect this will have on noise exposure to employees.

Figure 1: Summary of employers responsibilities under the Health and Safety in Employment Act 1992 with respect to noise



3. Preliminary Surveys – Identifying Noise Hazards

3.1 What is a Preliminary Assessment?

A preliminary assessment is often called a walkthrough survey. It is done to identify the areas in a place of work where noise levels are likely to, or actually, exceed the exposure limits. The results of the preliminary assessment should determine which tasks, processes or areas in the workplace require detailed assessment.

Preliminary assessments usually do not require sophisticated equipment or highly trained personnel. The emphasis is on identification of potential noise hazards, rather than full assessment of that noise.

Preliminary assessments should be carried out when there has been no previous assessment, or when previous assessments are 5 or more years old.

3.2 How Should a Preliminary Assessment Be Carried Out?

Preliminary assessments are carried out by walking through a particular work area, and noting the noise exposure of employees. A noise hazard identification checklist (see Figure 2) can be used. Notes should be made of plant and processes that are present, and the noise generated by them. Some limited noise measurement can be carried out, although it is not essential at this stage. A type 2 or type 3 sound level meter (see IEC 60651 and 60804 standards) is adequate for these assessments.

A preliminary assessment is a screening tool that should identify probable or possible noise exposures above the exposure limits. A detailed assessment is required to assess these further.

Preliminary assessments often find noise sources or processes where simple noise control measures may be introduced before conducting a detailed assessment. For example, fastening down a loose vibrating panel on a machine. Employers should consider whether the preliminary assessment provides enough information to implement noise control measures. A subsequent detailed assessment would then be performed to evaluate the effectiveness of the controls in place.

Alternatively, the employer could arrange for a detailed assessment to be performed and then implement control measures (see Part 5). A second detailed assessment should then be performed to evaluate the effectiveness of the control measures put in place. This is the preferred method, to ensure an accurate assessment of how much the noise has been reduced.

Preliminary Noise Survey Checklist

Date: ___ / ___ / ___

Assessed by: . . . . . Position: . . . . . .

Location of assessment: . . . . . .

NOTE

- The existence of any one of the following key factors indicates the need for further asssessment (see Part 4 of this code).
- Some employers may not have enough information to answer questions 7 and 8.

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1 Is there difficulty in communication between two people at 1 metre distance? (Difficulty means that the speaker must raise his/her voice, or that the listener may not understand what is said.)

Yes ❑ No ❑

2 Do employees in the area notice a reduction in hearing over the course of the day? (This reduction might not be noticed until after work.)

Yes ❑ No ❑

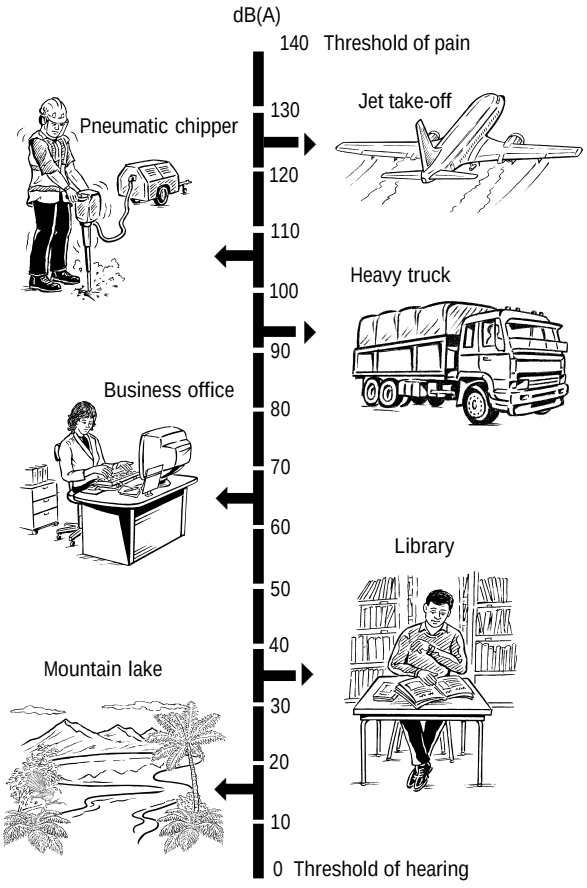
3 Do employees experience ringing in the ears (tinnitus) or blurred/dull hearing?

Yes ❑ No ❑

4 Are hearing protectors being used?

Yes ❑ No ❑

Figure 2: Decibel levels of common sound



5 Are signs posted at the entrance to or in the work area indicating that hearing protectors should be worn?

Yes ❑ No ❑

6 Does noise in any part of the workplace sound as loud as or louder than 85 dB(A) using the scale in Figure 2 below.

Yes ❑ No ❑

7 Do results of past noise measurements or assessments indicate noise levels equal or greater than any of the following?:

(a) 85 dB(A) "Slow" or Fast" response

Yes ❑ No ❑

(b) 85 dB(A) $L_{Aeq,T}$ (See Note 1) (or L_{eq})

Yes ❑ No ❑

(c) 80 dB(A) Sound Power Level

Yes ❑ No ❑

8 Does any equipment have noise information including labels that indicate noise levels equal to or greater than any of the following?

(a) 80 dB(A) L_{Aeq},T (or L_{eq})

Yes ❑ No ❑

(b) 130 dB Peak (unweighted)

Yes ❑ No ❑

(c) 80 dB(A) Sound Power level (See Note 2)

Yes ❑ No ❑

9 Do the results of the audiometry indicate that any past or present employees have a hearing loss due to noise?

Yes ❑ No ❑

10 Have there been any industrial deafness claims?

Yes ❑ No ❑

Notes:

1. For a variety of reasons, the $L_{Aeq,T}$ quoted may underestimate noise levels that actually result.
2. Sound Power Level is not a noise level. For example, under some circumstances equipment generating a sound power level of 80 dB(A) may result in a noise level of 85 dB(A) or higher.

4. Detailed Surveys – Assessing Noise Hazards

4.1 The Purpose of Detailed Noise Assessments

The aim of a noise hazard assessment is to assess the noise environment and to establish whether or not the workplace contains noise that exceeds the exposure limits. A detailed assessment is required:

- Where complex noise sources are present;
- If there is doubt about whether the noise levels exceed the exposure limits; or
- If there is any reason to believe, (such as from preliminary assessment results), that noise levels are, or may exceed the exposure limits.

Detailed assessments will provide information that will:

- Quantify the amount of noise to which employees are exposed;
- Help identify sources of noise;
- Assist in developing noise control strategies; and
- Determine appropriate hearing protector needs.

4.2 Detailed Noise Assessments to be Carried Out by a Competent Person

Detailed noise assessments must be carried out by a competent person. The competent person carrying out the assessment should have a thorough understanding of the:

- Objectives of the assessment;
- Correct way to use noise measuring instruments;
- Limitations of noise measuring instruments;
- Limitations of the noise exposure assessment strategy;
- Interpretation of the results;
- Recording of the results;
- The Act, AS/NZS 1269 and this code.

The knowledge and skills that a competent person should have acquired to perform noise assessments are described in Appendix B.

4.3 Methods and Equipment for Detailed Noise Assessments

The methods of how measurements and assessments must be undertaken are detailed in AS/NZS 1269, 1998: Part 1 *Measurement and assessment of noise immission and exposure*. The Regulation 11 of the Health and Safety in Employment Regulations require that measurements of noise levels and exposure be carried out in accordance with this standard.

The type of instruments selected to carry out the work depend on the circumstances and purpose of the noise assessment. Type 1 meters are preferred, although type 2 meters can be used except in marginal cases. Type 3 meters can only be used for preliminary assessments.

All sound level meters used must comply with the requirements of AS 1259.1 (IEC 60651) and/or AS 1259.2 (IEC 60804). Sound exposure meters must comply with the requirements of IEC 601252. Reference sound sources (calibrators) must comply with Class 2 specifications of IEC 60942.

4.4 Noise Evaluation Procedures

The procedures for determining the levels of noise and the noise exposures from the results of the levels measured during the detailed assessment are stated in Appendix E of AS/NZS 1269.1. These procedures should be followed.

4.5 Frequency of Assessments

A detailed assessment should be performed as follows:

- At least every five years after the most recent assessment.
- Following any change in the workplace or the work process to which the last assessment relates, and which is likely to change an employee's noise exposure. Changes likely to alter employees' noise exposure include:
  - installation or removal of plant and equipment;
  - a change in workload or machine speed likely to cause a significant change in noise level;
  - a change in building structure likely to cause a significant change in noise level;
  - a change to longer hours of work which causes an increase in the exposure to noise;
  - modification of working arrangements which increase the length of time employees would spend in noisy places (examples of such changes are work shift schedules and overtime).
- Upon the use of a new workplace, plant or process.
- When requested by a health and safety inspector.
- When reasonably requested by an employee.

An employer should keep a record of all assessments for a period of at least 10 years.

4.6 Follow-up Assessments

Where a follow-up assessment is required, for example, to monitor changes to the noise exposure(s) due to various factors, the assessment must be made with appropriate instruments and in accordance with AS/NZS 1269.1 to ensure comparability with the results obtained previously.

4.7 Consultation with Employees

It is important to consult with employees. During the assessment process, consultation with employees who are exposed to noise will assist in identifying health hazards due to noise. These employees are most likely to be best aware of the times and locations where they are exposed. The Health and Safety in Employment Act 1992 requires employees to have the opportunity to be fully involved in the development of safety and health procedures.

4.8 Extended Work Shifts

As the exposure limits in Regulation 11 are based on an 8-hour working day, extended shifts need to be taken into account in any noise assessment. This is due to the longer period of time a person is exposed to potentially hazardous noise, and the shorter time the person's ears have to recover before noise exposure resumes. Situations may also exist when the longer exposure time is a key factor in noise exposure exceeding the exposure limits.

5. Control of Noise at Source

5.1 Introduction

The Act clearly establishes a priority, or hierarchy of control for significant hazards. This starts with elimination of the noise hazard, followed by isolating people from the hazard, and minimising the effects of the hazard on people. While elimination and isolation are very specific control options, minimisation covers many methods and techniques. Generally speaking, the most effective noise minimisation control options are those that reduce the amount of noise produced. This is the main theme of this section.

Note that the use of hearing protectors is not strictly a form of noise control. Noise control refers to techniques that reduce the amount of noise that reaches a person. Hearing protectors only limit a person's exposure to noise that reaches them. Hearing protectors should be considered as a permanent control option only when all other options for reducing noise below the exposure limits have been exhausted.

New developments in noise control are continually occurring. Employers and industry groups should request up-to-date information on noise control from equipment and process suppliers. While technical difficulties prevent immediate reduction of noise in many situations, regular reviews of new developments in technology may reveal control solutions at a later date.

5.2 The Role of Employers and Competent Persons

It is not expected that employers will become experts in noise reduction techniques. The employers' role is to ensure that noise reduction techniques are used where possible, and that "all practicable steps" are taken to reduce noise at source.

The assistance of a competent person with expertise in noise control will be needed when prioritising, developing and implementing noise control options. This is particularly important when considering options that involve an engineering solution. A competent person can also assist at the planning stage if the solutions are unclear.

Examples of individuals who may possess competence in the control and reduction of noise, or may readily gain it through a combination of education, training and experience, are acoustic engineers, consultants and scientists.

5.3 The Noise Reduction Programme

AS/NZS 1269.2:1998 *Occupational noise management – Noise control management* outlines the requirements and guidance on the control and reduction of noise in both new and existing workplaces. It covers the following aspects of a suitable programme of planning and works:

- Noise control planning and design in new workplaces;
- Noise control management in existing workplaces; and
- Outlines basic noise control techniques.

It must be stressed that the best and most cost effective time to consider noise reduction is at the design stage. Noise reduction should be considered when designing any new workplace, and change in an existing workplace such as installing new equipment or a new process. People such as project managers, architects and process engineers should consider noise control, in addition to other health and safety concerns in their plans and designs. Aspects of noise control that these key people should consider is outlined in AS/NZS 1269.2.

5.4 Overview of Noise Control Solutions

This section is intended to simplify some basic theory behind noise control techniques. To do this, we will consider noise control through the "Source, Path, Receiver" model. This provides a useful picture of how and where noise solutions can be applied.

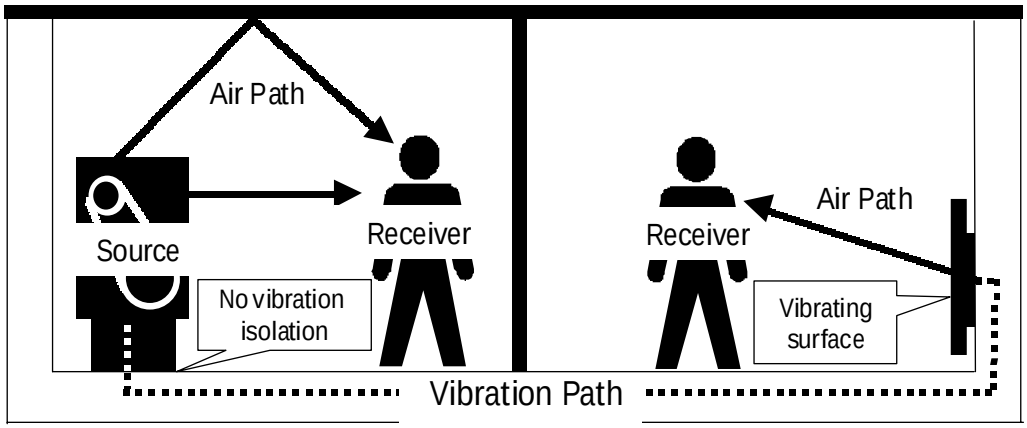
5.4.1 The Source, Path, Receiver Model

Every noise problem (and every airborne health and safety problem) has three basic elements:

- **A source**: from which the noise originates and radiates;
- **A path**: along which the noise travels. The noise path includes passage through the air, or along or through an object such as a wall or pipe;
- **A receiver**: the ears of the person hearing the sound.

These are shown graphically in Figure 4.

Figure 4: Diagram showing the source, path and receiver elements of a noise problem



Noise can be controlled at the point of **source**, by blocking the **noise path**, or protecting the **receiver**. Noise control options centred on the noise source are the most effective, while noise control options centred on protecting the receiver are the least effective. Receiver-based options control exposure to noise rather than the noise itself.

Noise control options are based around:

- Engineering controls – e.g. modifying a process or equipment;
- Administrative controls – e.g. reducing the time a person is exposed to a noisy process;
- Provision of personal protection – e.g. providing hearing protectors.

These can be drawn as a matrix, which outlines noise control techniques. This is shown in Table 1.

Noise control measures should first be directed at the source, and then at the sound path. If these control measures are unsuccessful, hearing protectors can be used as the final option.

5.5 The Cost of Not Controlling Noise at Source

While employers may consider the cost of noise control options to be high, they should also consider the ongoing costs of exposing employees to hazardous noise and administering a hearing protector program. These costs could include:

- ACC costs, as even wearing the correct hearing protectors all the time will not protect 100% of workers. The amounts of time a day hearing protectors are worn is critical to their effectiveness. Workers who do not wear hearing protectors even for a short period of time are at an increased risk of noise-induced hearing loss;
- Costs of hearing protectors (plugs and muffs) and their replacements;
- Administrative costs for subsequent noise assessments, ensuring hearing protectors are worn and audiometric tests;
- Possible compliance costs.

Table 1: Showing examples of noise reduction techniques

ELEMENT	ENGINEERING CONTROLS	ADMINISTRATIVE CONTROLS	PERSONAL PROTECTION
SOURCE	• Modify a noisy process or equipment to eliminate or reduce the noise and vibration output. • Regularly maintain machinery and equipment so equipment in disrepair is not contributing to the total noise.	• Eliminate the need for a noisy machine or process. • Substitute a noisy machine or process for a quiet(er) one. • Institute a “buy quiet” policy so that when equipment needs replacing, a quiet option is purchased.	
PATH	• Use noise absorption materials to reduce reflected noise inside a room or enclosure. • Use a noise enclosure to surround and contain a noise source. • Use a noise enclosure, such as a soundproof control room, to isolate an operator from the noise source. • Place machinery or a process in a location where reflected noise is minimised. • Prevent transmittance of vibration to prevent structure-borne noise.	• Isolate employees from noise by doing noisy tasks at a time most people are not present. • Isolate employees from noise by placing noise source in another location. • Ensure that only people necessary to work on a machine or process are exposed to a noise source.	
RECEIVER		• Restrict time workers are in a noisy environment. • Warn employees about noise hazards with signage. • Training and education in noise, its effects, and control policy.	• Use of hearing protectors

6. Control of Noise Exposure with Hearing Protectors

6.1 Introduction

Immediately it is known that employees are being exposed to noise that exceeds the exposure limits, an employer must develop and implement a noise control programme. While this programme is being developed, appropriate hearing protectors must be issued to and worn by the affected people. **Hearing protectors must not be used as a substitute for noise control.** They must be regarded as an interim measure while the control of excessive noise exposure by engineering or other means is achieved. The removal of hearing protectors for even very brief periods of time can dramatically reduce their effectiveness. A worker not wearing a hearing protector for as little as 30 minutes a day can reduce by a half the protection it is giving over the entire day.

6.2 A Hearing Protector Programme

As part of a hearing protector programme, employers need to consider:

- The need for hearing protectors;
- Defining hearing protector areas;
- Selection of hearing protectors;
- The issuing of hearing protectors to individuals
- Cleaning and maintenance of hearing protectors;
- Training and education for people wearing hearing protectors.

6.3 The Need for Hearing Protectors

Every person in a designated hearing protector area must wear hearing protectors. This includes people working full or part time in those areas, and people passing through or spending very short amounts of time there.

6.4 Hearing Protector Areas

When the noise levels exceed, or are likely to exceed, the exposure limits stated in the Regulations, the area must be designated as a hearing protector area. The areas or machinery concerned must be clearly labelled and the boundaries where the noise hazard exists must be clearly defined. Signs identifying a hearing protector area may be necessary. The signs used to identify these areas and machines should conform to the specifications in NZS/AS 1319. (See Figure 5 on following page.)

The construction, location, maintenance and use of signs should conform to Section 4 of NZS/AS 1319.

Figure 5: Mandatory sign indicating that hearing protectors must be worn

The requirements for hearing protector areas are detailed in Clause 10 *Hearing protector areas* of AS/NZS 1269.3.

The meaning of signs must be explained to employees as a part of training (Part 6: Training and Education).

Where sign-posting is not practicable, alternative arrangements should be made in consultation with employees to ensure that they and other persons can recognise circumstances in which hearing protectors are required.

Methods of achieving these include:

- Attaching prominent warning notices to tools and equipment indicating that hearing protectors must be worn when operating them and where they may be obtained.
- Providing written and oral instructions on how to recognise circumstances in which hearing protectors are needed.
- Effective supervision of the specified high-noise areas.

6.5 Selection of Hearing Protectors

It is important to ensure that the hearing protectors selected provide adequate protection to the wearer.

The method used for the selection of an appropriate hearing protector will depend on the Standard to which it has been tested. The methods approved for use in New Zealand are shown in Table 2. Further details on these methods are given in Appendix D.

Table 2: Methods of hearing protector selection

Method	Selection up to 30 June 2003	Selection After 1 July 2003
Grade	Yes	No
Classification	Yes	Yes
Octave Band	Yes	Yes

6.6 Personal Issuing of Hearing Protectors

Provided that adequate protection is given, it is preferable for the user to be allowed a personal choice from different models of protectors, to accommodate particular needs. Once chosen, employees should retain hearing protectors for their individual and exclusive use. Individual selection of hearing protectors should be based on:

- The degree of protection required in the employees' environment.
- The suitability for use in the type of working environment and the job involved. For example, ear plugs are difficult to use hygienically in work that requires them to be inserted with dirty hands, and in such jobs ear muffs might be better. On the other hand, ear muffs tend to be more uncomfortable in hot environments, or may make it difficult for the wearer to enter a confined space or to wear a helmet.
- The comfort, weight and clamp force of the protector. Any person is more likely to wear a comfortable hearing protector than an uncomfortable one.
- The fit to the user. Individual fitting of the wearer is necessary for optimum protection, and this should be checked while the user is wearing any other items that will normally be used and which might affect the performance of the protector. For example, spectacle wearers should be fitted with ear muffs while wearing their normal spectacles. Disposable plugs of comfortable material do not need individual fitting, but the ability of the material to conform to the user's ear canal should be taken into account in selection.
- The safety of the wearer and fellow workers. For example, the suitability for use in conjunction with any other personal protective equipment that might be required, such as safety helmets or respiratory protective equipment; the wearing of hearing protectors should not mask warning sounds.

NOTE: Different ethnic groups have different body dimensions, e.g. Pacific Island people have broader faces than Asian people. There are large variations in the dimensions of the ear canal between various ethnic groups, and also between males and females. These differences will affect the proper fit of a hearing protector and should therefore be taken into account when selecting and fitting hearing protectors.

A list of tested, graded and classified hearing protectors is available from the Website of the Occupational Safety and Health Service of the Department of Labour.

6.7 Cleaning and Maintenance of Hearing Protectors

Employers should ensure that hearing protectors worn by staff are clean and in a good state of repair. Employees should be encouraged to clean reuseable plugs in soap and water at the end of each day. Wearers should clean the cushion on earmuffs periodically.

Hearing protectors should be inspected for any damage that will make them uncomfortable, harm the wearer or make the device less effective in protecting hearing. Employers should make supplies of replacement cushions and other replaceable parts available so repairs can be made immediately where necessary. AS/NZS 1269.3 Clause 8 *Cleaning and Maintenance* has further details.

6.8 Education and Training

Before hearing protectors are issued, the need for their use must be fully explained. Employees must be given training in the selection, fitting, use, care and maintenance of appropriate hearing protectors and this instruction must be repeated at regular intervals. It is extremely important to point out the effect of removing hearing protectors when exposed to excessive noise.

Managers and supervisors should encourage the use of hearing protectors by explanation and personal example. The format and content of an appropriate training programme is given in Appendix D of AS/NZS 1269.3 *Hearing protector program.*

7. Monitoring the Health Effects of Noise (Audiometry), and Notification of Serious Harm

7.1 Introduction

Audiometry is testing the hearing of a person in order to determine if they have any loss of hearing. In New Zealand, the method of audiometric testing used is known as Pure Tone Audiometry. It is important to understand that audiometric tests only give an estimate of hearing loss. Where hearing loss is due to noise exposure, it may take months or even years of repeated noise exposure before permanent hearing loss becomes measurable.

The absence of hearing loss on an audiogram may be false reassurance. If, however, audiometric tests indicate that hearing loss due to noise exposure has occurred, then exposure assessments and controls must be reviewed to determine changes that will ensure no further hearing loss. OSH has criteria for when hearing loss is considered to be serious harm. When audimetric testing first reveals serious harm, OSH must be notified.

7.2 Employers Duties to Provide Audiometric Testing for Employees

Where a detailed noise assessment shows noise levels to be above the exposure limits, or for any reason it is assumed the noise level exceeds the exposure limits:

- An employer must gain the informed consent of employees exposed to noise that exceeds the exposure limits to carry out audiometric tests; and
- An employer must arrange for those audiometric tests to be carried out.

This is required by Section 10 of the Health and Safety in Employment Act 1992. For the purposes of audiometric testing, an employee exposed to noise above the exposure limits means the noise as it would be measured, rather than the noise exposure attenuated by hearing protectors.

7.3 Frequency of Tests

When this code requires audiometric testing to be carried out, employers must arrange:

- reference audiometry as soon as possible after the noise hazard is identified;
- reference audiometry at the commencement of employment of any new employee who will be exposed to noise that exceeds the exposure limits, preferrably before they are exposed to any noise in the workplace;
- reference or monitoring audiometry at no greater than 12-month intervals.

It is recommended that reference or monitoring audiometry also be carried out for new employees 3 months after the commencement of employment.

7.3 Audiometric Testing to be Carried Out By a Competent Person

Only a "competent person" with the necessary skill and training should perform audiometric tests (see Appendix B). Most employers will need to engage a competent person to do this work for them.

7.4 Informed Consent to Carry Out Audiometric Tests

Under the Health and Safety in Employment Act 1992, the employer is required to take all practicable steps to gain the informed consent of employees to carry out audiometric tests. In practice, this can be done by the competent person carrying out the audiometric testing.

Audiometric testing will reveal information about the health status of an individual. In this respect it is subject to privacy laws and should not be passed to a third party. However, this information is required by employers to enable them to better manage noise hazards and employees exposure to them. Consent should be gained from employees allowing the results of audiometric tests to be given to employers. Employers should treat this information as confidential, and ensure no other party has access to it.

All employees should be given the results of their personal audiometric tests.

7.5 Standards for Audiometric Testing

Audiometric testing can be carried out according to AS 1269:1989 *Acoustics - Hearing conservation* or AS/NZS 1269.4:1998 *Occupational noise management,* Part 4: *Auditory assessment*. Details on these methods are included in Appendix E.

7.6 OSH Criteria for Noise-Induced Hearing Loss and Serious Harm

Serious harm in the form of Noise-Induced Hearing Loss (NIHL) is considered to have occurred when the results of audiometry under AS 1269:1989, or reference audiometry under AS/NZS 1269.4:1998 show:

- The threshold at 4 kHz is at least 30 dB Hearing Loss (HL) and is at least 15 dB worse than the 2 kHz threshold, **and the loss can be attributed to exposure to noise at work where it is in excess of the exposure limits.**

Further information on notification criteria and interpretation of audiograms is available in the OSH publication *Noise-Induced Hearing Loss of Occupational Origin — A Guide for Medical Practitioners*.

7.7 Employers to Notify OSH When Serious Harm Occurs

Employers must notify OSH when serious harm in the form of noise-induced hearing loss is revealed through an audiometric test, with the exception of the following circumstances:

- When the audiometric test that reveals serious harm is a baseline test at the commencement of employment, where the new employee has not been exposed to noise in that workplace; and
- When the audiometric test occurs at a later date than another audiometric test where serious harm was detected, and OSH was notified.

In both these exceptions an employer should record the details of the test and the reason for not notifying OSH.

7.8 Other Action to Take Following Audiometric Tests

An employer should take action to review noise control and hearing protector programmes when:

- Monitoring audiometry reveals a temporary hearing loss (temporary threshold shift or TTS);
- Reference audiometry reveals serious harm as defined in Section 7.6 of this code of practice; or
- Reference audiometry reveals further deterioration in the hearing of a person already diagnosed with noise-induced hearing loss.

These actions could include:

- Checking to see if there has been any change in the employee's work that would change his or her noise exposure;
- Checking to ensure that noise control solutions are still being used and are effective;
- Re-evaluating the employee's noise exposure if necessary;
- Re-evaluating the suitability and fit of any hearing protector;
- Evaluating whether the hearing protector is being worn correctly and consistently.

7.9 Requests for Information by a Health and Safety Inspector or Departmental Medical Practitioner

The employer must provide a health and safety inspector with the information regarding health monitoring on request. However, no details of any individual's health status may be passed to a health and safety inspector without that person's consent.

A Departmental Medical Practitioner may examine personal health records such as audiometric test results without the person's consent. The employer may arrange for the person or persons doing audiometric testing to forward the appropriate information to a Departmental Medical Practitioner.

8. Training and Education

8.1 Groups Requiring Training

The groups requiring training are:

- Employees who are likely to be, or are actually, exposed to excessive noise at work.
- Managers and supervisors of these employees.
- Employees responsible for purchasing plant, and for the designing, scheduling, organisation and layout of work.
- Employees responsible for the acquisition and maintenance of hearing protectors.

The needs of each group are different, and the content and methods of training must be tailored to meet the specific needs of each of these groups.

8.2 Topics to be Covered

Topics that should be included in a training programme aimed at prevention of noise-induced hearing loss include:

- A brief overview of noise, the hearing mechanism and the hearing protector programme;
- The reasons for wearing hearing protectors;
- The selection of suitable hearing protectors;
- The use and proper fitting of hearing protectors;
- The importance of wear time and consequences of hearing protector removal;
- The maintenance and storage of protectors; and
- A summary of the session emphasising the most important factors.

NOTE: Before employees are first provided with hearing protectors, they should be properly trained.

Details of the content and outline of a suitable training programme are stated in Appendix D of AS/NZS 1269.3 *Hearing protector program*.

8.3 Training Supervisors

Before a person is first given supervisory responsibility for employees, that person must be trained to understand:

- The control measures implemented to reduce noise exposure;
- The locations where, times when and the type of hearing protectors that must be worn where such equipment is provided;
- The arrangements for the selection, fitting, use, cleaning, maintenance and replacement of hearing protectors.

8.4 Training on Hearing Protector Maintenance

Before a person, who may be the user, is first given responsibility for maintenance of hearing protectors, that person must be trained in how to clean and maintain hearing protectors and to undertake visual examination of hearing protectors for defects.

8.5 Training Persons Responsible for Purchasing Hearing Protectors

Before a person is first given responsibility for the purchasing of hearing protectors, that person must be trained to understand the HSE Act and regulations and AS/NZS 1269.3, and how to interpret both the attenuation data provided by manufacturers and the field measurements of attenuation required to provide adequate protection.

8.6 Training Workers of Non-English-Speaking Backgrounds

The employer must ensure that the content of the training is clearly understood by all employees. The employer must take into account the specific needs of workers with a non-English-speaking background.

9. Duties of Employees and the Self-Employed Regarding Occupational Noise

An **employee** is any person who is employed to do any work for hire or reward. An employee may be permanent, temporary, casual, full-time, or part-time.

The Act requires that as an employee, you must take all practicable steps to ensure:

- Your own safety at work; and
- That no action or inaction by you while at work causes harm to any other person.

The effect of this duty is to create an obligation for employees not to undertake work which is unsafe, or which involves unsafe practices. Particular duties that employees have are:

- Following the employers instructions regarding noise hazards in the place of work;
- Reporting noise hazards;
- Using and caring for protective equipment, e.g. ear muffs, plugs;
- Co-operating with the monitoring of workplace hazards and employees' health, e.g. noise level monitoring, audiometry;
- Reporting work-related injuries or ill health, e.g. NIHL.

Section 17 of the Act creates a general duty for the **self-employed** to maintain their own health and safety and that of others who may be affected by their work. The duty is similar to that of employees.

Section 17 creates an obligation for the self-employed not to undertake work which is unsafe, or which involves unsafe practices. There may also be situations where a self-employed person becomes aware of an unsafe situation or practice. In this instance, if they are in control of the place of work, they have a duty to make it safe. Otherwise they should make the person who is in control aware of the situation, and seek a solution.

10. Duties of Designers, Manufacturers and Suppliers of Plant and Hearing Protectors

The Health and Safety in Employment Regulations 1995 place duties on designers, manufacturers and suppliers of plant and hearing protectors (see Regulations 66-69 of the Health and Safety in Employment Regulations 1995).

Duties of designers can be summarised to say that plant and protective equipment must be designed so it is not a source of harm, or offers the necessary protection, assuming it is manufactured as specified.

Duties of manufacturers and suppliers can be summarised to say that they must choose a design of plant or protective equipment that is not a source of harm, or offers adequate protection, and it must be manufactured to the correct specifications.

These duties, and means of complying with them are detailed in Appendix F and G of this code.

APPENDIX A: SUMMARY OF THE HEALTH AND SAFETY IN EMPLOYMENT ACT AND REGULATIONS

A.1 Health and Safety in Employment Act 1992

The principal object of the Health and Safety in Employment Act 1992 is to prevent harm to employees at work. To do this, it imposes duties on employers, employees, principals and others, and promotes excellent health and safety management by employers. It also provides for the making of regulations and codes of practice.

A.1.1 Duties of Employers in Relation to Hazard Management

Employers have the most duties to perform to ensure the health and safety of employees at work. These are summarised in Table A1.

Table A.1: Duties of Employers in Relation to Hazard Management

Section of Act	Duty
Section 6	• Provide and maintain a safe working environment; • Provide and maintain facilities for the safety and health of employees at work; • Ensure that machinery and equipment is safe for employees; • Ensure that working arrangements are not hazardous to employees; and • Provide procedures to deal with emergencies that may arise while employees are at work.
Hazard Management	
Section 7	• Have effective methods to identify new and existing hazards to employees at work; • Have effective methods to regularly reassess hazards to determine if they are significant hazards.
Section 8	• Take all practicable steps to eliminate significant hazards.
Section 9	• Where there are no practicable steps to eliminate a significant hazard, or steps taken have not been successful, take all practicable steps to isolate employees from the significant hazard.
Section 10	• Where there are no practicable steps to eliminate or isolate a significant hazard, or steps taken have not been successful, take all practicable steps to: - Minimise the likelihood that the hazard will harm employees; - Ensure appropriate protective clothing/equipment is provided for, accessible and used by employees; - Monitor employees exposure to the hazard; - Take all practicable steps to gain the employees consent to monitor health effects of the hazard; and - With informed consent, monitor possible health effects of the hazard.

Other Duties of Employers	
Section 11	• Give employees results of monitoring
Section 12	• Provide information on: - Hazards employees may be exposed to while at work; - Hazards employees may create which could harm people; - How to minimise the likelihood of these hazards becoming a source of harm to themselves and others; - The location of safety equipment; and - Emergency procedures.
Section 13	• Provide training and supervision
Section 14	• Involve employees in development of health and safety
Section 15	• Take all practicable steps to ensure that no action or inaction of an employee harms any other person.

A.1.2 Duties on Other Parties

The Health and Safety in Employment Act places duties on a number of other people. These include people who control a place of work, self-employed people, principals and employees. Information on the self-employed and employees is found in Section 9 of this code. Information on other parties can be found in *A Guide to the Health and Safety in Employment Act* available online at www.osh.dol.govt.nz or your local OSH office.

A.1.3 Accidents and Serious Harm (Recording and Notification)

The HSE Act requires employers to keep a register of work-related accidents and serious harm. This includes every accident that harmed (or might have harmed):

- Any employee at work; or
- Any person in a place of work under the employer's control.

Employers are also required to investigate all accidents and near-misses to determine whether they were caused by or arose from a significant hazard.

Employers are required to notify serious harm that occurs to employees while at work to the Secretary of Labour (in practice, the nearest OSH office), as soon as possible. In addition, the circumstances of the accident must also be notified in the form prescribed within 7 days. (Suitable forms for notification are available from OSH offices and selected stationers.)

If a person suffers serious harm, the scene of the accident must not be disturbed unless to:

- Save life or prevent suffering;
- Maintain public access for essential services, e.g. electricity, gas; or
- Prevent serious damage or loss of property.

The OSH office will advise whether it wishes to investigate the accident and what action may be taken in the meantime.

A.2 Health and Safety in Employment Regulations 1995

A.2.1 Regulation 10 — Noise

Regulation 10 redefines the terms “employer” and “employee”.

For the purposes of Regulation 11, the term “employer” includes a person who controls a place of work, and a principal who controls contractors.

The term “employee” includes contractors or subcontractors, their employees and any other person working under the control of a person who controls a place of work.

A.2.2 Regulation 11 — Noise

Regulation 11 of the Health and Safety in Employment Regulations 1995 requires employers to take all practicable steps to ensure that no employee is exposed to noise above the following levels:

(c) Eight-hour equivalent continuous A-weighted sound pressure level, $L_{Aeq,8h}$, of 85 dB(A); and

(d) Peak sound pressure level, L_{peak}, of 140 dB,—

whether or not the employee is wearing a personal hearing protector.

Regulation 11(3) qualifies the issue of wearing personal hearing protection. Wearing of hearing protectors as a long-term solution is allowed provided the employer has taken all practicable to reduce noise to a level below the exposure limits, but has not been successful doing this. The employer is required to communicate clearly the fact that hazardous noise exists in a given area, the sort of hearing protectors required to protect against the noise, and where they can be obtained.

A.2.2 Regulations 65-69 – Duties of Designers, Manufacturers and Suppliers

Regulations 65-69 deal with the duties of designers, manufacturers and suppliers of plant; and the duties of designers, manufacturers and suppliers of protective clothing and protective equipment. These are summarised in Sections F and G of this code.

APPENDIX B: THE "COMPETENT" PERSON

The following training and knowledge is required by persons performing:

- noise assessments;
- audiometric testing.

B.1 Noise Measurements and Assessments

People carrying out assessments shall be able to demonstrate a thorough understanding of:

(a) the objectives of the assessment;

(b) the basic physics of sound;

(c) the correct usage and limitations of sound-measuring instruments required to gather data for noise assessments;

(d) the information needed and methods used to determine occupational noise exposures;

(e) how to record results and explain them to people in the workplace;

(f) the normal operating conditions of the workplace;

(g) the method for evaluating personal hearing protectors;

(h) when to advise that someone with more specialised knowledge on noise measurement or noise control is required; and

(i) the relevant statutory requirements, codes of practice and standards used in New Zealand.

(j) They shall also have a basic understanding of:

- The mechanism of hearing;
- The harmful effects of noise; and
- The principles of engineering noise control and noise management measures.

Topics recommended for inclusion in a training course for noise assessment should include:

- Basic acoustics;
- Revision of basic physics and mathematics; the nature of sound; physical properties of sound; propagation (reflection, diffraction, refraction, absorption and transmission); sound intensity; sound power; sound pressure; pure tones; sound spectra; and noise;
- Analysis of sound waves;
- dB scale; frequency weightings; octave bands; RMS, peak, 'F' and 'S' weighting; L_{eq}; $L_{Aeq,T,}$ $L_{Ceq,T,}$ $L_{Aeq,8h,}$ $E_{A,T}$; impulsive noise, L_{max}, L_{peak}; and the relationship between sound power and sound pressure; time-weighting.
- Sound measurement instrumentation;
- The use and limitations of sound level meters, integrating-averaging

sound level meters, personal sound exposure meters, auxiliary equipment (including filters) and meter characteristics. The need for calibration standards and noise measurement procedures including daily checks and periodic calibration by laboratories with traceability to national standards;

- Need for noise control (Hearing Protector Programme);
- Mechanism of hearing; effects of noise on hearing; work and social implications of noise-induced hearing loss; other effects of noise, e.g. interference with communications, masking of warnings; tinnitus and other physiological effects; personal hearing protector: classification system, selection, fitting;
- Evaluation of noise;
- Noise assessments: preliminary and detailed assessments of noise levels and exposure, measurement for noise control and monitoring; identification of sources and areas which contribute to exposure; standing waves in rooms and their effect on measurement accuracy; recording of results; and explanation of results;
- Practical noise assessments;
- Measurements; evaluation; and reports for the workplace;
- Other noise measurements;
- Measurements for assessment of personal hearing protectors and audiometric booths and ways of identifying hearing protector zones;
- Noise reduction;
- An appreciation of: ranking noise sources; engineering approach to noise reduction (i.e.reduction at source, transmission path, receiver); vibration isolation; noise information needed for specifications on new plant and buildings; work techniques; maintenance; and outside expertise;
- Noise regulations and guidance literature;
- Understanding of the HSE Act, the regulations relating to noise, AS/NZS 1269:1998 and a general knowledge of this code of practice.

B.2 Audiometric Testing

Audiometric testing for the purposes of the Act may only be carried out by a person who has received proper training in basic pure tone audiometry. The level of training, education and experience required of the tester may be specified by the Occupational Safety and Health Service of the Department of Labour and may include a licence, approval or accreditation system with associated time frames.

Assessment of competency should include the means to test knowledge of relevant legislation and codes of practice as well as AS/NZS 1269, compliance with the standard's audiometric test procedure and factors affecting the accuracy of results.

The tester must make the necessary arrangements to ensure that all testing is carried out in accordance with AS/NZS 1269:1998.

In particular a person or group carrying out assessments should be able to demonstrate a thorough understanding of:

- objectives of audiometric tests in noise management;
- basic physics of sound;
- correct usage and limitations of audiometers and audiometric booths;
- basic anatomy and physiology of the auditory pathway;
- basic mechanisms of hearing;
- an audiogram and its relationship to the detection and understanding of human speech;
- noise-induced hearing loss, its pattern, progress, cause and prevention;
- correct headphone placement and test subject instruction;
- correct audiometric test technique;
- how to record the results of an audiometric test;
- basic audiometric test result interpretation and how to explain the results to the test subject;
- when to advise that a test subject required referral for audiological, medical or rehabilitative purposes;
- Correct selection, usage and limitations of personal hearing protectors;
- AS/NZS 1269.3; and
- the requirements of the HSE Act and regulations relating to noise and audiometry in occupational noise management, particularly those relating to confidentiality of audiograms, and the reporting requirements of noise-induced hearing loss as serious harm.

APPENDIX C: NOISE REDUCTION BY ENGINEERING CONTROL

The following information may be found useful to enable simple engineering controls to be implemented within a relatively short time-frame.

C.1 Engineering Noise Control at Source

C.1.1 Plant and Equipment

Noise control solutions and examples of particular engineering measures which may be implemented include:

- Eliminate or replace the plant or its operation by a quieter operation with equal or better efficiency;
- Replace the noisy plant by installing newer equipment designed for operating at lower noise levels;
- Correct the specific noise source by minor design changes;
- Maintain plant properly. Badly worn bearings and gears, poor lubrication, loose parts, slapping belts, unbalanced rotating parts and steam or air leaks all create noise which can be reduced by good maintenance;
- Correct the specific plant elements causing the noise by a local source approach, rather than by consideration of the entire plant as a noise source. For example, noise may be reduced by adding noise barriers, noise enclosures, vibration isolation mountings, lagging to dampen vibrating surfaces, mufflers or silencers for air and gas flows, or reducing air velocity or free jets. These may be considered as a solution for the individual noise-producing elements of the total operation.
- Move the noisy elements which need not be an integral part of the basic plant. For example, move pumps, fans and air compressors that service the basic machine. NOTE: Separation is only effective where room surfaces tend to absorb sound;
- Isolate the vibrating plant parts to reduce airborne noise from vibrating panels or guards.

C.1.2 Process

In addition to engineering changes to plant, a process can be modified to reduce noise. Specific means of modification include the use of a process or processes which are inherently quieter than the alternatives, for example, mechanical pressing rather than drop forging. Metal-to-metal impact should be avoided or reduced where possible and vibration of the surfaces of the plant or the material being processed should be suppressed, for example, by the choice of suitable

materials, by adequate stiffness and damping, or by careful dynamic balancing where high-speed rotation is used.

Materials handling processes, in particular, can also be modified to ensure that impact to stock during handling and transport is minimised as far as possible. Some ways by which materials handling may be modified are:

- Minimising the fall height of the product onto hard surfaces;
- Stiffening and/or fixing damping materials to tables, walls, panels or containers where they are struck by materials or items during processing;
- Absorbing shocks through the provision of wear-resistant rubber or plastic coatings;
- Using conveyor belts, rather than rollers which are more likely to rattle;
- Controlling the speed of processes to match the desired production rates, thereby obtaining a much smoother work flow and less likelihood of noise generation due to stop-start impact noise;
- Matching air supply pressure to the actual needs of air-powered equipment. Pneumatic devices such as vibrators are often supplied with air at a higher pressure than is necessary for efficient operation. It is better to supply them through a pressure-reducing valve which is set to supply the lowest pressure at which the device will operate efficiently;
- Making arrangements to ensure that noisy devices are only switched on when actually in use. This includes the pneumatic ejector on a press which should only be on during that part of the cycle when the product is ejected; and
- Using air nozzles and blow-off cleaning guns constructed on aerodynamic principles, however, where possible, these devices should be avoided.

C.2 Engineering Treatment of the Noise Transmission Path

C.2.1 Engineering Treatment Principles

If it is not possible to change or modify the noise-generating equipment or processes by engineering noise reduction procedures, treatment of the noise transmission path between the source and the exposed employee should be investigated.

Methods include isolating the noise-emitting object(s) in an enclosure or placing them in a room or building away from the largest number of employees and then acoustically treating the area to reduce noise to the lowest levels practicable.

As an alternative, it may be desirable to protect the employee(s) instead of enclosing the sound sources. In this case, design of the soundproof room or sound-reducing enclosures should still follow the same principles.

The principles to be observed in carrying out modifications include:

- Distance is sometimes the cheapest solution but it may not be effective in reverberant conditions.

- In some cases, erection of a partial noise barrier between the noise source and the exposed employee can be used to advantage. In cases where either area has a false ceiling, care should be taken to ensure that the dividing wall extends to the true ceiling and that all air gaps in the wall are closed and airtight.
- Once the acoustical barrier is erected, further treatment such as the addition of absorbing material on surfaces facing the noise source might be necessary.
- Materials which are good noise barriers, for example lead, steel, brick and concrete, are poor absorbers of sound. The denser and heavier the material, the better the noise barrier. However, the material will also reflect sound well. To reduce the reflection of sound, a good sound absorber is needed.
- Good sound absorbers — for example, some polyurethane foams, dacron, fibreglass, rock-wool and thick pile carpet — are also very poor barriers to the transmission of sound. The two types of material (barriers and absorbers) should therefore be used in combination to obtain the best effect.
- Walls and machine enclosures should be designed to minimise resonances, which will transmit acoustic energy at the resonant frequency to the protected ear. This can be achieved by placing reinforcement or bracing in strategic areas during construction or modification.
- The reverberation in the room due to hard reflective surfaces should be reduced as far as practicable by the introduction of acoustically absorbent material(s). The presence of reverberation can reduce speech intelligibility.

C.2.2 Implementation

These principles can be applied in a number of ways:

- Using a sound-reducing enclosure which fully encloses the machine:
  - Consideration should be given to the adverse effects of small openings in an acoustic enclosure. For a completely effective enclosure, the joints should be sealed airtight. Cement rendering the inside of a brick wall or mastic sealing the joints of a sheet metal panel enclosure should be undertaken. Sound rated doors should always be fitted with elaborate rubber or labyrinth seals.
  - When enclosing a machine such as an automatic metal stamping press, it is necessary to acoustically treat the material feed and product delivery chutes with absorbent lining. This will limit the amount of noise escaping through these openings.
  - Adequate ventilation should always be provided when designing noise-tight enclosures for plant such as air compressors and diesel generators. Ventilation openings should be fitted with absorptive-type silencers and air flow should be assisted by motorised fans.

- Separating the noisy areas from the area to be quietened by a sound-reducing partition which follows these principles.
- Using sound-absorbing material on floors, ceiling and/or walls to reduce the overall sound level due to reverberation.
- Using acoustical silencers in intake and exhaust systems associated with gaseous flow, for example internal combustion engine exhaust systems or air conditioning systems. The silencers should be:
  - Absorptive-type silencers, which are used to reduce fan or turbine noise travelling in an air or gas stream along a duct or pipe.
  - Reactive-type silencers, for reducing low-frequency engine exhaust noise (noise is attenuated by reflecting the noise energy back to its source).
  - Combined reactive-absorptive silencers, where a wide range of frequency response is required.
  - Resonant silencing where a noise comprises one single pure tone.

APPENDIX D: SELECTION OF HEARING PROTECTORS

D.1 Determination of Appropriate Protectors

Hearing protection device selection methods supported by this code of practice are summarised in Table D.1.

Table D.1: Hearing protection device selection methods supported by the Noise Code of Practice

Selection Method	Documentation	Measurements of Noise Exposure Required	Comments
Grade	AS 1270:1988 or ISO 4869.1:1990	• L_{eq} in dBA for work shift or period of exposure. • L_{peak} readings for impact noise.	This method is the old standard for hearing protection selection in New Zealand. It will be discontinued as an approved method after 30 June 2004.
Class	AS/NZS 1269.3: 1998 and AS/NZS 1270:1999	• L_{eq} in dBA for work shift or period of exposure. • L_{peak} readings for impact noise.	This method is the new standard for hearing protection selection from the date of publication of this code of practice. This method does not apply when the noise exposure level equals or exceeds 110 dBA $L_{eq,8h.}$
Octave Band	AS/NZS 1269.3: 1998 and AS/NZS 1270:1999	• Individual sound pressure level readings in dB for octave band centre frequencies ranging from 125 Hz to 8 KHz	This method is recommended when the sound exposure level exceeds 110 dBA $L_{eq,8h,}$ or when the noise exposure is predominantly tonal in nature.

WARNING:

- Hearing protection devices have been offered for sale in New Zealand using overseas hearing protection device selection methods that have not been endorsed in New Zealand. These include the Australian SLC_{80} method, the USA Noise Reduction Rating (NRR) method, and the HML Method.
- Although the SLC_{80} and HML methods are listed in AS/NZS 1269.3, their use is not recommended in New Zealand as they are based on dBC rather than dBA noise exposure readings.
- The NRR method is also based on dBC readings. Significant correction factors for this method have been published by the United States National Institute of Occupational Safety and Health (NIOSH) in their publication *Criteria for a Recommended Standard — Occupational Noise Exposure, Revised Criteria 1998*. Hearing protection devices that offer an NRR number, but have not been tested to AS/NZS 1270:2002 (or AS 1270:1988 up to 30 June 2003) should not be used.

The suitable type of hearing protector for a given exposure condition therefore normally requires only the determination of the Noise Exposure Level ($L_{Aeq,8h}$) and the Peak Level (L_{peak}). Details of the determination of the $L_{Aeq,8h}$ and L_{peak} are contained in AS/NZS 1269.1.

D.2 The Grade Method

This method is only applicable up to 30 June 2003. Hearing protectors are assigned to one of five hearing protector grades according to their acoustic performance. A personal hearing protector should be selected on the basis of the $L_{Aeq,8h}$ or the L_{peak} (whichever has the greatest excellence) to which a worker is exposed during a working day.

The hearing protector grades and the levels to which they will provide adequate protection are as follows in Table D.2.

Table D.2: Hearing Protector Grades

Hearing Protector Grade	Protection to $L_{Aeq,8h}$ (dB(A))	Protection to L_{peak}(dB)	Types of Suitable Hearing Protector
1	91	146(1)	Earplugs or earmuffs
2	97	152(1)	Earplugs or earmuffs
3	103	158(1)	Earmuffs
4	109	164(1)	Earmuffs
5	115	170(1)	Earmuffs
5		>140(2)	Earplugs + earmuffs
Where L_{CFMax} - L_{AFMax} <5 (L_{CFMax} is the Maximum, C-Weighted, “fast” time response level.) Where L_{CFMax} - L_{AFMax} >5 (L_{AFMax} is the Maximum, C-Weighted, “fast” time response level.) NOTE: In most situations, the L_{CFMax} - L_{AFMax} will be <5. It will only exceed 5 when the impacts/impulses contain very high levels of low frequencies.			

D.3 The “Classification” Method

Hearing protectors are assigned to one of five hearing protector classes according to their acoustic performance. A personal hearing protector should be selected on the basis of the $L_{Aeq,8h}$ to which a worker is exposed during a working day. The classes are defined in Table D.3.

Table D. 3: Hearing Protector Classes (as reproduced from page 17 of AS/NZS 1269.3)

Class	$L_{Aeq,8h}$,dB(A)
1	Less than 90
2	90 to less than 95
3	95 to less than 100
4	100 to less than 105
5	105 to less than 110

On the surface, the grade and class methods appear to be very similar. There are, however, significant differences. These are:

- The hearing protection devices are tested to a different standard. Tests carried out in the manner specified by AS/NZS 1270:2002 give a better indication of the performance of the hearing protection device as it would be used under normal workplace conditions.
- The classes are in steps of 5 rather than 6 dB from the hazardous noise criteria level of 85 dBA.
- There is no restriction, other than acoustic performance, on the class that can be assigned to an ear plug.
- No hearing protection devices are classified for noise exposures greater than or equal to 110 dBA L_{eq}. The *Octave Band* method can be used for noise exposures of 110 dBA or more.

D.4 Octave Band Method

This hearing protection selection method is more accurate than the *grade* or *class* methods, but requires that the octave band frequency spectrum (between 125 Hz and 8 kHz) of the noise to be known (or measured).

The measured data is combined with the attenuation data of particular hearing protectors. Attenuation data is available for hearing protection devices tested to AS 1270:1988, or for hearing protection devices tested to AS/NZS 1270:2002. From 1 July 2003, only attenuation data for hearing protection devices tested to AS/NZS 1270:2002 should be used. From this data, the protector that will provide sufficient attenuation to meet the exposure limit can be determined. This determination should be conducted by a person competent to do so.

The *Octave Band Method* is described with a worked example in Appendix A of AS/NZS 1269.3.

In a few cases, very low-frequency noise (in the 31.5 or 63 Hz octave bands) or very high-frequency noise (in the 16 kHz octave band) may be present in significant amounts. In this situation, it is necessary to measure the noise in the 31.5 to 125 Hz and 8 to 16 kHz bands. As protectors are normally listed with attenuation figures only from 125 to 8 kHz, the expected attenuation values of particular hearing protectors may be estimated as follows:

- The attenuation and standard deviation values for the 31.5 and 63 Hz bands should be assumed to equal those for the 125 Hz band.
- The attenuation and standard deviation values for the 16 kHz band should be assumed to equal that of the 8 kHz band.

For the majority of situations encountered in the workplace, the octave band method does not give results that differ significantly from the *grade* or *class* methods. In these situations, the *grade* or *class* methods should be used. However, if the noise contains a lot of low or high frequencies or prominent tones, then the *grade* or *class* methods may give results that differ by at least one grade from the "octave band" method. In these cases the *octave band* method should be used.

The *octave band* method should also be used when the noise exposure level is greater than 115 dB(A) for the grade method, or greater than or equal to 110 dB(A) for the class method. It should also be used in circumstances when the use of appropriate hearing protectors is not practicable, for example, when ear muffs are required but are not compatible with other safety equipment.

APPENDIX E: AUDIOMETRY

E.1 Audiometry Testing According to AS/NZS 1269:1989

Audiometry under AS 1269:1989 should be carried out as follows:

- Audiometry should be conducted in accordance with the procedures stated in AS 1269 or ISO 6189, except where specified differently in this code.
- Reference audiometry should be carried out in accordance with AS 1269 or ISO 6189; and
- The test frequencies for both reference and monitoring audiometry should include 500; 1,000; 1,500; 2,000; 3,000; 4,000; 6,000 and 8,000 Hz. Monitoring audiometry should be conducted well into the workshift so that comparison with the reference audiogram will reveal any TTS due to inadequacies in the noise management or hearing protection programme. The tester needs to obtain and record information on the noise exposure of the subject in the 16 hours prior to the test, including information concerning the state and use of any hearing protectors.

Where the monitoring audiogram shows:

- the threshold at 4 kHz or 6 kHz is at least 30 dB Hearing Loss (HL) and is at least 15 dB worse than the 2 kHz threshold; or
- a threshold shift greater than or equal to 15 dB at any frequency when compared with the reference audiogram,

the individual should have another monitoring audiogram on another day, after at least 16 hours in quiet conditions, to determine any PTS.

Audiometric testing should be carried out in a quiet environment. The background noise levels at the position which will be occupied by the employee's head during the audiometric test should not exceed the values listed in Table E.1 below:

Table E..1: Maximum acceptable background noise levels for audiometry

Type of earphone/cushion/ enclosure combination connected to audiometer	Octave band noise levels (dB re 20 μPa)						
	125	250	500	1k	2k	4k	8k
TDH39 or TDH49 earphone in MX41AR cushion	57	42	19	17	33	40	33
TDH39 or TDH49 earphone in PN51AR cushion	58	40	20	20	32	39	35
TDH39 or TDH49 earphone in Amplivox Audiocup enclosure	60	40	35	37	42	52	45
TDH39 or TDH49 earphone in Auraldome AR-100 enclosure	68	50	32	25	34	47	38

TDH39 or TDH49 earphone in Auraldome AR-200 enclosure	59	47	33	26	41	47	38
TDH39 or TDH49 earphone in Madsen ME-70 enclosure	58	50	30	31	42	52	44
TDH39 or TDH49 earphone in Telex/Peltor enclosure	64	49	39	38	45	53	47
ER-3A Insert earphones	72	56	36	30	42	51	51

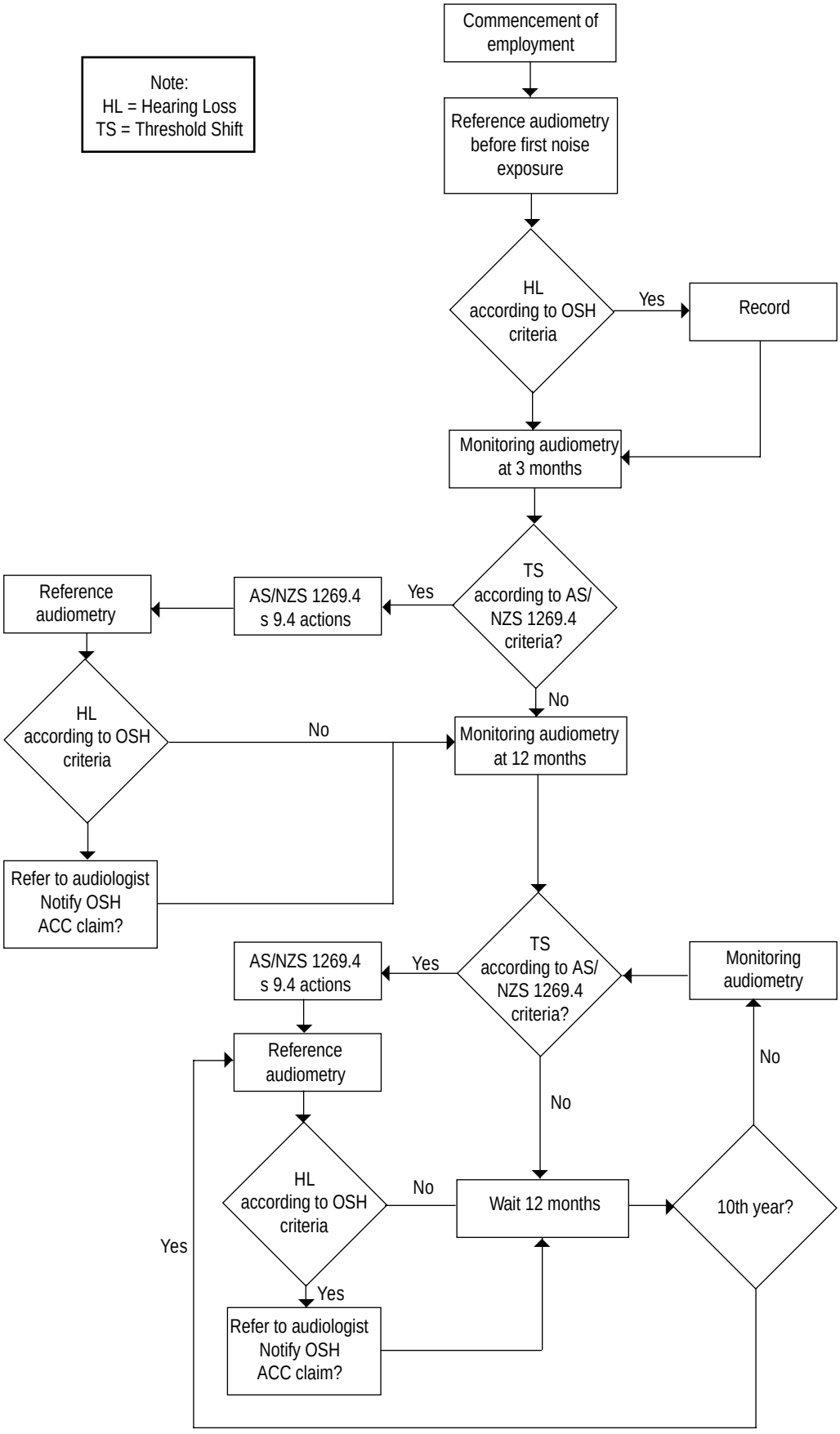
NOTES:

1. The values set out in this table, which permit the measurement of 0 dB hearing threshold level for test frequencies 500 Hz and above, are calculated from information given in a paper entitled Ambient Noise Limits for Audiometry, B. F. Berry, *NPL Acoustic Report AC60*, February 1973, and the acoustic attenuation characteristics of the earphone/cushion and earphone/enclosure combinations listed in the first column as determined by the National Acoustic Laboratories, Sydney, Australia.
2. To achieve the background noise levels, it will be necessary in many circumstances to use a sound-isolating booth.
3. Where sound-excluding earphone enclosures are used, it should be borne in mind that sound-pressure levels corresponding to 0 dB hearing threshold levels have not yet been standardised for these devices. This means that although suitable for hearing conservation audiometry, the audiograms obtained may not be suitable for calculation of percentage loss of hearing for compensation claims, nor for determination of hearing threshold with reference to International Standards for normal hearing.
4. The values apply only for the particular type of earphone/cushion or earphone/enclosure combination specified in the first column. Where other types of earphone/cushion or earphone/enclosure combinations are used, the maximum acceptable noise levels should be determined from the attenuation characteristics of the configuration using the procedure derived by Berry. In this determination, the value of the mean headset attenuation minus one standard deviation must be used, as calculated from the results of measurements on at least 15 subjects.
5. A calibration interval of not more than one year is recommended for audiometers. New audiometers should be checked at more frequent intervals until calibration stability is established. Regular testing of a subject with normal hearing or the audiometrist's own hearing will disclose any gross discrepancy which might occur between formal calibrations.

E.2 Audiometric Testing According to AS/NZS 1269.4:1998

A flow chart of the audiometric test procedures outlined in AS/NZS 1269.4 is shown in Figure E.1 on the following page.

Figure E.2: Flow chart of audiometry testing procedure given in AS/NZS 1269.4



NOTE: All audiometry should be conducted in accordance with the procedures stated in AS/NZS 1269.4:1998.

E.3 Reference and Monitoring Audiometry

AS/NZS 1269.4 outlines two methods of pure tone audiometry, named as reference and monitoring audiometry.

Reference audiometry is a hearing test that is carried out after 16 hours of quiet. Its purpose is to establish a baseline of a person's hearing at the commencement of employment, and to establish if a permanent threshold shift has occurred at a future date after exposure to noise in a workplace. It should be performed at the following times:

- At the start of an individual's employment, preferably before he or she is exposed to any noise in that workplace;
- Whenever the monitoring audiogram shows a threshold shift;
- At an interval of no greater than 10 years.

Monitoring audiometry is a hearing test that is carried out in the middle of a work shift. Its purpose is to detect a temporary threshold shift in a person's hearing. Detection of a temporary threshold shift will provide information on the effectiveness of noise controls, such as hearing protectors. It is also an early warning of a permanent threshold shift. It should be performed at the following times:

- Within three months after the initial exposure to noise in the workplace;
- At least every 12 months;
- When there has been a significant change to the employee's noise exposure; and
- When reasonably requested by an employee or a health and safety inspector.

The methods, equipment and conditions in which the reference and monitoring audiometry tests are carried out is the same. This is outlined in AS/NZS 1269.4, sections 5-8. Temporary and permanent threshold shifts are explained in Section 2.1 *Health Effects of Occupational Noise Exposure*.

E.4 Definition of a Temporary Threshold Shift

When monitoring audiometry is carried out, a temporary threshold shift has occurred if the monitoring audiogram differs from the reference audiogram in the following way:

- A shift in average threshold at 3,000, 4,000 and 6,000 Hz greater than or equal to 5 dB; or
- A shift in mean threshold greater than or equal to 10 dB at 3,000 and 4,000 Hz; or
- A change in mean threshold greater than or equal to 15 dB at 6,000 Hz; or
- A threshold shift greater than or equal to 15 dB at 500, 1,000, 1,500 or 2,000 Hz; or
- A threshold shift greater than or equal to 20 dB at 8,000 Hz.

APPENDIX F: DESIGNERS, MANUFACTURERS AND SUPPLIERS OF PLANT

F.1 Introduction

Regulations 66 and 67 require designers, manufacturers and suppliers of plant to take all practicable steps to ensure that there is no likelihood that the plant will be a cause or source of harm to any person, or to minimise, as far as is practicable, the likelihood that the plant will be such a cause or source of harm. In addition, there are requirements for comprehensive and comprehensible information to be made available with the plant.

"Plant" may be anything from a simple hand tool to a large and complex processing plant that incorporates control rooms and multiple workstations. It also includes such things as amplifying systems as used in discos.

F.2 Designers

The most cost-effective way to reduce noise exposure is at the design stage. It is usually far more expensive to redesign or modify existing plant and workplaces than it is to incorporate noise control measures into the design of the plant and workplace. Designers have an important role and a legal responsibility in ensuring that adequate noise control measures are incorporated into their designs.

It should be noted that, due to the extensive range of possible hazardous noise sources, this code does not specify in detail the measures which should be included at the design stage to control noise emitted by plant. Some general advice, however, is given as follows:

- Designers should ensure that they have a basic understanding of noise control principles, noise specifications and the effects of noise. Experts in the field should be consulted as appropriate.
- If, in normal operation, the plant is likely to expose the operator or other people nearby to a noise hazard, design features should incorporate effective engineering noise controls to reduce noise to as low a level as practicable.
- These features may depend upon several factors including the size and type of plant to be designed, whether the plant is to be custom-made or for general distribution.
- Where plant is to be designed for a particular workplace, designers should:
  - Obtain agreement with the client on goals for noise control and establish a budget, that will allow for effective noise controls, at the design stage.

- Consider the effect of building reverberation, building layout and workstation location on overall noise.
- Consider the transmission of noise through structures and ducts.
- Consider the auditory environment of plant rooms and control rooms at the design stage.
- Design for internal noise and external environmental noise control. Controlling noise at the source will reduce both occupational and community noise exposure.

Designers should ensure that manufacturers receive accurate and complete written instructions, specifications and drawings so that each item of plant can be properly constructed to achieve the design goals for noise.

F.3 Manufacturers and Suppliers

F.3.1 General Duties

Manufacturers and suppliers should ensure that all purchasers of plant are provided with relevant written information regarding noise levels where such levels are likely to give rise to a noise hazard.

This information would typically be compiled by the manufacturer. Suppliers could then obtain this same information from the manufacturer. This information should include:

- Where there are workstations:
  - the $L_{Aeq,T}$ and the L_{peak} at the position(s) of the operator during normal use.
- Where there are no workstations:
  - the highest $L_{Aeq,T}$ and the L_{peak} measured at a distance of 1 metre from the plant and at a height of 1.5 metres from the floor or on any access platforms.
- Sound power level.
- Octave band sound power levels where they are available.
- A summary of the conditions of measurement, which should be representative of normal use adequate to enable the test results to be repeated and reproduced.

Manufacturers and suppliers should provide appropriate and adequate written information on:

- the proper use of the plant;
- methods used to reduce noise when operating the plant;
- noise-reducing attachments which may be available separately;
- any design limitations of the product or special situations where its use would be likely to result in a noise hazard; and
- methods for proper erection and installation of the plant.

Specific guidance for manufacturers, suppliers and employers is given below.

F.3.2 Manufacturers

Manufacturers should make a preliminary assessment of the noise that is likely to be emitted by each new product. The assessment should take into account all reasonably foreseeable ways in which the plant might be used.

Where it is likely that a noise hazard will exist, the product should be reviewed in an attempt to reduce the noise. The methods used to reduce the noise may include:

- Improved manufacturing tolerances;
- The use of more highly damped materials, e.g. nylon gears instead of steel;
- The application of acoustic damping, absorbing or barrier materials as appropriate;
- The redesign of the product to reduce rotational speeds, impacts, vibration, etc; and
- Other relevant noise control methods.

Any changes to the original specifications should be done in consultation with the designer of the product.

Manufacturers should conduct testing programmes on existing products likely to result in a noise hazard when in use. Consideration should be given to using alternative production methods or redesigning to reduce noise.

Manufacturers should put in place a testing programme to assess the potential for noise hazards arising from the use or operation of their product. The assessment should take into account all reasonably foreseeable ways in which the plant might be used. This programme may operate at several levels:

- In-house reviews of existing products or assessment of new products;
- Quality assurance testing on the production line;
- Formal testing of a prototype or production model to specified standards or methods (with the use of expert assistance where appropriate); and
- Noise testing as part of a research and development programme.

The results of noise and sound power measurements collected through the testing programme may form part of the data to be made available to purchasers of plant.

Manufacturers should ensure all purchasers of plant are provided with relevant information regarding noise levels where such noise may give rise to a noise hazard as a result of the proper use or operation of their product.

In some cases, it may not be necessary to test each individual unit of plant. Where each unit is not measured, the average and range of results for different lots of the same model of plant should be made available.

F.3.3 Suppliers

A supplier includes a person who sells second-hand plant or provides plant for use in workplaces on a hire basis.

Suppliers should request from the manufacturers all relevant test data not supplied with the plant. Suppliers should then assess whether a noise hazard is likely to exist as a result of proper use or operation of the plant, and whether further action in either testing or noise reduction is required. The assessment should take into account all reasonably foreseeable ways in which the plant might be used.

Suppliers should ensure that all plant is supplied complete with noise-reducing equipment where this is required.

Suppliers should arrange for noise testing of plant for which no manufacturers' data is available, where it is suspected that the use or operation of the plant may result in a noise hazard. Expert assistance may be needed to establish appropriate test procedures and to conduct the measurements.

Suppliers should provide adequate information on the noise emission as a result of the proper use and operation of the plant.

F.4 Employers

F.4.1 General

Employers should obtain noise information prior to purchasing plant. This can then be used to plan workplaces and systems of work that result in exposure levels lower than the exposure limits.

The sound levels produced in test conditions may be less than those produced when the plant is used at the workplace. Reasons for this include:

- Reflections from walls, floors, etc.;
- Differences in the method of mounting;
- Differences in loading conditions;
- The additive effect of noise from nearby machines.

Specific guidance for employers on the use of the information made available by suppliers is given in F.3.3 of this code.

F.4.2 Application of Information

In considering the information supplied by manufacturers and suppliers of plant, employers should be aware that several factors affect the extent to which tests of sound power and sound power levels may be applied to sound pressure:

- Test conditions and procedures;
- Conditions of load;
- Methods of construction and installation;
- Design and layout of workplace.

An employee's noise exposure is essentially the noise measured at the ear during a representative working day (see AS/NZS 1269.1 for more information). This noise level may vary depending on several factors:

- The position of the employee;
- The type of noise generated (e.g. continuous, tonal, impulsive noise);
- The plant being used and processes carried out;
- The amount of time the equipment is used or the process is carried out;
- Background noise levels due to other equipment or processes that occur in adjacent areas (these can also vary); and
- The length of the work-shift.

An employer should take these factors into account when purchasing equipment. While specific guidance is provided, the advice of a competent person may be needed in some situations.

NOTE: Sound power is not a noise level and cannot be directly compared with the exposure limits. However, a competent person can use sound power to calculate the noise levels generated by a machine in a given situation.

Details of the method used to calculate noise level from sound power are available in Irwin and Graf 1979 (see Bibliography).

F.4.3 Determining Noise Exposure from Information

The test results of sound pressure levels provided by manufacturers and suppliers can, in some cases, be used by the employer to estimate noise exposure. Results on peak noise levels and $L_{Aeq,T}$ measurements in particular, can be used to estimate noise exposure in order to make comparisons with the exposure limits.

L_{peak} The peak noise level measured can be directly compared with the exposure limit of 140 dB (unweighted). The test results should give a reasonable indication of exposure likely to occur during proper use of the plant.

$L_{Aeq,T}$ The $L_{Aeq,T}$ measured can be used to estimate noise exposure by comparison with the $L_{Aeq,8h}$ exposure limit if:

- The plant is operated for the whole shift;
- The operator works an 8-hour day;
- The machine is being used for its proper use.

If this is not the case, the test results need to be modified and adjusted in order to give an estimate of the total noise level when installed (See the procedure for the determination of $L_{Aeq,8h}$ in Appendix E of AS/NZS 1269.1).

Exposure is measured as the noise level at an employee's ear over an 8-hour shift. If the employee is exposed to a noise level for more or less than 8 hours, the noise cannot be directly compared with the exposure limit.

If the time the plant is used and/or the length of the shift differs from 8 hours, then the noise exposure needs to be recalculated. Exposure to other noise sources during the shift should also be allowed for.

Noise levels less than 75 dB(A) will not contribute significantly to harmful exposure and can be ignored.

To estimate an employee's noise exposure so that it can be compared with the $L_{Aeq,8h}$, the following data are needed:

- The noise levels to which the employee is currently exposed;
- The noise level of any new plant the employer is considering purchasing; and
- The time that the employee is exposed to each noise.

The procedures in AS/NZS 1269.1 should be followed to determine the estimate of the employee's daily noise exposure level ($L_{Aeq,8h}$).

F.5 Test Procedures for the Evaluation of Equipment Noise Emission

Where no standard test is available, a new test may need to be developed to obtain noise information to supply to purchasers. The test conditions and procedures should provide a fair and reasonable test of the plant's capacity for generating noise and sound power.

Noise levels and sound power should be measured in the loaded and unloaded conditions. Where plant produces highly variable noise levels in different modes of use, it is necessary to measure noise under several conditions. These measures are necessary to establish the highest noise levels likely to be encountered in proper use and to obtain representative data.

The test should be carried out in an environment of known and reproducible properties. The background level at measurement points should be checked at all relevant frequencies to ensure that it is at least 10 dB below the noise level produced by the plant.

During the test, the plant should be constructed and installed as described in the manufacturers instructions. For example, anti-vibration mounts should only be used when the manufacturer's instructions specify their use.

Where sound power is being tested, the need for a highly controlled environment can be somewhat reduced by using a sound intensity meter. This technique should only be used by competent persons who are able to correctly perform such measurements and achieve consistent and accurate results.

In any event, all testing should always be supervised by a competent person conversant with both the plant being tested and acoustics.

Sound level meters used should be at least Type 1 and comply with IEC 60804 and AS 1259.

Many of the test conditions specified above can often be met by following a relevant and recognised standard, for example, a New Zealand, Australian or international standard.

Where is it necessary to devise a new test procedure, the procedure itself should be tested to ensure:

- That it provides a fair and reasonable test of all potentially noisy components of the machine; and
- That the result is reproducible and repeatable.

APPENDIX G: DESIGNERS, MANUFACTURERS AND SUPPLIERS OF HEARING PROTECTORS

G.1 Introduction

The Health and Safety in Employment Regulations 1995 (Regulations 68 and 69) require designers, manufacturers and suppliers of hearing protectors to take all practicable steps to ensure that the protector(s) will give adequate protection from the noise against which they are intended to protect. In addition, there are requirements for comprehensive and comprehensible information to be made available with the protector(s). Regulation 65 also allows for standards relating to the duties of designers, manufacturers and suppliers of hearing protectors to be recognised by the Occupational Safety and Health Service of the Department of Labour.

The Joint Australian/New Zealand standard AS/NZS 1270:2002 *Acoustics — Hearing protectors* was published on 18 January 2002. Hearing protectors must be type tested to an appropriate Standard. Until the end of October 2001 the appropriate standards are:

- AS 1270:1988 *Acoustics — Hearing protectors*; or
- ISO 4869-1:1990 *Acoustics — Hearing protectors, Part 1: Subjective method for the measurement of sound attenuation*; or

From November 2001 onwards the only acceptable standard will be:

- AS/NZS 1270: 2002 *Acoustics – Hearing protectors* or its successor(s).

NOTE: This cut-off date gives suppliers 2 years to have their protectors type tested to the new Standard. It also then makes older protectors redundant that may have been in occasional use or in store, since they will not then comply with the requirements of the new Standard.

G.2 Designers

It is most important that, at the design stage, a hearing protector is designed in such a way that if it is manufactured to specification, it will give adequate performance and protect against the level of noise to which it was designed. The design should also ensure that it will also maintain that standard of performance for the life of the device. Designers have an important role and a legal responsibility in ensuring that adequate and reliable protection from excessive noise is incorporated into their designs.

G.3 Manufacturers and Suppliers

Manufacturers and suppliers of hearing protectors must have each type of protector tested to an appropriate standard and classified (or graded) according to their effectiveness at reducing noise.

G.3.1 Marking

Manufacturers and suppliers must ensure that each protector is marked (except for earplugs where the information shall be on their storage package container or on a nameplate securely attached thereto) with the following information:

- Name or registered trade name or mark of the manufacturer;
- Product identification or catalogue number; and
- Directions to indicate how the hearing protector has to be worn if it cannot be worn symmetrically, e.g. “top”, “front”.

NOTE: This information will enable a protector to be identified. Hence, it will be capable of being checked for compliance with the relevant Standard.

G.3.2 Information on the packaging

To facilitate selection of an appropriate hearing protector, the following information/statement shall be displayed so that it can be viewed without opening the packaging:

Prior to 30 June 2003

Where type testing has been conducted according to either AS 1270, or ISO 4869:

- The Standard to which the protector has been tested
- The protection grade of the protection.

Where type testing has been conducted according to AS/NZS 1270:2002 the following statement shall be displayed:

- “Hearing protector class X tested to AS/NZS 1270. When selected, used and maintained as specified in AS/NZS 1269, this protector may be used in noise up to Y dB(A) assuming an 85 dB(A) criterion. A lower criterion may require a higher protector class.”

Where X is the class of the protector and Y is the corresponding dB(A) value shown for that class (See Clause 2.3.2 of AS/NZS 1270:2002).

After 1 July 2003

The following statement shall be displayed so that it can be viewed without opening the packaging:

- “Hearing protector class X tested to AS/NZS 1270. When selected, used and maintained as specified in AS/NZS 1269, this protector may be used in noise up to Y dB(A) assuming an 85 dB(A) criterion. A lower criterion may require a higher protector class.”

Where X is the class of the protector and Y is the corresponding dB(A) value shown for that class. (See Clause 2.3.2 of AS/NZS 1270:2002.)

G.3.3 Labelling

The following information should also be provided for the wearer in or on the package in which the protector is supplied:

- Where a range of sizes is offered, the method of selecting the correct size of protector.
- The method of adjusting and fitting the protector.
- Instructions for cleaning and disinfecting the protector, if appropriate.
- Maintenance requirements, if appropriate.
- A list of spare parts available for replacing worn or damaged components.
- For earmuffs, the mass of the protector.
- For earmuffs and ear canal caps, the clamping force as measured in accordance with the relevant Standard.
- A note warning that the reported attenuation will be obtained only if the protector is in good condition and worn as directed.
- For earmuffs, a note warning that noise reduction will be adversely affected by anything that impairs the seal of the earmuff cushions against the head, such as thick spectacle frames, balaclavas, etc., and a note stating that cushions may deteriorate with use and should be renewed regularly.
- Details of the attenuation of the protector measured according to the relevant standard, and expressed as a set of: Mean, standard deviation and mean-minus-standard deviation octave band attenuation values.

To facilitate selection of an appropriate hearing protector, this latter information shall be displayed so that it can be viewed without opening the packaging.

Each packaged pair of earplugs should be accompanied by fitting instructions. The use of diagrams for fitting instruction is recommended.

APPENDIX H: GUIDELINES FOR THE EXPOSURE TO ULTRASOUND AND INFRASOUND

H.1 Ultrasound

Ultrasound is sound that is at a frequency (pitch) too high for humans to hear. It is normally taken to be sound at a frequency above about 20,000 Hz. Ultrasound is used in a number of industrial processes including: cleaning, drilling, welding plastics, mixing and emulsification. It is also used in hospitals for medical procedures such as the breaking up of gallstones.

Guidance on levels under which it is believed nearly all workers may be repeatedly exposed without adverse effects are described in publications of the American Conference of Governmental Industrial Hygienists (ACGIH 1989, see Bibliography).

H.2 Infrasound

Infrasound is sound that is at a frequency too low for humans to hear, though if it is at a sufficiently high level, it can often be felt (i.e. not perceived by the hearing mechanism). It is normally taken to be sound at a frequency below about 20 Hz. Airborne infrasound is generated by several processes including high-powered aircraft and rocket propulsion systems, explosions, sonic booms, bridge vibration and some air heating/cooling equipment. At present there are no standards set for infrasound. Guidance on levels under which it is believed nearly all workers may be repeatedly exposed without adverse effects are described in Von Gierke and Nixon 1976 and Woodson 1981 (see Bibliography).

APPENDIX I: DEFINITIONS

The definitions of the terms used in this code are stated in the relevant parts of AS/NZS 1269. Some terms not defined in AS/NZS 1269 together with the more frequently used ones are stated below:

Acoustic calibrator means a device for applying a sound pressure of known level to the microphone of a sound measuring system for the purpose of field reference level setting (calibration checking).

Act means the Health and Safety in Employment Act 1992.

Administrative control means management or location of a job that reduces noise exposure but does not include engineering controls or the use of personal hearing protectors.

Attenuation means a reduction in the level of sound.

Audiometry means the measurement of the hearing threshold level of a person by means of a bilateral pure tone air conduction threshold test.

A-weighting means the A-frequency weighting specified in the International Standard IEC 60651. (Note: A-frequency weighting is used because it approximates the response of the human ear.)

Competent person means a person who, through a combination of training, education and experience, has acquired appropriate and adequate knowledge and skills enabling that person to correctly perform a specified task and achieve consistent and accurate results.

NOTE: An employer may choose to employ or engage a competent person. Alternatively, the employer may arrange for an existing employee to gain competence by the means described above.

dB an abbreviation for decibel (see decibel).

dB(A) means A-weighted decibel. The A-weighting is that specified in the International Standard IEC 60651.

dB(C) means a C-weighted decibel. The C-weighting is that specified in the International Standard IEC 60651.

Decibel is a dimensionless unit used to compare the magnitudes of sound pressure squared. It is used as a measure of the level of sound above a reference value being approximately the quietest sound that a person can hear.

Engineering controls means any engineering procedure that reduces the sound level either at the source of the noise or in its transmission but does not include the use of any hearing protector.

Exposure limit means an exposure to noise greater than either $L_{Aeq,8h}$ 85 dB(A) (1 Pa^2h) or L_{peak} 140 dB.

Hearing protector means a device or pair of devices that have been tested to an appropriate national or international standard and classified (or graded) by a suitably equipped and independently audited laboratory with full trace ability to National Standards. Such a device is worn by a person or inserted in the ears of a person to protect that person from exposure to noise.

Impulse noise means noise consisting of a single pressure peak, or a sequence of such peaks, or a single burst with multiple pressure peaks, or a sequence of such bursts.

$L_{Aeq,T}$ means the equivalent continuous A-weighted sound pressure level in decibels and is the value of the steady continuous A-frequency weighted sound pressure level that, within a measurement time interval, *T*, has the same mean square sound pressure as the sound under consideration whose level varies with time during the interval, *T*. The time interval for every $L_{Aeq,T}$ measurement should be stated.

It is the average level of noise over a specified period of time, *T*.

$L_{Aeq,8h}$ means the eight-hour equivalent continuous A-weighted sound pressure level in decibels referenced to 20 mPa, is that steady sound pressure level which would, in the course of an eight hour period, deliver the same A-frequency weighted sound energy as that due to the actual noise on any particular representative working day.

It is the average level of noise to which a person is exposed, averaged out over a period of 8 hours.

NOTE: $L_{Aeq,8h}$ is the same as $L_{EX,8h}$

L_{peak} means the highest unweighted (linear) peak sound pressure level in decibels, and is ten times the logarithm, to the base ten, of the ratio of the square of the maximum instantaneous sound pressure to the square of the reference sound pressure (20 micropascals). It is determined by sound measuring equipment with "P" time-weighting, as specified in the International Standard IEC 60651.

NOTE: The maximum instantaneous sound pressure level (L_{peak}) is not the same as the maximum rms level (L_{max}).

Monitoring audiometry means audiometry carried out under methods specified in AS 1269:1989 or AS/NZS 1269.4:1998 where the audiometry is carried out into a work shift.

Noise means any sound which is present in the place of work whether it is wanted or not wanted, and includes sound energy of any frequency, whether or not capable of being perceived by the unaided human ear.

Noise exposure means the amount of sound energy a person is exposed to during a representative day and is stated as the $L_{Aeq,8h}$ in dB(A) or in pascal-squared hours.

Noise exposure level is the $L_{Aeq,8h}$ and is a measure of the level of noise exposure of a person.

Pascal-squared hours (Pa^2h) is a measure of the exposure of a person. It is an alternative means of stating how much noise to which a person has been exposed. A noise exposure level of 85 dB(A) is the same as 1 Pa^2h.

Plant has the same meaning as that in section 2(1) of the Health and Safety in Employment Act 1992 and that in the Health and Safety in Employment Regulations 1995.

Reference audiometry means audiometry carried out under methods specified in AS 1269:1989 or AS/NZS 1269.4:1998 where the audiometry is carried out after 16 hours of quiet.

Regulations means the Health and Safety in Employment Regulations 1995.

Sound power level means the total sound energy radiated per unit time, measured in decibels referenced to 1 picowatt using octave bands or A-weighting.

Supply (supplier) in relation to any plant, includes any person who sells or hires any plant or offers any plant for sale or hire. In relation to hearing protectors, it includes any person who sells or hires any hearing protectors or offers any hearing protector for sale or hire.

Tonal noise means noise that produces a definite pitch sensation in a listener.

Unweighted sound pressure levels are measured using an instrument that responds equally to all frequencies, i.e. it has a flat or linear frequency response. These measurements are identified by units of dB or dB(Linear).

Workplace has the same meaning as a 'place of work' in section 2(1) of the Health and Safety in Employment Act 1992.

APPENDIX J: BIBLIOGRAPHY

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IEC 60225	*Octave, half-octave and third-octave band filters intended for the analysis of sounds and vibrations*
IEC 60804	*Integrating-averaging sound level meters*
IEC 942:1988	*Sound calibrators*
IEC 1252:1993	*Electroacoustics — Specifications for personal sound exposure meters*
ISO 1999:1990	*Acoustics — Determination of occupational noise exposure and estimation of noise-induced hearing impairment*
ISO 2631:1997	*Mechanical vibration and shock — Evaluation of human exposure to whole-body vibration — Part 1: General Requirements*
ISO 2631:1989	*Evaluation of human exposure to whole-body vibration — Part 2: Continuous and shick-induced vibration in buildings (1 to 80 Hz)*
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ISO 6189:1983	*Acoustics — Pure tone air conduction threshold audiometry for hearing conservation purposes*
BS 6841:1987	*Measurement and evaluation of human exposure to whole-body mechanical vibration and repeated shock*
AS 1081:1990	*Acoustics — Measurement of airborne noise emitted by rotating electrical machinery*
AS 1217:1985	*Acoustics — Determination of sound power levels of noise sources* (Parts 1-7)
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AS/NZS 2399:1998	*Acoustics — Specification for personal exposure meters*