



# CODE OF PRACTICE

# MANAGING NOISE

# AT WORKPLACES

2 0 0 2



ELIMINATION



SUBSTITUTION



SOURCE CONTROL



TRANSMISSION  
CONTROL



LAYOUT

# FOREWORD

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*The Occupational Safety and Health Act 1984* established the WorkSafe Western Australia Commission which comprises representatives of employers, unions, government and experts. The Commission has the function of developing the legislation and supporting guidance material and making recommendations to the Minister for implementation. To fulfil its functions the Commission is empowered to establish advisory committees, hold public enquiries and publish and disseminate information.

The Commission's objective is to promote comprehensive and practical preventive strategies that improve the working environment of Western Australians.

This code of practice has been developed through this tripartite consultative process and the views of employers and unions along with those of government have been considered.

The following information should be read by employers, self-employed persons, managers, supervisors, and employees as background for understanding this code of practice.

## THE ACT

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*The Occupational Safety and Health Act 1984* provides for the promotion, co-ordination, administration and enforcement of occupational safety and health in Western Australia.

With the objective of preventing occupational injuries and diseases, the Act places certain duties on employers, employees, self-employed persons, manufacturers, designers, importers and suppliers.

In addition to the broad duties established by the Act, it is supported by a further tier of statute, commonly referred to as regulations, together with lower tiers of non-statutory codes of practice and guidance notes.

## Regulations

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Regulations have the effect of spelling out the specific requirements of the legislation.

Regulations may prescribe minimum standards. They may have a general application or they may define specific requirements related to a particular hazard or a particular type of work.

Regulations may also be for the licensing or granting of approvals, certificates, etc.

## Codes of Practice

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A code of practice is defined in the Act as a document prepared for the purpose of providing practical guidance on acceptable ways of achieving compliance with statutory duties and regulatory requirements.

Codes of practice:

- should be followed, unless there is another solution which achieves the same or better result; and
- can be used to support prosecution for non-compliance.

## Guidance Notes

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A guidance note is an explanatory document issued by the Commission providing detailed information on the requirements of legislation, regulations, standards, codes of practice or matters relating to occupational safety and health.

## DEFINITIONS

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Appendix 1 defines some of the terms used in this code of practice.

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CODE OF PRACTICE

# MANAGING NOISE

# AT WORKPLACES

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2 0 0 2

WorkSafe  
Western  
Australia  
COMMISSION

## AUTHORITY

This code of practice was approved by the Minister pursuant to Section 57 of the *Occupational Safety and Health Act 1984* on 19 March 2002. This code replaces the *National Code of Practice for Noise Management and Protection of Hearing at Work [NOHSC:2009(1993)]* as an approved code of practice. The approval of 13 November 1996 was revoked by the Minister on 19 March 2002.

## SCOPE

This code of practice applies to all workplaces in Western Australia covered by the *Occupational Safety and Health Act 1984* where excessive noise may exist. This code provides practical guidance for the management of noise which may be damaging to the hearing of people in workplaces. The approved code of practice *Control of Noise in the Music Entertainment Industry* provides additional information on controlling noise in that industry.

## WHO SHOULD USE THIS CODE OF PRACTICE?

This code should be used by all persons involved with workplaces where noise may be excessive, including employers, contractors, employees, self-employed persons, safety and health representatives, designers, manufacturers, importers and suppliers of plant.

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# 1. INTRODUCTION

## 1.1 EFFECTS OF NOISE

Noise at the workplace is a major cause of deafness in Western Australia.

Not only does workplace noise cause deafness, it can lead to increased absenteeism and employee turnover, as well as lowered work performance. It can also contribute to workplace injuries and accidents.

Occupational noise-induced hearing loss (NIHL) is a major compensable industrial disease that entails substantial economic costs.

Noise-induced hearing loss cannot be reversed or cured. People suffering from NIHL often have communication and personal relationship difficulties. They may face social isolation and reduced quality of life. Family and friends are often affected.

Hearing aids are of limited benefit. Twenty per cent of people affected by NIHL also suffer from tinnitus or ringing in the ears, some severely.

## 1.2 EXCESSIVE NOISE

Long periods of repeated exposure to workplace noise between 75 and 85 dB(A) (decibels) present a small risk of hearing disability to some people. As noise levels increase, so does the risk. Above 85 dB(A) the risk increases substantially.

Excessive noise means noise that exceeds the exposure standard for noise set in the *Occupational Safety and Health Regulations* or by the workplace's noise control policy, whichever is the lower.

*See Appendix 3  
Regulation 3.45*

The exposure standard for noise set in the *Occupational Safety and Health Regulations* is:

- a daily noise exposure level,  $L_{Aeq,8h}$  of 85 dB(A); or
- a peak noise level,  $L_{C,peak}$  of 140 dB(C)

measured at the position of the person's ear without taking into account any protection which may be provided to the person by personal hearing protectors.

An  $L_{Aeq,8h}$  of 85 dB(A) means that the actual energy of varying noise levels experienced by a person over the working day is equivalent to the energy from 8 hours of exposure to a constant noise level of 85 decibels.

The table below shows a range of noise levels and exposure times that are all equal to an  $L_{Aeq,8h}$  of 85 dB(A).

| Noise Level dB(A) | Exposure Time         |
|-------------------|-----------------------|
| 85                | 8 hours               |
| 88                | 4 hours               |
| 91                | 2 hours               |
| 94                | 1 hour                |
| 97                | 30 mins               |
| 100               | 15 mins               |
| 103               | 7 <sup>1/2</sup> mins |

The 85 dB(A) exposure standard for noise in Western Australia is legally the maximum acceptable exposure level for noise at the workplace. Workplace noise exposure levels therefore must not exceed 85 dB(A), and should be kept below that level where practicable.

Peak noise levels,  $L_{C,peak}$ , above 140 dB(C) can cause immediate hearing damage from a single event and must therefore be avoided.

## 2. GENERAL PRINCIPLES

**2.1** This code of practice provides a framework for managing exposure to noise at work and for minimising the risk of noise-induced hearing loss. It also provides guidance to help employers, employees and self employed people to understand and comply with the *Occupational Safety and Health Act 1984* and *Occupational Safety and Health Regulations 1996* as they relate to noise.

### OBJECTIVES

**2.2** The objectives of this code of practice are to promote:

- (a) engineering noise control measures as the main approach to reducing and managing noise levels at work;
- (b) recognition and understanding of the effects of workplace exposure to noise;
- (c) adoption of a systematic approach to reducing and managing exposure to excessive noise; and
- (d) the reduction and management of exposure to excessive noise through consultation between employer and employees.

### STRATEGIES

**2.3** The most effective way of controlling exposure to workplace noise is through reduction of noise at its source.

**2.4** A comprehensive approach should be adopted using hazard identification, risk assessment and risk control. Measures could include equipment and job redesign and training.

### CONSULTATION

**2.5** Consultation and cooperation between employers, employees and safety and health representative(s) is essential. This should include free exchange of information on workplace noise, NIHL and safety and health.

**2.6** This code of practice should be implemented by employers in consultation with employees and safety and health representative(s).

**2.7** Where they exist, occupational safety and health committees or representatives should review all existing processes involving exposure to excessive noise, and participate in developing programs for equipment and job redesign. Changes in workplace or job design should occur only after full consultation with employees and safety and health representative(s) through established consultative processes.

*See Appendix 3  
The Act (s. 19(1)(c))*

## EMPLOYERS' RESPONSIBILITIES

*See Appendix 3  
The Act (s. 19(1))*

- 2.8** The employer has prime responsibility for ensuring that a safe working environment is established, and safe work practices are implemented and maintained. Employers should ensure that:
  - (a) statutory requirements are complied with;
  - (b) a noise control policy and action program are developed;
  - (c) all levels of management and employees are aware of the control measures to reduce exposure to noise;
  - (d) all employees and contractors are encouraged to cooperate in using agreed safe work practices;
  - (e) information on noise, the risks of exposure to noise and the appropriate control measures are communicated in a way appropriate to the workplace;
  - (f) a comprehensive personal hearing protection program is implemented, including selection of personal hearing protectors and instruction in their correct use and maintenance; and
  - (g) employees receive appropriate training when it is required.
- 2.9** Employers should recognise the supervisor's role in workplace noise management and hearing protection and there should be close liaison between supervisors and employees.

## EMPLOYEES' RESPONSIBILITIES

*See Appendix 3  
The Act (s. 20)*

- 2.10** Employees should take reasonable care to ensure their own safety and health in relation to workplace noise, and avoid adversely affecting the hearing or safety and health of others. They should comply as far as they are reasonably capable with safety and health instructions given by their employer relating to noise management and hearing protection.

## SELF-EMPLOYED PERSONS' RESPONSIBILITIES

*See Appendix 3  
The Act (s. 21(1))*

- 2.11** Employers and self-employed people should take reasonable care to ensure their own safety and health in relation to workplace noise and avoid adversely affecting the hearing or safety and health of others.

## DUTIES OF MANUFACTURERS, IMPORTERS AND SUPPLIERS OF PLANT

*See Appendix 3  
The Act (s. 23(1)(a))*

- 2.12** Manufacturers, importers and suppliers should ensure that plant is designed and constructed so that its noise emission is as low as practicable when properly installed and used. Where necessary, research and development work should be carried out to reduce noise emission.

**2.13** In deciding whether plant is likely to require noise reduction, manufacturers, importers and suppliers should take into account the range of uses for which it is sold, available information on likely workplace conditions and ways the plant is likely to be used.

**2.14** If operating the plant is likely to create a noise hazard, the manufacturer, importer or supplier should ensure adequate information is made available to the employer, if possible prior to the supply of the plant, about:

- (a) its noise emission; and
- (b) means of installation, maintenance and use that will enable the plant to generate the lowest practicable noise levels.

**2.15** Guidance for manufacturers, importers and suppliers on how to present information on plant noise levels is provided in Appendix 2.

*See Appendix 3  
The Act  
(s. 23(1)(b) & (c))*

## PROVIDING INFORMATION

**2.16** Information should be provided by the employer, taking language and literacy into account, to familiarise employees with:

- (a) what noise is;
- (b) range of health effects due to noise;
- (c) social handicaps of noise-induced hearing loss and tinnitus;
- (d) exposures to noise in their particular workplace;
- (e) reasons for, and nature of, the general noise control measures used to protect employees and others who might be affected;
- (f) specific control measures necessary for each employee's job. These may include instruction in correct use and maintenance of noise control equipment and correct operating methods for minimising noise levels;
- (g) noise control policy, action program and a timetable for future improvements;
- (h) arrangements for reporting defects likely to cause excessive noise;
- (i) when and how to use personal hearing protectors provided and their proper care and maintenance; and
- (j) statutory responsibilities of employers, employees and self-employed persons.

*See Appendix 3  
The Act (s. 19(1)(b))*

# 3. NOISE CONTROL PLANNING

**3.1** Where excessive noise may exist the employer, in consultation with employees and safety and health representative(s), should develop a written noise control policy and action program to implement noise control and manage exposure to noise. Copies of the policy and action program should be available to all employees and safety and health representative(s) on request, and form a basic part of the information, induction and training activities.

## POLICY

**3.2** A noise control policy should set goals for workplace peak noise and daily noise exposure levels and strategies by which to achieve them.

**3.3** The policy should be reviewed at appropriate intervals and updated as necessary.

**3.4** A workplace noise control policy should cover the following issues, where applicable:

- (a) goals for daily noise exposure levels and peak noise levels in existing work areas;
- (b) design goals for new work areas (both for the building and plant);
- (c) the selection and purchase of quiet plant;
- (d) noise controls in temporary work areas and situations;
- (e) agreements with contractors in terms of responsibilities for noise control and provision of information on noisy processes;
- (f) audiometric (hearing) testing and availability of records;
- (g) funding for the noise control program; and
- (h) period of review for the noise control program.

## ACTION PROGRAM

**3.5** Steps in the program should be implemented in agreed timeframes. Steps should include the following:

- (a) assign a management person overall responsibility for implementing and monitoring the program;
- (b) conduct a preliminary noise check to determine whether problems with exposure to noise are likely to exist;
- (c) decide the type and detail of assessments to be carried out, the intervals between them and the persons carrying them out;
- (d) develop a program for selecting new or replacement plant that can minimise exposure to noise;

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See Appendix 3  
Regulation 3.1(a)

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See Appendix 3  
Regulation 3.1(b)

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See Appendix 3  
Regulation 3.1(c)

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- (e) decide whether or not engineering noise control measures are practicable and what priorities should be given to different noisy situations;
- (f) decide on suitable administrative noise control measures;
- (g) select, provide and maintain suitable personal hearing protectors;
- (h) identify, with the use of appropriate signs, hearing protection areas;
- (i) provide on-going training to employees;
- (j) provide voluntary audiometric (hearing) testing;
- (k) develop monitoring procedures that include the following:
  - (i) checking noise control measures such as silencers or enclosures, are maintained in good order and in position during the operation of noisy machines;
  - (ii) checking the noise level where necessary to ensure hidden defects are not causing high exposure to noise;
  - (iii) monitoring the use of personal hearing protectors; and
  - (iv) checking hearing protectors are maintained in good condition; and
- (l) maintaining relevant records and making them available. (The records should be easily understood by those likely to be exposed.)

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*See Appendix 3  
Regulation 3.46*

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*See Appendix 3  
Regulation 3.47*

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*Regulation 3.34(1)*

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*The Act (s. 19(1)(b))*

# 4. NOISE IDENTIFICATION AND ASSESSMENT

## NOISE IDENTIFICATION

*See Appendix 3  
Regulation 3.1(a)*

- 4.1** Identification of noise hazards in a workplace enables people who may be exposed to excessive noise to be identified so that their exposures can be assessed. It also enables situations where immediate control measures are possible to be recognised and acted on and provides information for the person carrying out the detailed assessment.
- 4.2** No special skills are needed to conduct noise identification, but it should be done in consultation with those who understand the work processes, affected employees and their safety and health representative(s). One way is to conduct a walkthrough of the workplace, identifying noisy processes and tasks. As an informal guide, when a raised voice is needed to communicate with someone about one metre away, a workplace noise assessment is needed. Other information can be gathered from plant manufacturers and suppliers. (See Appendix 2)
- 4.3** A noise identification checklist is provided in Appendix 4 to help with the process.

## NOISE ASSESSMENT

*See Appendix 3  
Regulation 3.1(b)*

- 4.4** All workplaces where it is identified that people may be exposed to noise exceeding the exposure standard for noise should be assessed, unless the exposure to noise can be reduced below the standard immediately. Workplaces where exposure is marginally below the standard should be re-assessed whenever any changes are made that may increase exposure.

## OBJECTIVES

- 4.5** The type and detail of assessments needed will depend on how the information will be used. The general objectives of noise assessments are to:
  - (a)** Identify all people likely to be exposed to noise above the exposure standard for noise. This will involve the evaluation of  $L_{Aeq,8h}$  and measurements of peak noise levels where relevant.
  - (b)** Obtain information on noise sources and work practices that will help employers decide what measures should be taken to reduce noise.
  - (c)** Check the effectiveness of measures taken to reduce exposure to noise. (Provided a baseline has been established in a more comprehensive assessment, it might be possible to restrict such surveys to measurement of noise levels at a few defined positions and under a restricted range of working or loading conditions of the equipment involved.)

- (d) Help in the selection of appropriate personal hearing protectors.
- (e) Delineate hearing protection areas.

**4.6** The detail and accuracy needed will depend on individual circumstances.

**4.7** Time intervals between noise assessments should be determined by management in consultation with employees through established consultative processes. Assessment should be repeated at intervals not exceeding five years or whenever there is:

- (a) installation or removal of machinery likely to cause a significant change in noise levels;
- (b) a change in workload or equipment operating conditions likely to cause a significant change in noise levels;
- (c) a change in building structure likely to affect noise levels; or
- (d) modification of working arrangements affecting the length of time people spend in noisy workplaces.

**4.8** Noise assessment records should be made in a consistent format and, where practicable, kept at or near the premises where they apply. Where this is not practicable, for example, because of the itinerant nature of the work, such as construction work, the records should be kept available at a designated office. Assessment records should be made available to management, safety and health representative(s) and relevant authorities.

## HOW TO CARRY OUT A NOISE ASSESSMENT

**4.9** A noise assessment may be simple or quite complex, depending on the type of workplace, the number of people in the workplace and the noise information already available.

**4.10** When no prior information is available, an assessment is made to establish if exposure to noise is acceptable or not.

**4.11** In some cases, more complex measurements are required in order to determine exposure to noise with acceptable accuracy, or for the selection of personal hearing protectors. For example, octave band analysis of the noise may be desirable if it contains intense tonal, high frequency or low frequency components.

**4.12** More detailed guidance on noise measurement and recording is available in Part 1 of Australian/New Zealand Standard AS/NZS 1269<sup>1</sup>.

**4.13** People employed to carry out a noise assessment should meet the competency requirements in Appendix A of Part 1 of Australian/New Zealand Standard AS/NZS 1269<sup>1</sup>. Organisations offering noise assessment services are listed in the Directory on the WorkSafe internet site ([www.safetyline.wa.gov.au/sub30.htm](http://www.safetyline.wa.gov.au/sub30.htm)).

## INSTRUMENTS

**4.14** Sound level meters (SLM) have four principal grades of precision:

| Type/Description               | Tolerance          |
|--------------------------------|--------------------|
| 0 – Laboratory reference meter | $\pm 0.4\text{dB}$ |
| 1 – Precision                  | $\pm 0.7\text{dB}$ |
| 2 – General purpose            | $\pm 1.0\text{dB}$ |
| 3 – Survey                     | $\pm 1.5\text{dB}$ |

**4.15** Noise assessments should be performed with Type 2 general purpose meters, or better. Type 3 survey meters are usually inexpensive but may have wide precision tolerances and some models cannot be calibrated. Type 3 survey meters are only suitable for preliminary noise checks to find out whether more accurate assessments are needed.

**4.16** The sound level meter may be equipped with an integrating/averaging function that enables the meter to process a continuous, variable, intermittent or impulsive signal to give a single integrated level or  $L_{\text{eq}}$  for the sampling period. A meter with this function is an integrating/averaging sound level meter (ISLM).

**4.17** The sound level meter may have a peak detector-indicating characteristic. This is necessary to measure the C-weighted peak noise level. The C-weighted peak noise level should not be confused with the maximum sound pressure level.

**4.18** Sound exposure meters (SEM), or noise dosimeters, can be worn by people for a given period, for example, a working day. The SEM records the personal daily noise exposure levels of the person. Some SEMs are capable of recording a time-history of a person's noise exposure level for the measurement period. A typical time-history report will provide a histogram of minute by minute noise exposure levels. This is a great advantage in identifying major contributors to the daily noise exposure level that can then be further investigated with a hand-held meter.

**4.19** The following points should be considered when using a SEM:

- Reflection of sound from the clothes and body can cause an increase of about 1-3 dB.
- The microphone should be attached as close as possible to the ear. Other inappropriate positioning of the microphone may give higher or lower results. For example, if the microphone is attached to the lower part of the collar or pocket, it may be much closer to a noise source than the ear and an unduly high result will be recorded. Also, the body may shield a noise source.
- The assessment of exposure over just one day may not give a representative sample. If possible, it is best to take measurements over a few days.
- It is advisable to check the SEM results with a hand-held sound level meter.
- Some SEMs do not measure impulse sound adequately.

**4.20** Sound exposure meters should comply with Australian/New Zealand Standard AS/NZS 2399<sup>2</sup>.

- 4.21** All SLMs and ISLMs should comply with the specifications laid down in Australian Standards AS 1259.1<sup>3</sup> and AS 1259.2<sup>4</sup> respectively. Octave band filters should comply with the specifications laid down in Australian/New Zealand Standard AS/NZS 4476<sup>5</sup>.
- 4.22** A full calibration of measuring systems should be performed at regular intervals not exceeding two years by a laboratory that produces calibration test reports recognised by the National Association of Testing Authorities, Australia, covering the relevant accredited tests.
- 4.23** Meters should be checked with an acoustic calibrator immediately before and after the measurements.

# 5. NOISE CONTROL MEASURES

## NEW PLANT AND NEW WORKPLACES

See Appendix 3  
Regulation 3.46

- 5.1 Purchasing new plant, designing an area for new plant to be installed or designing a new workplace all provide opportunities for cost-effective noise control measures.
- 5.2 Invitations to new plant tenderers should specify a maximum acceptable level of noise emission. If plant is purchased directly, without tender, noise emission data should be obtained from suppliers to enable selection of plant with the lowest practicable noise level. Guidance for plant manufacturers, importers and suppliers on the presentation of information about noise levels is provided in Appendix 2.
- 5.3 For guidance on interpreting suppliers' noise emission data, employers purchasing new plant can refer to the section 'Using Suppliers' Noise Information' in Module 8 'Buy Quiet' of the NOHSC publication *Noise Management at Work: Control Guide [NOHSC:12004(1991)]*<sup>6</sup>.
- 5.4 New workplaces, and installation sites for new plant in existing workplaces, should be designed and constructed to ensure that exposure to noise is as low as practicable.
- 5.5 If new plant is likely to expose people in the workplace to excessive noise, design features should incorporate effective engineering noise control measures to reduce noise to as low a level as practicable.
- 5.6 Where plant is to be designed for a particular workplace, designers should:
  - (a) obtain agreement with the client on goals for noise, be aware of the noise control policy for that workplace and establish a budget that will allow for effective noise controls at the design stage;
  - (b) consider the effect on overall noise levels of building reverberation, the building layout and the location of workstations relative to plant;
  - (c) consider the transmission of noise through structures and ducts;
  - (d) design for acoustical plant rooms and control rooms where appropriate; and
  - (e) design acoustic treatments for external environmental control in a way that will reduce internal noise and vice versa.

## EXISTING PLANT AND EXISTING WORKPLACES

See Appendix 3  
Regulation 3.46

- 5.7 Once a noise assessment has been carried out and the need to reduce exposure to noise is established, the task of controlling noise can be addressed. Priority should be given to noise sources that expose people to peak noise levels above the 140 decibel standard and to those that contribute to the highest exposures affecting the largest number of people. Daily noise exposure levels should be reduced to, or below, the 85 decibel exposure standard for noise whenever practicable. Even if the exposure standard cannot be met, any practicable reduction in noise levels should be carried

out. The need for noise control should be taken into account when deciding on production methods or processes. There are two basic engineering noise control measures for controlling noise levels:

- engineering treatment of the source; and
- engineering treatment of the noise transmission path (including enclosure of the operator).

For guidance on comparing the effectiveness and cost of various noise control measures, refer to Module 9 'Evaluating Options' in the NOHSC publication *Noise Management at Work: Control Guide [NOHSC:12004(1991)]*<sup>6</sup>. For guidance on using in-house resources for noise control work, especially in the course of plant maintenance and modification, refer to Module 3 'In-house Control' in the same publication.

## ENGINEERING TREATMENT OF THE SOURCE

**5.8** Engineering treatment of the source is the preferred method of permanently removing the problem of excessive workplace noise due to machinery or processes. Since all noise-emitting objects generate airborne energy (noise) and structure-borne energy (vibrations), the treatment of these noise problems may require modification, partial redesign or replacement of the noise-emitting object. Subjective inspection or acoustical measurement of the device can identify how and where the noise is generated. Some problems can be solved by relatively inexpensive and simple procedures, although some are difficult. Advice from specialists may help achieve the best results. This code of practice refers to some of the simpler noise control methods recommended for workplaces.

**5.9** When seeking to treat noise at the source, it is necessary to understand how a machine or process works. Engineering noise control measures can be targeted at the machine and its parts, or towards the processes, including material handling systems.

**5.10** Noise control solutions, including examples of engineering changes to machinery are provided below:

- (a) Eliminate or replace the machine or its operation by a quieter operation with equal or better efficiency, for example, by replacing rivets with welds.
- (b) Replace noisy machinery with newer equipment designed to operate at lower noise levels. Machinery power sources and transmissions can be designed to give quiet speed regulation, for example, by using stepless electric motors. Vibration sources can be isolated and treated within the machine. Cover panels and inspection hatches on machines should be stiff and well damped. Cooling fins can be designed to reduce the need for forced airflow and hence fan noise.
- (c) Correct the specific noise source with minor design changes. For example, avoid metal-to-metal contact by using plastic bumpers, or replace noisy drives with quieter types or use improved gears.
- (d) A high standard of plant and equipment maintenance should be provided to enable compliance with the exposure standard for noise and reduce noise levels to as low as practicable. 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. Plant and equipment resulting in excessive noise levels should be repaired immediately.

- (e) Correct specific machine elements causing the noise rather than considering the entire machine as a noise source. Consider 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 of free jets.
- (f) Separate noisy elements that may not be necessary as part of the machine. For example, move pumps, fans and air compressors that service the basic machine.
- (g) Isolate vibrating machine parts to reduce noise from vibrating panels or guards.

**5.11** In addition to engineering changes to machinery and parts, processes can be modified to reduce noise. Modification may include for example processes that are inherently quieter, such as mechanical pressing rather than drop forging. Metal-to-metal impact should be avoided or reduced, where possible, and vibration of machine or process material surfaces suppressed. This can be achieved, for example, by choosing more suitable materials, by applying adequate stiffness and damping or by careful dynamic balancing where high speed rotation is used.

**5.12** Material handling processes, can be modified to minimise impact and shock during handling and transport by:

- (a) minimising fall height of items on hard surfaces, eg onto tables or into containers;
- (b) fixing damping materials to, or stiffening, tables, walls, panels or containers that are struck by materials or items during processing;
- (c) absorbing shocks with wear resistant rubber or plastic coatings;
- (d) using conveyer belts rather than rollers, which are more likely to rattle; and
- (e) controlling processing speeds to match desired production rates, thereby obtaining a much smoother workflow and reducing noise generation from stop-start impacts.

## ENGINEERING TREATMENT OF THE NOISE TRANSMISSION PATH

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

**5.14** Engineering treatment of the noise transmission path includes 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 acoustically treating the area to reduce noise to the lowest practicable levels.

**5.15** Alternatively, it may be desirable to protect the operator(s) instead of enclosing the noise sources. In this case, design of noise reducing enclosures should follow the same principles.

**5.16** The principles to be observed in applying engineering treatment to the noise transmission path are listed below:

- (a) Distance is often the cheapest solution, but it may not be effective in reverberant conditions.

- (b) Erect a noise barrier between the noise source and the listener, in some instances a partial barrier 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.
- (c) Once the acoustical barrier is erected, further treatment, such as the addition of absorbing material on surfaces facing the noise source, may be necessary.
- (d) Materials that 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.
- (e) Good sound absorbers, for example, certain polyurethane foams, fibreglass, rockwool and thick pile carpet, are very poor barriers to the transmission of sound.
- (f) Walls and machine enclosures must be designed to minimise resonances that will transmit acoustical energy at the resonant frequency to the protected area. This can be achieved by placing reinforcement or bracing in strategic areas during construction or modification.
- (g) Reduce, as far as possible, reverberation of a room where noise is generated by introducing acoustically absorbent material(s). The presence of reverberation in a room shows the need for absorbing material. Excessive reverberation produces unpleasant and noisy conditions that can interfere with speech communication.

**Note:** Reducing the reverberation of a room is unlikely to significantly reduce the noise exposure level (i.e. by more than 1 dB(A)) of people close to noisy machines.

**5.17** These principles can be applied by:

- (a) using a noise-reducing enclosure that fully encloses the machine(s);
- (b) separating the noisy area from the area to be quietened with a noise-reducing partition;
- (c) using sound-absorbing material on floors, ceilings and/or walls to reduce the noise level due to reverberation; and
- (d) using acoustical silencers in intake and exhaust systems associated with gaseous flow activity, for example, internal combustion engine exhaust systems or air conditioning systems.

## INSPECTION AND MAINTENANCE OF CONTROLS

**5.18** A system should be established to ensure regular inspection and maintenance of vibration mountings, impact absorbers, gaskets, seals, silencers, barriers, absorptive materials and other equipment used to control noise.

## FURTHER GUIDANCE

**5.19** More detailed guidance on engineering noise control in new and existing workplaces is available in Part 2 of Australian/New Zealand Standard AS/NZS 1269<sup>1</sup>.

## 6. ADMINISTRATIVE NOISE CONTROL MEASURES

*See Appendix 3  
Regulation 3.46*

- 6.1** Where it is not practicable to comply with the exposure standard for noise solely through engineering noise control measures, administrative noise control measures may also be used. These measures reduce the noise to which a person is exposed by means of work arrangements, including -
  - (a) organising schedules so that noisy work is done when as few people as possible are present;
  - (b) notifying people in advance when noisy work is to be carried out so they can limit their exposure to it;
  - (c) keeping people out of noisy areas if their job does not require them to be there;
  - (d) sign posting noisy areas;
  - (e) providing quiet rest areas for food and rest breaks; and
  - (f) limiting the time employees spend in noisy areas by moving them to quiet work before their daily noise exposure becomes excessive.
- 6.2** If administrative controls are relied on, there should be regular checks to ensure that they are fully and correctly complied with.
- 6.3** More detailed guidance on administrative noise control is available in Part 2 of Australian/New Zealand Standard AS/NZS 1269<sup>1</sup>.

# 7. PERSONAL HEARING PROTECTORS

7.1 When engineering and administrative noise control measures do not reduce the workplace exposure to noise to or below the exposure standard for noise people should be supplied with, and wear, effective personal hearing protectors.

7.2 Personal hearing protectors should not be used when noise control by engineering or administrative noise control measures is practicable. They should normally be regarded as an interim measure while control of excessive noise is being achieved by these other means.

7.3 The removal of personal hearing protectors for even short periods of time can significantly reduce their effectiveness and result in inadequate protection. For example, taking off hearing protectors in a noisy environment for a total of just 15 minutes in an 8 hour day reduces the hearing protector performance to a class 2 (just 15 dB) regardless of how good the hearing protector is in theory. Due to the difficulties of wearing personal hearing protectors for long periods of time in certain environments, regular brief periods in quiet areas, without personal hearing protectors, should be included as part of the personal hearing protection program.

*See Appendix 3  
Regulations 3.47 & 3.35*

*See Appendix 3  
Regulation 3.32*

## HEARING PROTECTION AREAS

7.4 Areas where people may be exposed to excessive noise should be sign-posted as 'hearing protection areas', and their boundaries should be clearly defined. No person, including visitors, managers and supervisors, should enter a hearing protection area during normal operation, unless wearing appropriate personal hearing protectors. This is regardless of how long the person spends in the hearing protection area. The signs used to identify these areas should conform with specifications laid down in Australian Standard AS 1319<sup>7</sup>.

7.5 Additional signs within the hearing protection areas may also be necessary.

7.6 Where sign-posting is not practicable, alternative arrangements should be made in consultation to ensure that employees and others can recognise circumstances in which personal hearing protectors are required. Methods of achieving this include:

- (a) attaching prominent warning notices to tools and equipment indicating that personal hearing protectors must be worn when operating them;
- (b) providing written and verbal instructions on how to recognise circumstances in which personal hearing protectors are needed; and
- (c) effective supervision of identified 'hearing protection areas'.

*See Appendix 3  
Regulation 3.34(1)(e)*

## SELECTION OF PERSONAL HEARING PROTECTORS

See Appendix 3  
Regulation 3.47

**7.7** It is important to ensure that personal hearing protectors will provide wearers with reliable adequate protection. Personal hearing protectors should be selected in accordance with Part 3 of Australian/New Zealand Standard AS/NZS 1269<sup>1</sup> and should comply with the requirements of Australian/New Zealand Standard AS/NZS 1270<sup>8</sup>. The attenuation values used in all selection procedures should be derived from attenuation measurements made in accordance with Australian/New Zealand Standard AS/NZS 1270<sup>8</sup>. Suppliers should be instructed to provide full information on the attenuation likely to be provided including the SLC<sub>80</sub> ratings, Class and octave band attenuation values. Suppliers' reports are to be made available to employees and safety and health representative(s). Additional information is available in the National Acoustic Laboratories' publication *Attenuation and use of Hearing Protectors*<sup>9</sup>.

**7.8** Provided that adequate protection is given, users should be allowed a reasonable choice from a range of personal hearing protectors.

**7.9** Individual selection of personal hearing protectors should be based on:

- (a) The degree of protection required in the user's environment. Personal hearing protectors with unnecessarily high attenuation (noise reduction) may cause communication difficulties and ultimately be unsuitable because of discomfort and inconvenience.
- (b) Suitability for use in the type of working environment and the job involved. For example, earplugs are difficult to use hygienically in work that requires them to be inserted with dirty hands. For such jobs, earmuffs might be better. On the other hand, earmuffs 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.
- (c) The comfort, weight and clamping force of the hearing protector.
- (d) The fit to the user. Individual fitting of the wearer is necessary for optimum protection. This should be checked while the user is wearing other regularly used items which might affect the performance of the protector. For example, spectacle wearers should be fitted with earmuffs while wearing their normal spectacles. Disposable plugs do not need individual fitting, but the ability of the material to conform to the user's ear canal should be taken into account as this is difficult for a supervisor to observe in the workplace.
- (e) The safety of the wearer and others working nearby, 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 personal hearing protectors should not mask warning sounds. The use of personal hearing protectors may make it more difficult for wearers to hear sounds if they already have a hearing loss. Particular care may need to be exercised in such cases.

## INSPECTION AND MAINTENANCE

**7.10** Employers should ensure that personal hearing protectors are regularly inspected and maintained. Users should also inspect personal hearing protectors regularly to detect and report damage or deterioration.

**7.11** Adequate provision should be made for clean storage of protectors when not in use. Facilities should be readily available for the cleaning of reusable protectors.

**7.12** For further information on inspection, maintenance and storage of personal hearing protectors, refer to Australian/New Zealand Standard AS/NZS 1269.3 *Hearing protector program*<sup>1</sup>, the National Acoustic Laboratories' publication *Attenuation and use of Hearing Protectors*<sup>9</sup> or the NOHSC publication *Noise Management at Work: Control Guide [NOHSC:12004(1991)]*<sup>6</sup>.

*See Appendix 3  
Regulation 3.34(1)(c) & 3.35(c)*

## TRAINING AND SUPERVISION

**7.13** Before personal hearing protectors are issued, the need for their use and limitations should be fully explained. Users should be given guidance in selecting appropriate personal hearing protectors. Instruction in their use, fitting, care and maintenance should be repeated at regular intervals. For further information on a training program refer to Appendix D of Australian/New Zealand Standard AS/NZS 1269.3<sup>1</sup>.

**7.14** Particular care is needed with the fitting of earplugs, which if poorly fitted may provide little protection. For example, foam earplugs need to be held in place for about 10 seconds while they expand to fit the ear canal.

**7.15** Employers, managers and supervisors should ensure that personal hearing protectors are used correctly where and when required.

**7.16** Employees who have been properly instructed in the use of personal hearing protectors, must wear them where and when required.

*See Appendix 3  
Regulation 3.34 (1)(a) &(b)*

*See Appendix 3  
The Act (s19(1)(b) & (d))*

*See Appendix 3  
The Act (s20 (2)(b))*

## 8. TRAINING

*See Appendix 3  
The Act (s.19(1)(b))*

**8.1** Training is an integral part of a preventive strategy, and is in addition to the provision of information outlined in Section 2.16 of this code of practice. The target groups requiring training are:

- (a) managers and supervisors of employees considered at risk of noise-induced hearing loss and tinnitus;
- (b) employees who may be exposed to excessive noise at work;
- (c) workplace safety and health committees and safety and health representative(s); and
- (d) staff responsible for the purchasing of plant, noise control equipment, personal hearing protectors and for the designing, scheduling, organisation and layout of work.

### TRAINING OBJECTIVES

**8.2** The training objectives are:

- (a) to minimise noise-induced hearing loss and tinnitus by an approach that emphasises engineering noise control measures;
- (b) to recognise and promote an understanding of the nature of noise-related health effects, including the cumulative effects of workplace and other exposures to noise such as domestic and leisure activities; and
- (c) to promote the adoption of a systematic approach to the management of exposure to excessive noise.

### PROGRAM CONTENT

**8.3** The needs of each target group are different, and the content and methods of presenting training material should be tailored to meet the specific needs of each group.

**8.4** Handouts, prepared as simple guidelines related to the needs of the group being trained, should be provided for all participants. The workplace noise control policy and action program should be readily available to all participants.

**8.5** Advice on suitable training material and training providers is available from WorkSafe and employer and employee groups.

**8.6** Topics that should be included in a training program aimed at prevention of noise-induced hearing loss and tinnitus include:

- (a) what is noise and what is excessive noise;
- (b) effects of noise on hearing, health and communication;
- (c) social handicaps of noise-induced hearing loss and tinnitus;

- (d) rationale for the exposure standard for noise;
- (e) statutory responsibilities of employers, employees and self-employed persons;
- (f) overview of the workplace noise control policy and action program;
- (g) nature and location of noise hazards in the workplace associated with the technology, plant and/or work practices in use;
- (h) nature of the general noise control measures which are in use or are planned;
- (i) specific control measures that are necessary in relation to each employee's own job. (As appropriate, this should include instruction in the correct use and maintenance of exhaust silencers, enclosures and other measures that minimise noise levels.);
- (j) when and how to use personal hearing protectors provided, including selection, fitting, proper care and maintenance;
- (k) arrangements for reporting defects in plant or the workplace that are likely to cause exposure to excessive noise; and
- (l) purpose and nature of audiometric testing.

## FURTHER INFORMATION

**8.7** Further information on effects of noise and practical noise control solutions and case studies is available on the WorkSafe Internet site ([www.safetyline.wa.gov.au/sub30.htm](http://www.safetyline.wa.gov.au/sub30.htm)).

# 9. AUDIOMETRIC TESTING

- 9.1 The hearing of employees exposed to noise can be monitored through regular audiometric examinations. Such testing in itself is not a preventive mechanism, and is only relevant in the context of a comprehensive noise management program. Any changes in hearing levels over time revealed by audiometry should be thoroughly investigated as to their cause(s) and the need for corrective action.
- 9.2 An audiometric testing program should be available to any employee likely to be regularly exposed to excessive noise.

## TESTING SCHEME

- 9.3 All testing should be undertaken by appropriately trained and experienced persons, selected by management in consultation with employees and safety and health representative(s).
- 9.4 People who carry out audiometric testing should ensure that procedures and equipment used are in accordance with the specifications in Australian/New Zealand Standard AS/NZS 1269.4<sup>1</sup>.
- 9.5 The audiometric testing scheme should include an initial reference test with periodic monitoring audiometric tests to follow. The initial reference audiogram should be taken as soon as the employee commences work, or before any exposure to workplace noise occurs. Monitoring audiometry should be carried out within 12 months of initial work exposure for comparison with the results of reference audiometry. In the absence of significant threshold shift or change in the work situation, it may then be sufficient to repeat the test at yearly intervals.

NOTE: At high exposure levels (e.g. >100 dB(A)) more frequent audiometric testing may be desirable.

Monitoring audiometry should be scheduled well into the work shift so that comparison with the reference audiogram will reveal any temporary threshold shift due to inadequacies in the use of hearing protectors.

- 9.6 Each employee's hearing, and the best type of personal hearing protectors for the job, should be discussed with that employee. Proper fitting of the personal hearing protectors should be ensured at the completion of the examination. Instructions on their use should be repeated at each subsequent attendance for audiometric testing.

## ASSESSMENT OF AUDIOGRAMS

- 9.7 Audiograms should be assessed and action taken in accordance with Section 9 of Part 4 of Australian/New Zealand Standard AS/NZS 1269<sup>1</sup>.
- 9.8 When employees are found to have sufficient hearing loss to interfere with the safe performance of their jobs, all practicable steps should be taken to modify the work environment such as volume-

control telephones, acoustically treated meeting areas with low noise and low reverberation, and supplementary visual warning signals. Where these cannot remedy the situation, employees should be offered alternative work.

**9.9** Results should be given to employees within two months of the audiometric testing. All results should be accompanied by a written explanation, in lay terms, of their meaning and implications. Individual results should be released to other parties only on the written authority of the employee. Unidentifiable individual results and group data should be accessible to the relevant employer, the safety and health representative(s) and the relevant authority.

## ACTION TO BE TAKEN WHEN THRESHOLD SHIFT DETECTED

**9.10** When temporary or permanent threshold shifts are revealed by audiometry or new tinnitus reported, action should be taken to inform the responsible manager to arrange to:

- (a) review the employee's job to identify any changes that may have caused an increase in exposure to noise;
- (b) re-determine exposure to noise if necessary;
- (c) determine whether anything can be done to reduce the levels of noise to which the employee is exposed and the durations of exposure;
- (d) verify the nominal performance of the employee's hearing protector is adequate for the level of exposure to noise;
- (e) examine the protector carefully and ensure it is not worn or damaged;
- (f) check the employee is able to fit the protector properly;
- (g) check the protector fits the employee closely and there are no leakage paths for noise;
- (h) ask the employee if they have any difficulty using the protector;
- (i) check the employee actually uses the protector correctly and consistently on the job; and
- (j) deal with any problems revealed by the above procedure, calling on expert advice as necessary.

## UPDATING OF REFERENCE AUDIOTRAGMS

**9.11** The reference audiogram should be updated whenever a significant permanent threshold shift has occurred or every 10 years, whichever occurs sooner. After a significant permanent threshold shift has been found and medically assessed, the employer should ensure that an updated reference audiogram is obtained for the employee. Subsequent monitoring audiograms should then be compared with this most recent reference audiogram. Records of previous reference audiograms should be retained.

## RECORDS

**9.12** Audiometric test records of employees, where released to the employer, should be kept during the employee's period of employment and longer as necessary, as they may provide a useful reference for workers' compensation. The records should be kept in a safe, secure place and held as confidential documents.

## HEARING TESTS FOR WORKERS' COMPENSATION PURPOSES

**9.13** The Workers' Compensation and Rehabilitation Act and Regulations require certain hearing tests and audiological assessments to be carried out for compensation purposes. For further information on this matter, contact WorkCover Western Australia or see [www.workcover.wa.gov.au/PDF/NIHLGuide.pdf](http://www.workcover.wa.gov.au/PDF/NIHLGuide.pdf).

# APPENDICES

# APPENDIX 1

## DEFINITIONS

**'acoustic' (or acoustical)** means containing, producing, arising from, actuated by, related to, or associated with, sound.

**'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 calibration.

**'administrative noise control measures'** are work systems designed to substantially reduce exposure to noise, including the time exposed to noise. Examples are job redesign or rosters which are designed to reduce exposure to noise. Engineering noise control measures and the use of personal hearing protectors are not included.

**'attenuation'** means a reduction in the magnitude of sound.

**'audiogram'** means a chart or table relating a person's hearing threshold levels for pure tones to frequency.

**'audiometric test' (or testing)** means the measurement of the hearing threshold levels of a person by means of monaural pure tone air conduction threshold tests.

**'A-weighting'** refers to a standardised frequency response used in sound measuring instruments, specified in Australian Standard AS 1259.1<sup>3</sup>. Note: Historically it was developed to model the human ear response at low sound levels. However A-weighting is now frequently specified for measuring sounds irrespective of level and studies have shown a relationship between the long term exposure to A-weighted sound pressure levels and hearing damage risk.

**'C-weighting'** refers to a standardised frequency response used in sound measuring instruments, specified in Australian Standard AS 1259.1<sup>3</sup>. Note: Historically it was developed to model the human ear response at high sound levels. It is now used to measure peak noise levels.

**'competent person'**, in the context of supplying information on noise levels generated by plant, means a person whom the manufacturer or supplier ensures has acquired knowledge and skills, through a combination of training, education and experience, enabling that person to correctly perform a specified task.

**'consultation'** means the sharing of information and exchange of views between employers, employees and/or safety and health representative(s) on health and safety issues. It includes the opportunity to contribute to decision making in a timely fashion to minimise the risk(s) of exposure to excessive noise.

**'daily noise exposure level'** see definition for ' $L_{Aeq,8h}$ '.

**'dB'** means the abbreviation for decibel. Also see definition for 'decibel'.

**'dB(A)'** means A-weighted sound pressure level in decibels. Also see definition for 'A-weighting'.

**'dB(C)'** means C-weighted sound pressure level in decibels. Also see definition for 'C-weighting'.

**'decibel'** is the unit used to indicate the relative magnitude of sound pressure level and other acoustical quantities. The range of sound pressures commonly encountered is very large so a logarithmic

scale is used. The decibel is the unit used on this scale and is abbreviated to ‘dB’. On the decibel scale, the threshold of hearing occurs at a sound pressure level of about 0 dB and the threshold of pain occurs at about 120 dB. As the decibel is also used to describe the level of other quantities, such as sound power and vibration acceleration, it is always necessary to refer to the specific quantity being measured, for example,  $L_{Aeq,8h}$  or  $L_{C,peak}$ .

**‘engineering noise control measures’** 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 administrative noise control measures or personal hearing protectors.

**‘excessive noise’** means noise that exceeds the exposure standard for noise.

**‘exposure standard for noise’**, in relation to a person, means the exposure standard for noise set in Regulation 3.45 of the Occupational Safety and Health Regulations 1996, or in the workplace’s noise control policy, whichever is the lower.

**‘hazard’** means anything that may result in harm to the hearing of a person.

**‘hearing protection areas’** means areas where persons may be exposed to noise levels exceeding the exposure standard for noise. During normal operations, no person should enter such an area without wearing appropriate personal hearing protectors. Hearing protection areas should be clearly defined and sign-posted according to Australian Standard AS 1319<sup>7</sup>.

**‘impulse sound’** means sound consisting of a single pressure peak, or a sequence of such peaks, or a single burst with multiple pressure peaks whose amplitude decays with time, or a sequence of such bursts.

**‘ $L_{Aeq,8h}$ ’** (daily noise exposure level) means an 8 hour equivalent continuous A-weighted sound pressure level in decibels (dB(A)) referenced to 20 micropascals, that is to say, the steady noise level which would, in the course of an 8 hour period, cause the same A-weighted sound energy that would be caused by the actual noise during an actual working day, determined in accordance with Australian/New Zealand Standard AS/NZS 1269.1<sup>1</sup>.

**‘ $L_{C,peak}$ ’** means peak noise level, that is to say, C-weighted peak hold sound pressure level in decibels (dB(C)) referenced to 20 micropascals determined in accordance with Australian/New Zealand Standard AS/NZS 1269.1<sup>1</sup>.

**‘noise’** means any unwanted or damaging sound.

**‘noise control policy’** means a written policy, developed by the employer, in consultation with employees and safety and health representative(s), which sets goals for peak noise and daily noise exposure levels in the workplace and the strategies to achieve them.

**‘occupational noise-induced hearing loss’ (NIHL)** means hearing impairment arising from exposure to excessive noise at work. Occupational noise-induced hearing loss is also commonly known as industrial deafness.

**‘octave band analysis’** means analysis of the frequency content of noise into octave bands.

**‘octave band filter’** means a filter that attenuates all noise except that falling between two frequencies an octave apart. Octave band filters are used to measure which frequencies are present in a given noise.

**'peak noise level'** see definition for ' $L_{C,peak}$ '.

**'personal hearing protection program'** means a program for personal hearing protection and, where required, regular hearing testing, which is adopted where technical or economic problems delay, or make impracticable, the reduction of exposure to excessive noise by engineering or administrative noise control measures.

**'personal hearing protectors'** means a device, or pair of devices, worn by a person or inserted in the ears of a person to protect the person's hearing.

**'plant'** includes any machinery, equipment, appliance, implement, or tool and any component or fitting thereof or accessory thereto.

**'practicable'** means reasonably practicable having regard, where the context permits, to -

- (a) the severity of any potential injury or harm to health that may be involved, and the degree of risk of it occurring;
- (b) the state of knowledge about -
  - (i) the injury or harm to health referred to in paragraph (a);
  - (ii) the risk of that injury or harm to health occurring; and
  - (iii) means of removing or mitigating the risk or mitigating the potential injury or harm to health; and
- (c) the availability, suitability, and cost of the means referred to in paragraph (b) (iii).

**'reverberation'** means the persistence, by echo or reflection, of sound in an enclosure after the emission by the source has stopped.

**'risk'** means the probability of harm occurring to the hearing of a person.

**'safety and health representative'** means a safety and health representative elected under Part IV of the Occupational Safety and Health Act 1984.

**'sound'** means small fluctuations in the air pressure that result in a wave capable of exciting in a listener the sensation of hearing.

**'sound exposure meter (SEM)'**, or noise dosimeter, means an instrument for measuring a person's daily noise exposure levels by automatically integrating sound energy over a measurement period. The instrument is worn by the person concerned.

**'sound level meter (SLM)'** means an instrument consisting of a microphone, amplifier and indicating device, having a declared performance, and designed to measure a frequency-weighted and time-weighted value of the sound pressure level.

**'sound power'** means the total sound energy radiated per unit time. The standard units are watts (W).

**'sound power level'** means the relative magnitude of sound power, customarily expressed in decibels referenced to 1 picowatt.

**'sound pressure'** means the alternating component of the pressure at a point in a sound field. The standard units are Pascals (Pa).

**‘sound pressure level (SPL)’** means the relative magnitude of sound pressure, customarily expressed in decibels referenced to 20 micropascals.

**‘tinnitus’** means ringing or other noises in the head or ears which can be caused by exposure to excessive noise. Tinnitus can become permanent and when severe may disrupt sleep, reduce concentration and lead to irritability and depression. Tinnitus may lead to increased absenteeism and decreased productivity. It can also affect general job satisfaction and contribute to adverse health effects, such as, stress.

**‘workplace’** means a place, whether or not in an aircraft, ship, vehicle, building, or other structure, where employees or self-employed persons work or are likely to be in the course of their work.

# APPENDIX 2

## GUIDANCE MATERIAL FOR MANUFACTURERS, IMPORTERS AND SUPPLIERS ON THE PRESENTATION OF INFORMATION ABOUT NOISE LEVELS GENERATED BY PLANT

### INTRODUCTION

**A2.1** The purposes of this guidance material are:

- (a) to assist manufacturers, importers and suppliers in providing ‘appropriate and adequate’ information on noise levels generated by plant (see under the heading ‘Appropriate and Adequate’ Information on Noise elsewhere in this Appendix).
- (b) to assist purchasers to make an informed choice when purchasing plant, by being able to assess and, where possible, compare suppliers’ noise level information. This information will usually be obtained from tests under standardised conditions. The plant may, however, generate different noise levels in the workplace and it is the responsibility of the employer purchasing the plant to assess noise levels in the workplace. The purchase of plant should occur through the consultative mechanisms in the workplace, as part of a strategy to reduce noise levels in the workplace.

**A2.2** The reasons for providing information on noise levels prior to purchase are:

- (a) noise levels are a significant factor in making decisions on the purchase and hire of plant, since ‘buying quiet’ is a highly cost effective way to control workplace noise;
- (b) providing the information ‘up-front’ encourages manufacturers to produce quieter products; and
- (c) comparing noise levels will encourage local manufacturers and suppliers to move towards compatibility with information obtained/required overseas and in other parts of Australia.

### ‘APPROPRIATE AND ADEQUATE’ INFORMATION ON NOISE

**A2.3** For information on noise levels to be considered ‘appropriate’ and ‘adequate’, it should be:

- (a) collected by a competent person (See Appendix 1) according to good measurement practice as defined in relevant general international standards, or Australian Standards such as AS 2659<sup>10</sup>. This ensures a reasonable standard of accuracy;
- (b) presented in a clear, understandable format;
- (c) technically complete and unambiguous; and
- (d) representative of noise likely to be emitted by plant under typical conditions of usage.

**A2.4** The minimum testing information that should be supplied to the purchaser is listed in the table below. Where relevant information on test procedures is contained in a test standard or a test report, reference to the standard or the report should be included. Information should be provided on peak noise levels, where relevant, as well as on continuous noise levels. The manufacturer/supplier should be able to provide a full test report when requested.

**A2.5** Where there is a selection of noise measurement results available, the preferred measurement, for the purpose of this code of practice, is the sound pressure level at the operator's ear position.

**TABLE: MINIMUM NOISE TESTING INFORMATION TO BE SPECIFIED BY THE MANUFACTURER/SUPPLIER**

**Supplier's details** (for example, name, local address, telephone and/or facsimile number, e-mail).

**Manufacturer's details** (for example, name, address, telephone and/or facsimile number, e-mail).

**Details of the plant tested** (including any noise controls, for example, make, model, serial number, relevant capacity/rating).

**Title or number of specific test standard or code followed** (if any) and details of any departures from the standard. For example, if a machine needed to be mounted differently to the method given in the standard, the alternative mounting should be described.

**Details of operating conditions** if not specified in the standard, or if no specific test standard is available for the type of plant being tested. For example, test machine load, speed, type of material processed, details of installation and mounting of test machine, details of test environment, description of measurement instrumentation and procedure. Reference to a test report containing this information will suffice.

**Measurement position(s)** (for example, operator's ear position or 1 metre from machines).

**Sound pressure level or sound power level.**

**Frequency weighting** (for example, A, C or linear).

**Time weighting** (for example, slow, fast or peak) or  $L_{eq}$ .

**Sound level or levels determined in testing.**

**Units of measurement** (for example, dB re: 20 micropascals).

**Date issued.**

## SUGGESTED PROFORMA FOR PRESENTATION OF INFORMATION ON NOISE LEVELS GENERATED BY PLANT

**A2.6** A suggested proforma for the presentation of information on noise levels generated by plant is shown below. However, the information may be presented in any convenient way that will bring it to the purchaser's attention. For example, a catalogue or operating instructions would be suitable, provided the information is complete.

### ***SUPPLIER/MANUFACTURER***

**Supplier:**

Name \_\_\_\_\_

Address \_\_\_\_\_  
\_\_\_\_\_

Phone: \_\_\_\_\_ Facsimile: \_\_\_\_\_

E-mail: \_\_\_\_\_

**Manufacturer:**

Name \_\_\_\_\_

Address \_\_\_\_\_  
\_\_\_\_\_

Phone: \_\_\_\_\_ Facsimile: \_\_\_\_\_

E-mail: \_\_\_\_\_

### ***DETAILS OF PLANT TESTED***

Description of item \_\_\_\_\_  
\_\_\_\_\_

Make: \_\_\_\_\_

Model: \_\_\_\_\_ Serial No. \_\_\_\_\_

Noise reducing attachments fitted: \_\_\_\_\_  
\_\_\_\_\_

**TEST PROCEDURES**

Operating conditions \_\_\_\_\_

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Test environment \_\_\_\_\_

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Test standard followed: \_\_\_\_\_ Number \_\_\_\_\_

Title \_\_\_\_\_

Clauses \_\_\_\_\_

Departures from Standard \_\_\_\_\_

---



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Measurement method if no standard followed \_\_\_\_\_

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**RESULTS**

Measurement position \_\_\_\_\_

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Time weighting (fast, slow, or peak ) or  $L_{eq}$  \_\_\_\_\_

|                   | Range          | Mean             |
|-------------------|----------------|------------------|
| A-weighted        | _____ To _____ | _____ dB(A)      |
| C-weighted        | _____ To _____ | _____ dB(C)      |
| C-weighted, peak  | _____ To _____ | _____ dB(C) Peak |
| Sound power level | _____          | dB(A)            |
| Date issued       | _____          |                  |

## APPENDIX 3

### LEGISLATION - RELEVANT SECTIONS OF THE OCCUPATIONAL SAFETY AND HEALTH ACT 1984 AND THE OCCUPATIONAL SAFETY AND HEALTH REGULATIONS 1996

#### *Duties of employers*

##### **The Act: Section 19(1) states**

19.(1) An employer shall, so far as is practicable, provide and maintain a working environment in which his employees are not exposed to hazards and in particular, but without limiting the generality of the foregoing, an employer shall-

- (a) provide and maintain workplaces, plant, and systems of work such that, so far as is practicable, his employees are not exposed to hazards;
- (b) provide such information, instruction, and training to, and supervision of, his employees as is necessary to enable them to perform their work in such a manner that they are not exposed to hazards;
- (c) consult and cooperate with safety and health representatives, if any, and other employees at his workplace, regarding occupational safety and health at the workplace;
- (d) where it is not practicable to avoid the presence of hazards at the workplace, provide his employees with, or otherwise provide for his employees to have, such adequate personal protective clothing and equipment as is practicable to protect them against those hazards, without any cost to the employees; and
- (e) make arrangements for ensuring, so far as is practicable, that -
  - (i) the use, cleaning, maintenance, transportation and disposal of plant; and
  - (ii) the use, handling, processing, storage, transportation and disposal of substances, at the workplace is carried out in a manner such that his employees are not exposed to hazards.

##### **The Act: Section 19(4) states**

19.(4) For the purpose of this section, where, in the course of a trade or business carried on by him, a person (in this section called "**the principal**") engages another person (in this section called "**the contractor**") to carry out work for the principal-

- (a) the principal is deemed, in relation to matters over which he has control or, but for an agreement between him and the contractor to the contrary, would have had control, to be the employer of -
  - (i) the contractor; and
  - (ii) any person employed or engaged by the contractor to carry out or to assist in carrying out the work;

and

- (b) the persons mentioned in paragraph (a)(i) and (ii) are deemed, in relation to those matters, to be employees of the principal.

### ***Duties of employees***

#### **The Act: Section 20 states (in part)**

20.(1) An employee shall take reasonable care -

- (a) to ensure his own safety and health at work; and
- (b) to avoid adversely affecting the safety or health of any other person through any act or omission at work.

20.(2) Without limiting the generality of subsection (1), an employee contravenes that subsection if he -

- (a) fails to comply, so far as he is reasonably able, with instructions given by his employer for his own safety or health or for the safety or health of other persons;
- (b) fails to use such protective clothing and equipment as is provided, or provided for, by his employer as mentioned in section 19 (1) (d) in a manner in which he has been properly instructed to use it;
- (c) misuses or damages any equipment provided in the interests of safety or health; or
- (d) fails to report forthwith to his employer -
  - (i) any situation at the workplace that he has reason to believe could constitute a hazard to any person and he cannot himself correct; or
  - (ii) any injury or harm to health of which he is aware that arises in the course of, or in connection with, his work.

20.(3) An employee shall co-operate with his employer in the carrying out by his employer of the obligations imposed on him under this Act.

### ***Duties of self-employed persons***

#### **The Act: Section 21(1) states**

21.(1) An employer or a self-employed person shall-

- (a) take reasonable care to ensure his own safety and health at work; and
- (b) so far as is practicable, ensure that the safety or health of a person not being his employee is not adversely affected wholly or in part as a result of the work in which he or any of his employees is engaged.

***Duties of manufacturers, etc.***

**The Act: Section 23 states (in part)**

23.(1) A person who designs, manufactures, imports or supplies any plant for use at a workplace shall, so far as is practicable -

- (a) ensure that the design and construction of the plant is such that persons who properly install, maintain or use the plant are not, in doing so, exposed to hazards;
- (b) test and examine, or arrange for the testing and examination of, the plant so as to ensure that its design and construction are as mentioned in paragraph (a); and
- (c) ensure that adequate information in respect of -
  - (i) any dangers associated with the plant;
  - (ii) the specifications of the plant and the data obtained on the testing of the plant as mentioned in paragraph (b);
  - (iii) the conditions necessary to ensure that persons properly using the plant are not, in so doing, exposed to hazards; and
  - (iv) the proper maintenance of the plant,

is provided when the plant is supplied and thereafter whenever requested.

23.(2) A person who erects or installs any plant for use at a workplace shall, so far as is practicable, ensure that it is so erected or installed that persons who properly use the plant are not subjected to any hazard that arises from, or is increased by, the way in which the plant is erected or installed.

23.(3a) A person who designs or constructs any building or structure, including a temporary structure, for use at a workplace shall, so far as is practicable, ensure that the design and construction of the building or structure is such that -

- (a) persons who properly construct, maintain, repair or service the building or structure; and
- (b) persons who properly use the building or structure,

are not, in doing so, exposed to hazards.

***Identification of hazards, and assessing and addressing risks, at workplaces***

**Regulation 3.1 states**

A person who, at a workplace, is an employer, the main contractor, a self-employed person, a person having control of the workplace or a person having control of access to the workplace must, as far as practicable -

- (a) identify each hazard to which a person at the workplace is likely to be exposed;
- (b) assess the risk of injury or harm to a person resulting from each hazard, if any, identified under paragraph (a); and
- (c) consider the means by which the risk may be reduced.

***Risks to be reduced in first instance by means other than protective clothing and equipment***

**Regulation 3.32 states**

When a person is considering, for the purposes of regulation 3.1(c), the means by which a risk may be reduced, the person is to -

- (a) firstly consider the means other than the use of protective clothing and equipment by which the risk might be reduced; and
- (b) then consider the use of protective clothing and equipment to the extent that it is not practicable to reduce the risk by means other than the use of protective clothing and equipment.

***Responsibilities of persons who require personal protective clothing and equipment to be used***

**Regulation 3.34(1) states**

If a person is required under any of these regulations to identify a hazard at a workplace and to assess the risk of injury or harm to a person resulting from the hazard and the person concludes from the assessment process that personal protective clothing or equipment should be used at the workplace then the person must ensure that -

- (a) the person who uses the clothing or equipment is instructed in relation to the correct fitting, use, selection, testing, maintenance and storage of the clothing or equipment;
- (b) the person who uses the clothing or equipment is informed of the limitations in the use of the clothing or equipment;
- (c) the clothing or equipment is maintained in good working order;
- (d) the clothing or equipment is replaced -
  - (i) when it no longer provides the level of protection required to protect the wearer or user against the particular hazard;
  - (ii) when the safe working life, as specified by the person who manufactured the clothing or equipment, has expired; or
  - (iii) subject to subregulation (2), when it is damaged and cannot be repaired;

and

- (e) the area of a workplace at which the clothing or equipment is required to be used by a person other than the person who provides the clothing or equipment is identified by signs in accordance, and complying, with AS 1319.

***Responsibilities of users of personal protective clothing and equipment***

**Regulation 3.35 states**

A person to whom personal protective clothing or equipment is provided or made available for use at a workplace -

- (a) must use the protective clothing or equipment in a manner in which he or she has been properly instructed to use it;
- (b) must not misuse or damage the clothing or equipment; and
- (c) must, as soon as practicable after becoming aware of any
  - (i) damage to;
  - (ii) malfunction of; or
  - (iii) need to clean or sterilize,

the clothing or equipment, notify the person providing the clothing or equipment of the damage, malfunction or need to clean or sterilize the clothing or equipment.

***Interpretation***

**Regulation 3.45 states**

In this Division -

**“exposure standard for noise”**, in relation to a person, means -

- (a) an  $L_{Aeq,8h}$  of 85 dB(A); or
- (b) an  $L_{C,peak}$  of 140 dB(C),

measured at the position of the person’s ear without taking into account any protection which may be provided to the person by personal hearing protectors;

“ $L_{Aeq,8h}$ ” means an 8 hour equivalent continuous A-weighted sound pressure level in decibels (dB(A)) referenced to 20 micropascals, that is to say, the steady noise level which would, in the course of an 8 hour period, cause the same A-weighted sound energy that would be caused by the actual noise during an actual working day, determined in accordance with AS/NZS 1269.1;

“ $L_{C,peak}$ ” means C-weighted peak noise level, that is to say, the C-weighted peak sound pressure level in decibels (dB(C)) referenced to 20 micropascals, determined in accordance with AS/NZS 1269.1;

“noise” means any unwanted or damaging sound;

“personal hearing protectors” means a device, or pair of devices, worn by a person or inserted in the ears of a person to protect the person’s hearing.

### ***Avoidance of noise above exposure standard***

#### **Regulation 3.46 states**

A person who, at a workplace, is an employer, the main contractor or a self-employed person must, as far as practicable, ensure that noise to which a person is exposed at the workplace does not exceed the exposure standard for noise.

### ***Standard of personal hearing protectors***

#### **Regulation 3.47 states**

If it is not practicable to avoid exposing a person at a workplace to noise above the exposure standard for noise then a person who, at the workplace, is an employer, the main contractor or a self-employed person must ensure that the first-mentioned person is provided with personal hearing protectors that have been selected in accordance with the procedures specified in AS/NZS 1269.3.

# APPENDIX 4

## NOISE HAZARD IDENTIFICATION CHECKLIST

**Description of work location:** \_\_\_\_\_

**Task at workstation:** \_\_\_\_\_

**Assessed by:** \_\_\_\_\_

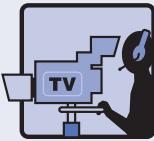
**Safety & Health Representative:** \_\_\_\_\_

**Date:** \_\_\_\_\_

**Yes to any of the following indicates the need for a detailed noise assessment.**

|  |                              |                             |
|--|------------------------------|-----------------------------|
| 1. Is a raised voice needed to communicate with someone about one metre away?  | Yes <input type="checkbox"/> | No <input type="checkbox"/> |
| 2. Do people working in the area notice a reduction in hearing over the course of the day? (This reduction might not be noticed until after work.)     | Yes <input type="checkbox"/> | No <input type="checkbox"/> |
| 3. Do employees experience any of the following:   |                              |                             |
| (a) ringing in the ears (tinnitus),  | Yes <input type="checkbox"/> | No <input type="checkbox"/> |
| (b) the same sound having a different tone in each ear (dipacusis),  | Yes <input type="checkbox"/> | No <input type="checkbox"/> |
| (c) blurred hearing?   | Yes <input type="checkbox"/> | No <input type="checkbox"/> |
| 4. Are any long term employees hard of hearing?  | Yes <input type="checkbox"/> | No <input type="checkbox"/> |
| 5. Are personal hearing protectors provided?   | Yes <input type="checkbox"/> | No <input type="checkbox"/> |
| 6. Are signs, indicating that personal hearing protectors should be worn, posted at the entrance or in the work area?                                  | Yes <input type="checkbox"/> | No <input type="checkbox"/> |
| 7. Have there been any workers' compensation claims for noise-induced hearing loss?  | Yes <input type="checkbox"/> | No <input type="checkbox"/> |
| 8. Does any equipment have manufacturer's noise information (including labels) that indicates noise levels equal or greater than any of the following: |                              |                             |
| (a) 80 dB(A) $L_{Aeq}$ ,   | Yes <input type="checkbox"/> | No <input type="checkbox"/> |
| (b) 130 dB peak noise level,   | Yes <input type="checkbox"/> | No <input type="checkbox"/> |
| (c) 88 dB(A) sound power level?  | Yes <input type="checkbox"/> | No <input type="checkbox"/> |
| 9. Do the results of audiometry indicate that past or present employees have hearing loss?   | Yes <input type="checkbox"/> | No <input type="checkbox"/> |
| 10. Does the noise in any part of the workplace sound as loud or louder than 85 decibels using the scale Decibel Levels of Common Sounds.              | Yes <input type="checkbox"/> | No <input type="checkbox"/> |

## DECIBEL LEVELS OF COMMON SOUNDS

| Examples  | Sound Pressure Level dB     |
|---|-----------------------------|
|    | 30m from a jet aircraft 140 |
|   | Threshold of pain 130       |
|   | 120                         |
|    | Chainsaw 110                |
|   | Disco 100                   |
|   | 90                          |
|  | Kerbside of busy road 80    |
|   | 70                          |
|  | Conversational speech 60    |
|   | 50                          |
|   | 40                          |
|  | Quiet bedroom at night 30   |
|  | Background in TV studio 20  |
|   | 10                          |
|   | Threshold of hearing 0      |

## REFERENCED DOCUMENTS

1. Standards Australia, *AS/NZS 1269 Occupational noise management Parts 0-4* Standards Australia, Sydney.
2. Standards Australia, *AS/NZS 2399 Acoustics - Specifications for Personal Sound Exposure Meters*, Standards Australia, Sydney.
3. Standards Australia, *AS 1259.1 Acoustics - Sound Level Meters, Part 1: Non-integrating*, Standards Australia, Sydney.
4. Standards Australia, *AS 1259.2 Acoustics - Sound Level Meters, Part 2: Integrating - Averaging*, Standards Australia, Sydney.
5. Standards Australia, *AS/NZS 4476 Acoustics - Octave Band and Fractional Octave Band Filters*, Standards Australia, Sydney.
6. National Occupational Health and Safety Commission, *Noise Management at Work: Control Guide [NOHSC:12004(1991)]*, 2nd Edition, Worksafe Australia, Sydney, 1991.
7. Standards Australia, *AS 1319 Safety Signs for the Occupational Environment*, Standards Australia, Sydney.
8. Standards Australia, *AS/NZS 1270 Acoustics - Hearing protectors*, Standards Australia, Sydney.
9. National Acoustic Laboratories, *Attenuation and use of Hearing Protectors, 8th Edition*, Commonwealth of Australia, Sydney, 1998.
10. Standards Australia, *AS 2659 Guide to the Use of Sound Measuring Equipment*, Standards Australia, Sydney.

## FURTHER READING

ACCI/ACTU, *Joint OHS Training Resources*, ACCI/ACTU, Melbourne 1998.

ACTU, *Noise Control at Work*, ACTU, Melbourne, 1987.

Berglund, B. and Lindvall, T (eds), *Community Noise, Archives of the Centre for Sensory Research, Vol 2, Issue 1*, Stockholm, 1995.

Goelzer, B., Hansen, C. and Sehrndt, G. (eds), *Occupational Exposure to Noise: Evaluation, Prevention and Control*, World Health Organisation, Federal Institute for Occupational Safety and Health, Dortmund, 2001.

Health and Safety Executive, *Sound Solutions*, HSE Books, Surrey, 1995.

Health and Safety Executive, *Reducing Noise at Work - Guidance on the Noise at Work Regulations, 1989*, HSE Books, Surrey, 1998.

Health and Safety Organisation (Victoria), *Share Solutions*, Health and Safety Organisation, Victoria, 1995.

International Organization for Standardization, International Standard *ISO 1999 Acoustics: Determination of Occupational Noise Exposure and Estimation of Noise-induced Hearing Impairment*, International Organization for Standardization, Geneva, 1990.

National Occupational Health and Safety Commission, *National Strategy for the Prevention of Occupational Noise-Induced Hearing Loss [NOHSC:4004 (1989)]*, Australian Government Publishing Service, Canberra, 1989.

National Occupational Health and Safety Commission and University of New England, *Occupational Noise-induced Hearing Loss: Prevention and Rehabilitation*, National Occupational Health and Safety Commission, Sydney and University of New England, Armidale, 1991.

Stellman, J.M., *Encyclopedia of Occupational Health and Safety, 4th Edition*, International Labour Office, Geneva, 1998.



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