What is a Code of Practice?

The term 'Code of Practice' has a particular meaning under the Victorian Occupational Health and Safety Act 1985. Other codes of practice, such as the advisory codes developed by the National Occupational Health and Safety Commission, voluntary codes agreed in an industry, or codes adopted by other states or countries do not come within the meaning of the term used in the Victorian Act.

The Victorian Occupational Health and Safety Act 1985 provides for codes of practice "for the purpose of providing practical guidance to employers, self-employed persons and employees, ..."(S.55[1].

Codes of practice are developed by the Victorian Occupational Health and Safety Commission with assistance from the Occupational Health and Safety Authority. The Commission is made up of employer, union, expert and government representatives. The Commission recommends the code of practice to the Minister for Labour for approval after a period of public review of the draft, and consideration of any comment received.

A code of practice approved by the Minister for Labour comes into effect when "notice of approval is published in the Government Gazette or on such later day as may be specified in the notice, ..." (S.55[6].

A code of practice does not have the same legal force as regulations. Contravention of, or failure to comply with, regulations made under the Act is an offence (S.47[1]). Failure to observe a provision of an approved code of practice is not in itself a breach of the Act (S.55[8]).

However, in proceedings under the Act, where it is alleged that a person contravened or failed to comply with a provision of the Act or the regulations, a relevant, approved code of practice is admissible as evidence. The court is required to take the matter as proved unless the person is able to show that compliance with the Act or regulations was achieved in some way other than that provided in the approved code of practice (S.56).

A health and safety representative is able to cite an approved code of practice in a Provisional Improvement Notice as a means by which the alleged non-compliance may be overcome. Similarly, an Inspector may cite an approved code of practice together with the relevant Section of the Act or regulations when issuing an Improvement Notice or Prohibition Notice.

In situations where it is impracticable to comply with the literal provisions of a code the employer must be able to show that an equivalent or better level of health and safety results from the alternative action taken.

In summary, an approved code of practice:

- provides practical guidance;
- should be followed, unless there is another solution which achieves the same result, or a better solution;
- is able to be used in support of the Act's preventive enforcement provisions; and
- can be used to support prosecution.

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SUMMARY

1. INTRODUCTION AND PART 2 OUTLINE OF THE CODE

These parts outline objectives, provide relevant definitions and explain the nature of the hazard and the health effects of noise, and the general approach in the code to control this hazard.

3. DESIGNERS, MANUFACTURERS, IMPORTERS SUPPLIERS

This notes the responsibilities of designers to meet the requirements of the regulations. It provides guidance on the duty of manufacturers, importers and suppliers to test plant for its sound power and sound pressure level and to provide this information to potential purchasers. It also notes that, manufacturers are *to* ensure that plant they manufacture can comply with the regulations. An outline is provided of the ways to estimate noise exposure from installed plant from the sound power and the noise level of the plant.

4. RISK IDENTIFICATION AND ASSESSMENT

This part describes means by which an employer can make an initial assessment of the workplace using the "Risk Identification Checklist". If this checklist suggests that employees are likely to be exposed to noise above the exposure standard set in the regulations, the employer is required to make an assessment as outlined in regulation ll. The importance of consulting with employees while in this assessment phase and the following control stage is emphasised in Part 2 of the code, both as a means of meeting the requirements of regulation 12 to consult with employees and health and safety representatives, and also of ensuring that assessments and any subsequent control measures are successfully undertaken.

This part also describes by whom and how noise assessments and measurements are to be carried out. It also contains a form, "Form 2 Data for Personal and Area Noise Exposure" which can be copied and used in making assessments.

5. CONTROL OF RISK

This part introduces the hierarchy of control for any risk identified by the assessment. A written plan of control measures, as outlined in regulation 13, is required to be developed within 6 months after carrying out the risk assessment.

Part 5 gives guidance on the control measures required to be implemented.

6. HEARING PROTECTION DEVICES

This notes the responsibilities of manufacturers, importers and suppliers of hearing protection devices to provide information to purchasers.

7. AUDIOMETRY

Where employees are required to wear hearing protection devices under regulation 13, there is a requirement that audiometric surveys be undertaken of those employees under regulation 15. Part 7 of the code indicates who can undertake audiometry, how they can undertake it, and what actions they must take in accordance with the regulations, as a consequence of the results of the tests.

8. TRAINING

This Part describes the training required to be given by an employer to employees, supervisors and those maintaining or acquiring hearing protection devices. It also notes that the training should take account of the needs of non-English speaking background employees.

1. AUTHORITY

This code of practice is approved pursuant to Section 55 of the Occupational Health and Safety Act 1985 (the Act).

2. SCOPE OF THIS CODE

This code of practice applies to all employers and employees as defined under Section 4 of the Victorian Occupational Health and Safety Act 1985 and all designers, manufacturers, importers and suppliers of plant to workplaces. ("Supply" and "Plant" and "Workplaces" are defined in Section 4 of the Act.)

3. PURPOSE

The purpose of this code of practice *is* to provide practical guidance *in meeting* the requirements of the Occupational Health and Safety (Noise) Regulations 1992 for the prevention, identification, assessment and control of risks arising from noise exposure in workplaces.

4. BACKGROUND AND OBJECTIVES

The risk of hearing loss due to excessive noise exposure at work is widespread in Victoria.

The total cost of Victorian Accident Compensation claims for work related deafness is currently around thirteen and a half million dollars each year *(see Note 1).* Over the period from September 1985 to March 1991, $57 million was paid as compensation for permanent hearing impairment in Victoria. However, these figures are not a reliable guide and are likely to under-estimate the size of the problem. Firstly, it is difficult to separate the effects of work and non-work related noise. Secondly, work related deafness claims are the result of exposure to noise over many years. Thirdly, less than one third of workers with work related deafness register a claim. So claims figures do not accurately indicate the current incidence of work related hearing loss.

Note 1. This figure was estimated by taking the average of the cost of deafness claims for the years 1989/1990, 1990/1991, 1991/1992

Knowledge of the effects of noise on hearing and of ways to prevent hearing loss has been available since last century and has been widely available since 1970. Yet the facts above indicate that this knowledge is not always being applied. Nor is it being applied as much as practicable.

For these reasons the prevention of noise induced hearing loss has been given high priority by authorities engaged in the prevention of workplace injury arid disease.

The major objective of the regulations and this code of practice is to reduce the incidence and severity of hearing loss resulting from excessive noise exposure in workplaces. The second objective is to require employers to assess and control the risk arising from exposure to noise while at work.

As hearing loss does not become apparent for up to twenty years, the benefits of this legislation may not be immediately felt. Employees who may shortly be diagnosed as suffering from work related hearing loss may have begun to develop it two decades ago.

The most effective way to prevent and control the risk of noise induced hearing loss is to eliminate or quieten the sources of noise to which employees are exposed. The regulations require that from 1 July 1997 other measures such as job rotation and hearing protection only be used if it is not practicable to control the noise by engineering means.

While this code aims to provide detailed guidance, it is not possible to deal with every situation, which 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 satisfactorily deal with the issues relating to the application of this code.
In some cases it may be necessary to seek expert assistance in the application of this code.

5. HEALTH EFFECTS OF NOISE

5.1 Hearing Loss

Noise induced hearing loss occurs because exposure to excessive noise damages the delicate hearing mechanism of the inner ear. Initially, the noise causes a temporary hearing loss (or temporary threshold shift) and hearing is recovered.

The extent of temporary threshold shift depends on the intensity of the noise, its duration and to some extent the frequency of the noise. Repeated exposure to excessive noise can transform this temporary threshold shift into a permanent threshold shift, which is irreversible. Temporary threshold shift may also be accompanied by a ringing in the ear, called *tinnitus*, which can become permanent.

Exposure to continuous high levels of noise may permanently damage the inner ear. The damage that results is irreversible. This permanent threshold shift or hearing loss may also be accompanied by tinnitus.

Such damage does not equally affect all frequencies which are important to speech communication. Persons suffering from occupational deafness therefore experience a distortion of the sounds they hear. High frequency consonant sounds like *t, k,* and *p* are lost and people can no longer distinguish between spoken works. Hearing aids offer limited benefit for people with noise induced hearing loss.

Humans naturally lose hearing with age, this is called presbyacusis. Hearing loss from excessive noise adds to this natural problem but, unlike ageing, it is avoidable.

The degree of hearing loss from noise exposure depends on the amount of noise energy that ears are exposed to and the sensitivity of the individual.

The amount of noise energy (often called acoustic energy) in turn depends on several factors:

- the nature of the noise (type, intensity, and pitch) and
- the duration of exposure to the noise.

Put simply, the more time the ears are exposed to excessive noise the greater the degree of hearing loss. More time equals more acoustic energy.

In general, the level of hearing loss depends on the level of noise and the duration of exposure. Some individuals are more sensitive to noise than others and will lose hearing more readily from noise exposure.

It should therefore be noted that, because of the large inherent variations of susceptibility between individuals, the limits set out in the regulations are not in themselves guaranteed to remove all risk of noise induced hearing loss.

The exposure standard does not apply to ultrasound or infrasound. Ultra and infra sound guidelines are noted in Appendix 3.

5.2 Other Effects

(a) **Non-auditory health effects**

The present state of *scientific* knowledge is such that, while some studies have identified non-auditory health effects, the evidence is inconclusive.

(b) **Non-auditory psychological effects**

Performance on reading, writing and listening tasks is affected by noise.

These tasks and those requiring a steady posture or balance are also disrupted, particularly, by sudden bursts of noise. Performance on tasks demanding continuous attention (ie. vigilance) may be affected by continuous noise.

Annoyance is determined by the intensity of the sound and by the attitude of the individual. Generally it has been found that when people believe they can exercise control over the source of the noise, the annoyance quality of the noise is reduced.

Excessive noise, below the exposure standard, can have negative effects depending on the environment (eg. noise from photocopiers can be distracting to staff in a nearby general office area). Guidelines on appropriate noise levels for particular work environments that should largely prevent these effects may be found in Australian Standard AS 2107.

6. DEFINITIONS

There are a number of key terms used throughout this code. Some of the terms are included in the definitions section (section 4) of **the Occupational Health and Safety Act 1985** and others are in the regulations. The terms are included here for the reader's convenience:

"**Act**" means the *Occupational Health and Safety Act 1985.*

"**administrative controls"** means systems of work that substantially reduce the exposure of employees to noise including reduction in exposure time but does not include engineering controls and hearing protection devices.

"audiometry" means the measurement of the hearing threshold level of persons by means of a bilateral pure tone air conduction threshold test.

"**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 a hearing protection device.

"hearing protection device" means a device or pair of devices worn by a person or inserted in the ears of a person to reduce noise exposure.

"plant" includes any machinery equipment appliance implement and tool, any component thereof and anything fitted connected or appurtenant thereto.

"practicable" means practicable having regard to:

(a) the severity of the hazard or risk in question;
(b) the state of knowledge about that hazard or risk and any ways of removing or mitigating that hazard or risk;
(c) the availability and suitability of ways to remove or mitigate that hazard or risk; and
(d) the cost of removing or mitigating that hazard or risk.

"sound power" is the total sound energy radiated per unit tune, measured as decibels referenced to 1 picowatt using octave bands or an A weighting.

"sound pressure level" is the size of the pressure fluctuations in the air at a point in the sound field. Sound pressure level is calculated as 20 times the logarithm to the base 10 of the ratio of the r.m.s. sound pressure to the reference sound pressure, (20 micropascals) measured in decibels.

"supply", in relation to any plant or substance, includes supply and resupply by way of sale, exchange, lease, hire or hire-purchase, whether as principal or as agent.

"**Workplace**" means any place, whether or not in a building or structure, where employees or self-employed persons work.

Further definitions of the technical terms used in this code are contained in Appendix 5.

7. DESIGN

7.1 Designers

The regulations require designers to consider noise emission and exposure when designing workplaces and plant to be used in workplaces, and to ensure that the noise levels are as low as practicable (regulation 9(1)).

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.

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 is given in Part 3 of this code.

7.2 Manufacturers, importers and suppliers

Manufacturers, importers and suppliers are required by the regulations to consider and assess the noise hazard likely to be posed by plant (regulation 9(2)). Where a noise hazard is identified appropriate measures should be taken to control the noise.

Specifically, the regulations require manufacturers, importers and suppliers to provide information about:

- sound power and sound pressure level
- correct means of construction, installation, maintenance and use

and ensure it is made available to the intending purchaser of the plant.

This information would typically be compiled by the manufacturer. Suppliers and importers could then obtain this same information from the manufacturer.

Guidance for manufacturers, importers and suppliers is given in Part 3 of this code.

7.3 Employers

Employers are required to consider noise information made available by manufacturers, importers or suppliers (regulation 10). This noise information should be obtained prior to purchasing plant. This can then be used to plan workplaces and systems of work that result in exposure levels less than the exposure standard.

The sound level and power produced in test conditions may be less than those produced when the plant is used at the workplace. Possible 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

Where an employer designs plant, the employer's responsibilities are also those of a designer. Where an employer manufactures plant, the employer's responsibilities are also those of a manufacturer.

Guidance for employers is given in Part 3 of this code.

8. RISK IDENTIFICATION, ASSESSMENT AND CONTROL

There are many factors involved in dealing with the risks associated with noise exposure at work. It is important for the employer to consider all relevant risk factors and not to focus on only one or two.

There are three key stages in a successful program:

- Identification of risk factors (regulation 11)
- Assessment of the level of employee noise exposure (regulation 11)
- Control of risk due to noise exposure (regulation 13)

9. CONSULTATION

The provisions of the Act and the regulations combine to place an obligation on the employer to consult with employees and health and safety representatives prior to taking action under the regulations and while the action is being undertaken (See section 31(2)(c) of the Act and regulations 11 and 12.)

Consultation should take place as early as possible when planning for the introduction of new or modified plant or in the review of existing noise control measures, to allow for changes arising from the consultation to be incorporated.

Employees should again be consulted when a particular control measure is being proposed. Employees should also be consulted when the effectiveness of implemented control measures are being reviewed.

Consultation is required with the relevant health and safety representative throughout the process. This consultation should occur:

- when the employer is identifying the problem areas in order to establish priorities for assessment
- when determining the approach and methods to be used in assessing the hazardous noise
- where the employer is to undertake a strategy or process for addressing hazardous noise which may affect the representative's designated work group, and
- when decisions are taken on various control measures to reduce the risk of hearing loss

10. CONTROL OF RISK

If an assessment shows that noise in any part of the workplace is likely to exceed the exposure standard, the employer ".must ensure that employees' exposure to noise is controlled so as to minimise risk to health and safety" (regulation 13).

10.1 Exposure Standard

The regulations set noise exposure limits and require employers to take specific actions where employees' noise exposure is likely to exceed either of these limits. Specifically, the noise exposure limits imposed by the regulations are an 8 hour average of 85dB(A) Leq (commonly written as LAeq8h 85dB(A)) and a peak noise level of 140dB (linear). These limits are referred to in the regulations as the exposure standard.

10.2 Development of a written plan

Regulation 13(2) requires an employer to produce a written plan which describes the proposed action to control noise in the workplace. The objective of this requirement is to ensure there is clear evidence that a control strategy has been developed.

The written plan should summarise the measures to be taken and set a series of deadlines before which each particular measure is to be implemented. The actions in the written plan should be in accordance with the priority *order in* 10.3 below. The plan *should be reviewed,* and if necessary modified where circumstances change.

10.3 Risk control priority

The regulations effectively contain two control hierarchies. The first provides that until 1 July 1997 an employer may rely solely on administrative controls and hearing protection devices to protect employees from noise in excess of the exposure standard. The 30 June 1997 is the last date that an employer can solely rely on administrative controls and hearing protection devices. The 1 July 1997 is the date on which the process of implementing the second hierarchy must be completed. *The* second hierarchy requires an *employer to* determine and. implement engineering controls to ensure workers are not exposed to noise in excess of the exposure standard, provided that this method of control is practicable. Administrative controls and hearing protection devices may only be considered appropriate if engineering controls can be shown to be impracticable or if engineering controls alone do not reduce noise to below the exposure standard.

11. AUDIOMETRY

Where hearing protection devices are relied on, audiometric tests are required by the regulations (regulation 15(2)). Audiometric tests are required to monitor employees' hearing. However, audiometric test results only give an estimate of hearing loss due to past noise exposure. This is because there is usually a lag between noise exposure and hearing loss. The absence of hearing loss on an audiogram may be false reassurance.

The results of audiometric tests can only be used to give an indication of the effectiveness of noise control measures in the past.

12. TRAINING

Employees exposed to noise, employees with supervisory responsibility, and those responsible for the acquisition and maintenance of hearing protection devices and other control measures, all require appropriate training (see regulation 17).

The employer is required to ensure that appropriate training is provided. and the content of any training program is tailored to the specific needs of the group being trained.

Further guidance is given in Part 8 of this code.

13. EMPLOYEES

Employees are required to use control measures introduced to reduce noise exposure, wherever possible, and if they have been given appropriate training in their selection, use, fit and maintenance (regulation 18).

14. DESIGNERS

This part contains information for designers, manufacturers, importers and suppliers. One person may have one or any combination of functions as an employer, designer, manufacturer, importer or supplier of plant.

Plant is defined in Section 4 of the Occupational Health and Safety Act 1985, which states:

> *Plant includes any machinery equipment appliance implement and tool, any component thereof and anything fitted connected or appurtenant thereto.*

In other works "plant" may be anything from a simple hand tool to a large *and* complex processing plant that incorporates control rooms and multiple workstations.

Regulation 9(1) states:

> *9(1) A designer who designs workplaces or plant to be used in workplaces, must take noise emission and exposure into account and ensure that the workplaces and plant are designed so that the sound power and sound pressure levels are as low as practicable.*

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.

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 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.

15. MANUFACTURERS, IMPORTERS AND SUPPLIERS

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15.1 The Regulations

The regulations require:

9(2) A manufacturer importer or supplier of plant to be used in workplaces, must take noise emission and exposure into account and ensure that the plant is constructed so that the sound power and sound pressure levels generated by the plant are as low as practicable.

9(3) The manufacturer, importer or supplier must ensure, as far as practicable, that -

(a) plant is tested for sound power and sound pressure level;
and
(b) information about test results and the correct means of construction, installation, maintenance and use of the plant is made available to the purchaser priorto the purchase of the plant.

15.2 Information to be Made Available to Purchasers

The information required to be provided by manufacturers, importers or suppliers includes:

- where there are workstations, the LAeq (see *Appendix 5)* at the position(s) of the operator's hearing zone representative of that occupied by the operators) during proper usage or, where there are no workstations, the highest LAeq measured at a distance of 1 metre from the plant and at a height of 1.5 metres from the floor and any access platforms
- the peak noise level
- sound power
- octave band levels where they are available
- a summary of the conditions of measurement which should be representative of proper usage (see Appendix 2) adequate to enable the test results to be repeated and reproduced.
- the proper use of the product
- methods for proper erection and installation of the plant.

Additional information that may be provided includes:

- methods used to reduce noise in the operation of the product
- noise reducing attachments which may be available
- any design limitations of the product or special situations where its use would be likely to result in a noise hazard

This information could be provided in a form similar to Form l.

16. MANUFACTURERS

The regulation requires manufacturers to ensure plant is tested for sound power and sound pressure level (regulation 9(3)(a)). This testing or assessment should also provide information on how the use, construction and installation of plant could reduce noise emissions. This testing or assessment should take into account reasonably foreseeable ways in which the plant might be used.

Where identical units of plant are being manufactured and where there is likely to be no, or very little, variation in the final plant (eg., same model) the manufacture may decide to only test a representative number of these. 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.

Example on how use, construction or installation of plant could reduce noise emissions include:

- improved manufacturing tolerances
- the use of more highly damped materials, eg 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 or
- other relevant noise control methods.

Advising the designer of the plant of any proposed changes to the original specifications may result in these changes being incorporated into future designs.

In regard to products that have yet to be manufactured *but* for which designs and production methods have been developed, manufacturers must give consideration to using improved or alternative production methods or designs that would reduce noise to the lowest practicable level, as required by the regulations.

Consideration of noise in plant design and construction can occur 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 possibly with the use of expert assistance.
- noise testing as part of a research and development program.

17. IMPORTERS AND SUPPLIERS

A supplier includes people who sell secondhand plant or provide plant for use in workplaces on hire or lease basis.

Importers and suppliers should request from the manufacturers all relevant test data not supped with the plant.

Importers/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.

Importers/suppliers should ensure that all plant is delivered complete with noise reducing equipment where this is required.

Importers/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.

18. EMPLOYERS: NEW PLANT AND WORKPLACES

The regulations require:

> *9(4) An employer must ensure, as far as practicable, that the design and construction of a new workplace under the control and management of the employer and new plant to be used in the workplace prevents employees from being exposed to noise at levels which are in excess of the exposure standard.*
>
> *10. **Use of plant***
> *An employer who installs, maintains and uses plant must do so having regard to any relevant information made available by the manufacturer, importer or supplier in accordance with regulation 9 (3) (b).*

Issues which should be considered in the design and construction of a new workplace include:

- location of plant
- effects of mobile plant
- location of major constant noise sources
- effects of work processes, for example: metal stamping; use of compressed air
- the flow of work and consequent need for doorways and openings
- ability to isolate particular operations

19. USE OF INFORMATION MADE AVAIIABLE BY MANUFACTURERS/IMPORTERS/SUPPLIERS

19.1 Application of Noise Level Results

The regulations (see regulation 9(3)) require that manufacturers, importers and suppliers make available to purchasers information about sound power and sound pressure levels generated by plant. In considering this information, as required by regulation 10, employers should be aware that several factors acct the extent to which tests of sound power and levels, may be applied to sound pressure:

- test conditions and procedures
- conditions of load
- methods of construction and installation
- design and layout of workplace

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19.2 Determining Noise Exposure from Information Made Available to Purchaser

An employee's noise exposure is essentially the noise measured at the ear during a representative shift (see Part 4 for more information). This noise level may vary depending on several factors:

- the position of the employee
- the type of noise generated (eg continuous, tonal, impulsive etc)

- the plant being used and processes carried out
- the amount of time the equipment is used or process is carried out
- background noise levels due to other equipment or processes that occur in adjacent areas (these can also vary}
- the length of the workshift.

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

Sound power is not a noise level

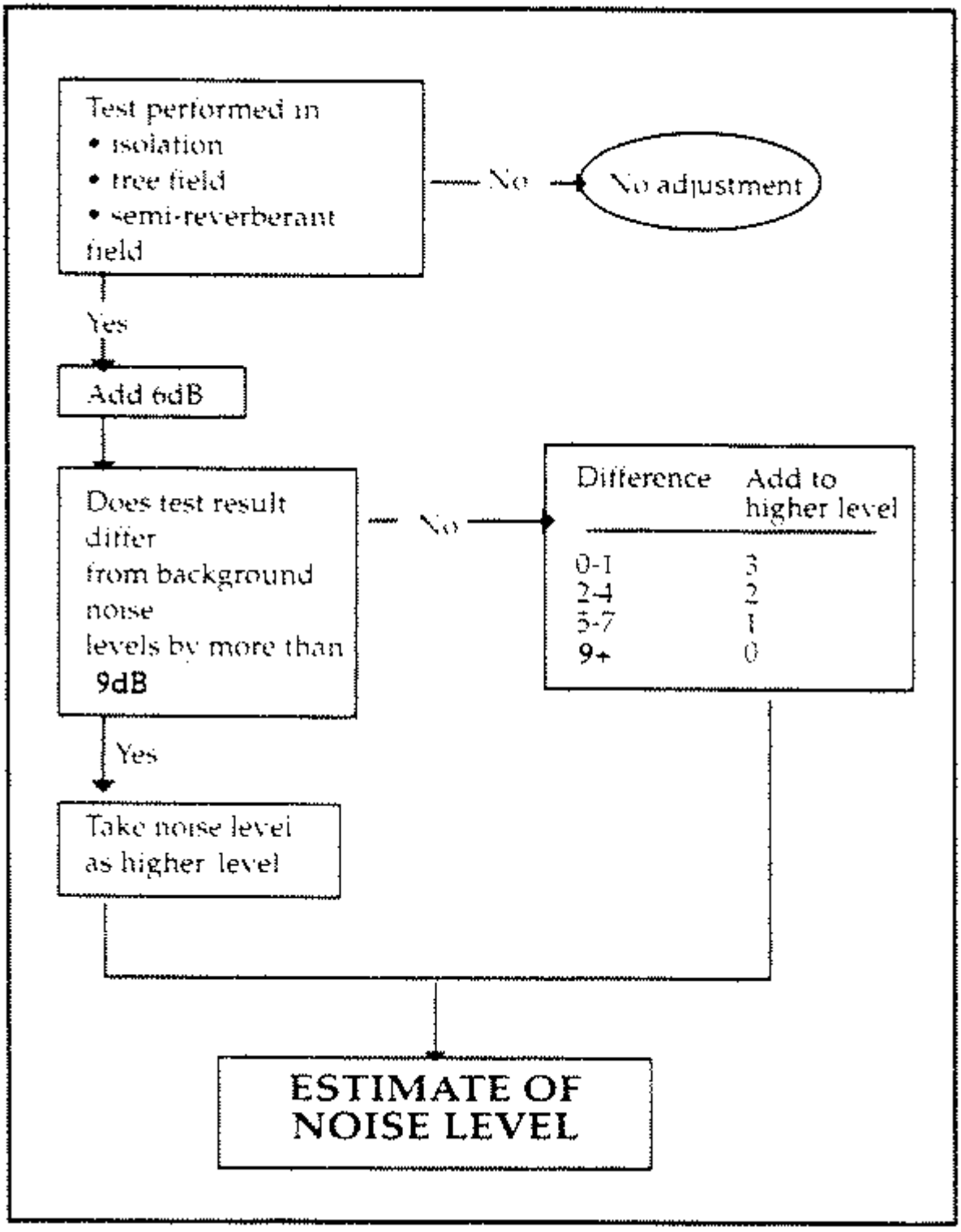
Sound power is not a noise level and cannot be directly compared with the exposure standard. However, a competent person should be able to use sound power to calculate the noise levels generated by a machine in a given situation.

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

The test results provided by manufacturers/importers/ suppliers can, in some cases, be used by the employer to estimate noise exposure. Results on peak noise levels and LAeq measurements in particular can be used to estimate noise exposure in order to make comparisons with the exposure standard.

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

Note: the assumptions stated below should be considered when using this flowchart.


Test performed in
• isolation
• tree field
• semi-reverberant field
No
No adjustment
Yes
Add 6dB
Does test result differ from background noise levels by more than 9dB
No
Difference
Add to higher level
0-1
3
2-4
2
5-7
1
9+
0
Yes
Take noise level as higher level
ESTIMATE OF NOISE LEVEL

The Laeq8h is a function of noise level and the length of exposure.

The LAeq measured can be used to estimate noise exposure by comparison with the LAeq8h exposure standard 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.

The flow chart in Figure 1 can be used to adjust the test results.

The flow chart in Figure 1 is based on the following assumptions:

- the conditions of load are the same as in the test
- if the test noise level and the background level differ by more than 9 decibels then the lesser of the two will not add much to the noise
- when equipment is tested in isolation a rule of thumb is to add 6dB(A) to allow for reflections from nearby surfaces
- the correct method of construction and installation is used.

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 standard.

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

Noise levels less than 75dB(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 LAeq 8h, the following data is needed:

- the noise levels to which the employee is exposed
- the noise level of any new plant the employer is considering purchasing
- the time that the employee is exposed to the noise

Figure 2 can be used to estimate the LAeq8h using the following method

- use noise level and exposure time to read off
- fractional exposure
- convert fractional exposure to LAeq8h.

This provides an estimate of the employee's likely exposure. An example of how to calculate daily noise exposure is given in Figure 3.

The average noise levels LAeq8h of 85dB(A) and 90dB(A) for different shift duration's are outlined in the following Figure 2.

Duration of Shift	LAeq8h	
Hours	**85dB(A)**	**90dB(A)**
2	91	96
4	88	93
8	85	90
10	84	89
12	83	88
16	82	87

Figure 2: Average noise level (LAeq) for different shift duration's.
.

19.3 Tonal versus broad band noise

Noise largely emitted over a small frequency range is called tonal noise. Noise that is emitted equally, over a wide range of frequencies is called broad band noise.

If it is not practicable to use engineering and administrative controls to reduce exposure below the standard, hearing protection is required (regulation 13(1)). The level of hearing protection can be estimated. The specific technique used to estimate the protection factor depends upon whether the noise is tonal or broad band. For tonal noise, it is more accurate to use the octave band method described in AS1269 to estimate the protection provided by the hearing device.

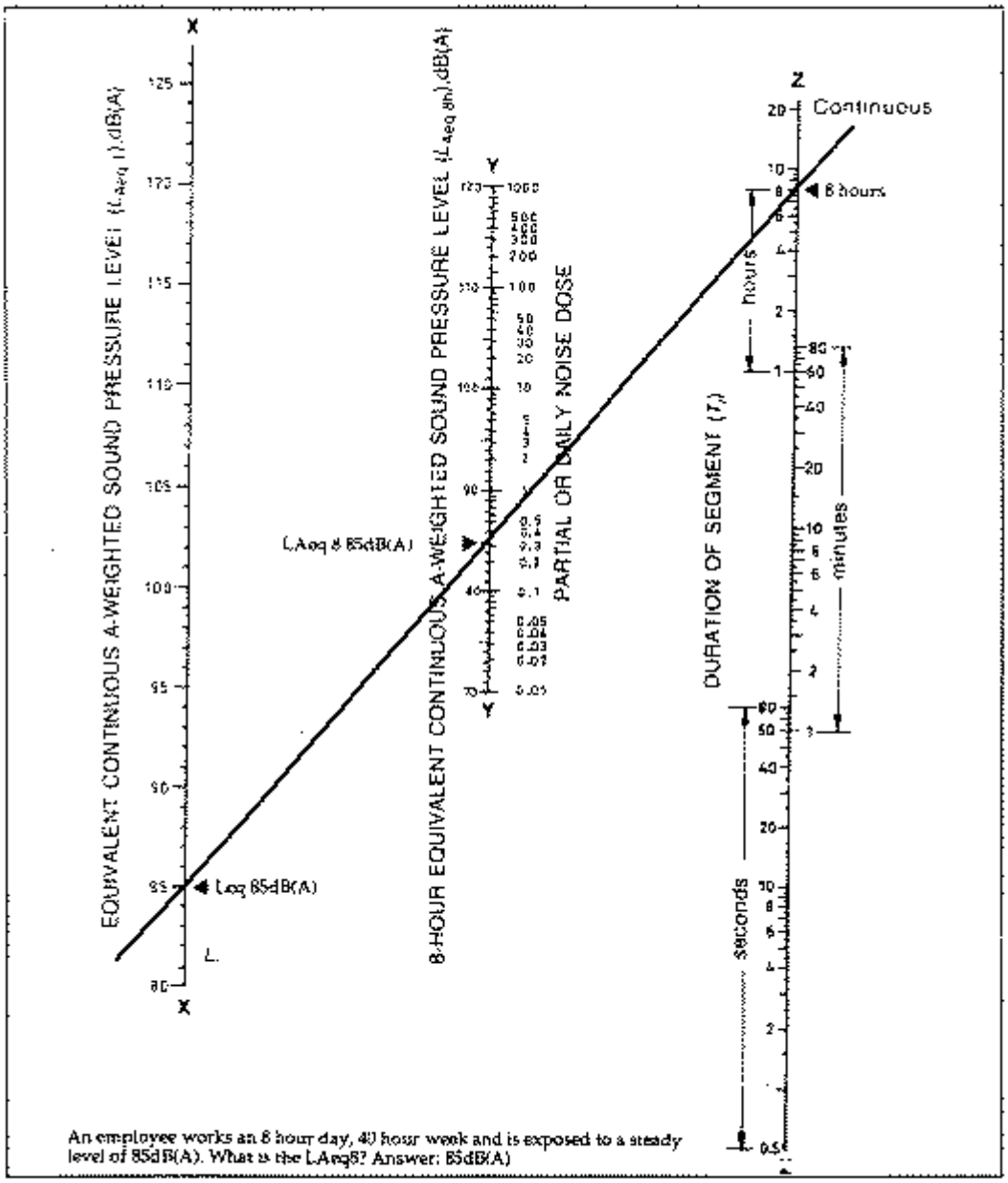


Figure 3: Nomogram for calculating LAeq8 from noise levels and exposure times (from AS 1269)

Note: This nomogram can also be used for the calculation of daily noise dose.

FORM 1 NOISE INFORMATION FROM MANUFACTURERS/SUPPLIERS

1. Subject:

Manufacturer: .....

Address: .....

.....

.....

.....

Model: ..... Date: .....

Serial No.: .....

Power: .....

.....

2. Noise Levels

LAeq and Peak noise level can be used to estimate likely noise exposure. A method is given in the Code of Practice on Noise (see Part 4)

Condition/Location	Result	
	Mean	Range
☐ LAeq at operator's position(s)		
☐ LAeq workstations absent		
Peak noise level		
☐ operator's position		
☐ no work station		

Condition	Octave Band (H_z)
	31.5 63 125 250 500 1k 2k 4k 8k
	☐ Broad band ☐ Tonal

Test Conditions and Instrumentation:

.....

3. Sound Power

Sound power is not a noise level and cannot directly be compared with noise exposure standards. A competent person should be able to use sound power to calculate noise level generated by plant in any given situation.

Conditions	Result	
	Mean	Range
☐ A weighting		
☐ C weighting		

Condition	Octave Band (H_z)
	31.5 63 125 250 500 1k 2k 4k 8k

Test Conditions and Instrumentation:

4. Method of Construction, Installation and Use.

eg. Noise reducing attachments, methods to minimise noise during operation, situations or factors that would result in a noise hazard.

Attach details

5. Other Information

Add any additional information that you believe is likely to contribute to the equipment producing the least amount of noise.

Employers using this information should note that several factors effect the extent to which the above test results can be extrapolated to workplace conditions:

- test conditions and procedures
- conditions of load
- method of construction and installation
- design and layout of the workplace

Where doubt exists the advice of a competent person should be sought.

20. THE REGULATIONS

Regulation 11 (1)(a) provides:

11(1) An employer must-

(a) identify if there is a risk to employees from exposure to noise

21. RISK IDENTIFICATION CHECKLIST

A Risk Identification Checklist (Table 1) is included in the code to assist in identifying employees whose noise exposure is likely to exceed the exposure standard or whose exposure requires closer examination.

The existence of any one of the risk factors in Table 1 would indicate the need for further assessment as outlined in Part 4 of this code.

The boxes at the top of the form enable the person performing the risk identification to record relevant details such as:

- building, plant and equipment (description of work location)
- details of the task and/or process
- the person conducting the assessment on behalf of the employer, and
- (where relevant) the name of the health and safety representative consulted in the process

Table 1: Risk Identification Checklist

Description of Work Location

Date

Task Workstation

Assessed by

Health and Safety Representative

The existence of any one of the following key risk factors indicates the need for further assessment as required by regulation 13(1)(b) and outlined in Part 4 of the Code of Practice on Noise.

1. Is there difficulty in communication between two employees at 1 metre distance? (Difficulty means that the speaker must raise his or 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 any of the following:
   (a) ringing in the ears (tinnitus)?
   (b) the same sound having a different tone in each ear (diplacusis)?
   (c) blurred hearing?
   Yes ☐ No ☐

4. Are any long term employees hard of hearing?
   Yes ☐ No ☐

5. Are hearing protection devices provided?
   Yes ☐ No ☐

6. Are signs indicating that hearing protective devices should be worn, posted at the entrance or in the work area?
   Yes ☐ No ☐

7. Does the noise in any part of the workplace sound as loud or louder than 85 decibels using the scale in Figure 4?
   Yes ☐ No ☐

8. Do results of past noise measurements or surveys indicate noise levels equal to or greater than any of the following:
   (a) Surveys performed after 1/7/92
   (i) 85 dB(A) Slow or Fast? Yes ☐ No ☐
   (ii) 85 dB(A) L_{Aeq}? Yes ☐ No ☐
   (iii) 140 dB(lin) Peak Noise? Yes ☐ No ☐
   (iv) daily noise dose of greater than 0.3 (i.e. $L_{Aeq,8}$ 85dB(A))?
   Yes ☐ No ☐
   (b) Surveys performed prior to 1/7/92
   (i) 115 dB(A) Slow? Yes ☐ No ☐
   (ii) daily noise dose greater than 1.0 (i.e. $L_{Aeq,8}$ 90dB(A))?
   Yes ☐ No ☐

9. Have there been any industrial deafness claims?
   Yes ☐ No ☐

10. Does any equipment have noise information including labels that indicate noise levels equal or greater than any of the following
    (a) 80dB(A) L_{Aeq}? Yes ☐ No ☐
    (b) 135dB(lin) Peak Noise? Yes ☐ No ☐
    (c) 80dB(A) Sound Power? Yes ☐ No ☐

    Note
    1. The L_{Aeq} or dB(lin) measurement supplied may, for a variety of reasons, under estimate noise levels that actually result. The levels in (a), (b) and (c) are thus some decibels below the standard.
    2. Sound Power is not a noise level. Under some circumstances, equipment generating a sound power of 80 dB may result in a noise level of L_{Aeq} 85dB(A) or higher.

11. Do the results of audiometry indicate that any past or present employee have hearing loss?
    Yes ☐ No ☐

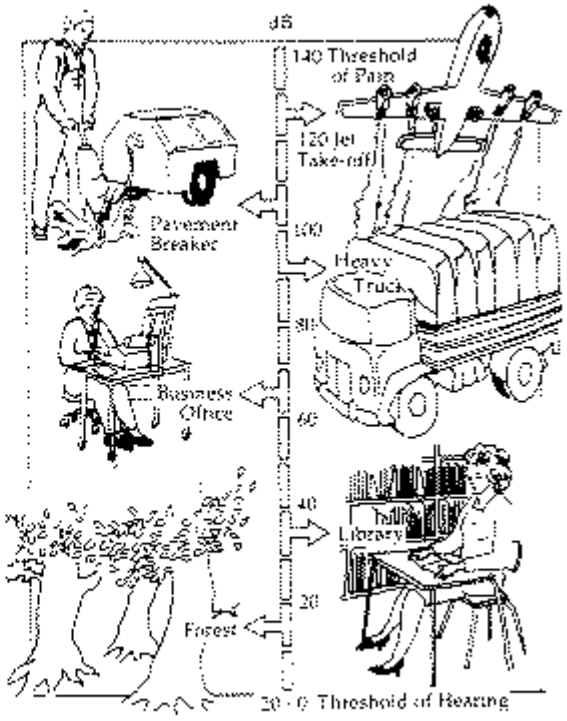


Figure 4. Decibel level of common sounds
A further copy of this form can be found in Appendix 4

22. THE REGULATIONS

Once a potential risk has been identified, the regulations provide for the undertaking of an assessment to determine whether the exposure standard is exceeded.

Exposure standard means:

7. Exposure standard and how exposure to noise must be measured

(1) For the purpose of these regulations the "exposure standard" means-
(a) the 8 hour equivalent continuous sound pressure level of 85dB(A) measured in A-weighted decibels referenced to 20 micropascals; and
(b) the linear (unweighted) peak hold sound pressure level reading of 140 dB(lin) measured in decibels referenced to 20 micropascals determined by sound measuring equipment with a P time weighting function

(2) Exposure to noise must be measured at the employee's ear position and must not take account of the effect of any hearing protection device.

The risk assessment therefore requires employers to determine whether either of the above noise exposure limits are exceeded. If an employee's noise exposure exceeds either of these limits (ie. LAeq8h 85 dB(A) or peak noise 140 dB(linear), the employer is required to take action to control noise exposure (see Part 5 of the code).

The requirements for risk assessment are as follows:

11 (1) An employer must -.....

(b) make an assessment of an employee's exposure to noise if the employee's exposure to noise may exceed the exposure standard.

11 (2) The employer must ensure that the assessment is undertaken-

(a) by a person whom the employer ensures has, through a combination of training, education and experience, acquired knowledge and skills enabling the person to correctly perform the assessment;

(b) in consultation with-
(i) the employees who are exposed to the noise;
(ii) any health and safety representative for the designated work group of which those employees are members.

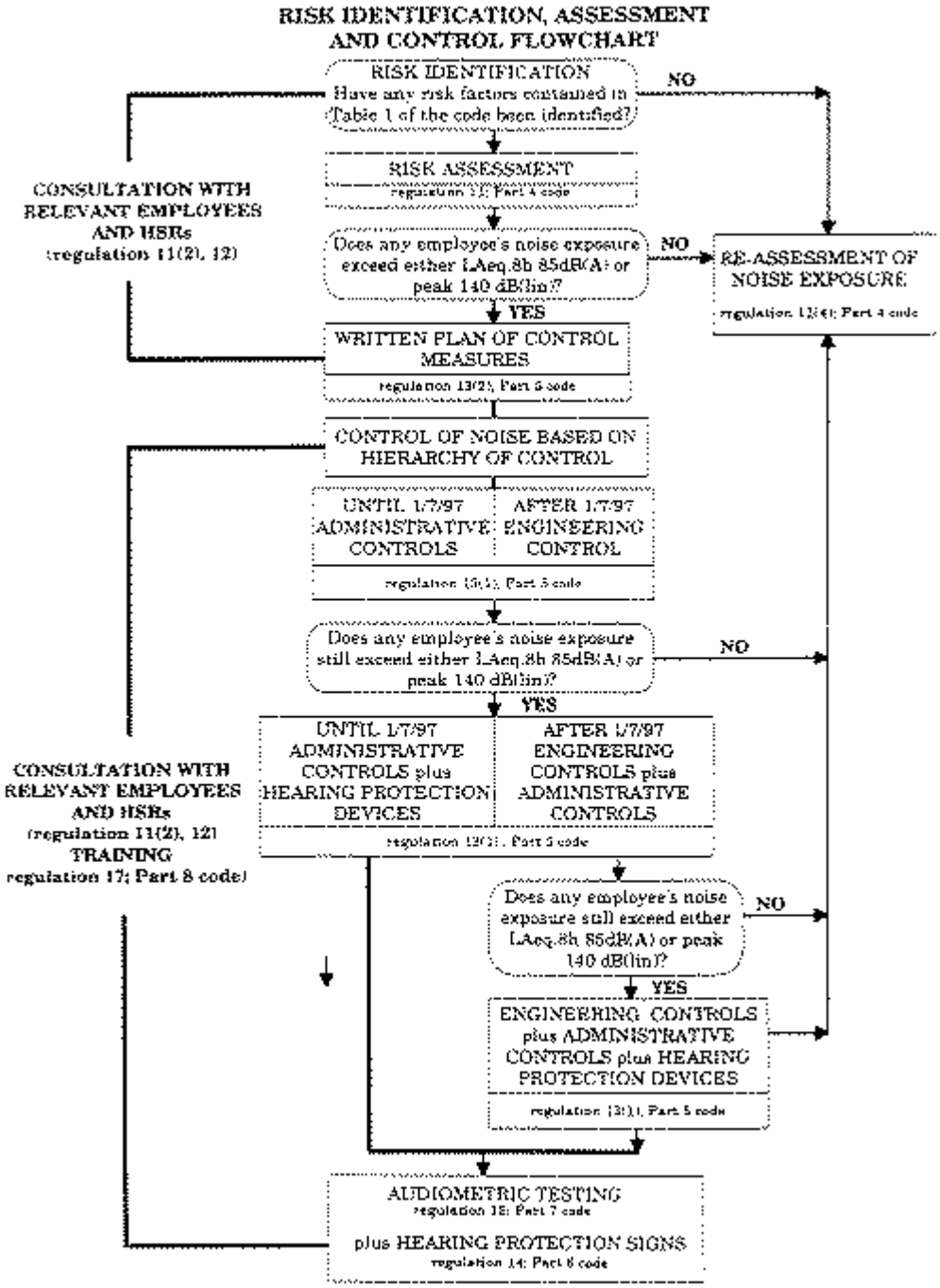
11 (3) The assessment must take into account the following factors-

(a) the plant in use at the workplace and the manner in which it is used;
(b) the layout and the condition of the workplace environment;
(c) any available information on the noise emission and sound power of the plant;
(d) the exposure of employees to noise;
(e) the systems of work;
(f) any other factors considered relevant to noise induced hearing loss by the employer, the employees or the health and safety representative.

Assessments are undertaken in order to:

- quantify the amount of noise to which employees are exposed and hence their risk of hearing loss, and
- help identify sources of noise and control strategies.

RISK IDENTIFICATION, ASSESSMENT AND CONTROL FLOWCHART



This flowchart provides an overview of employers requirements under the regulations and on the use of this code. The relevant sections of the regulations and code should be referred to for clarification and further detail.

23. PERSON WHO MAY CARRY OUT AN ASSESSMENT

Regulation 11(2) states:

> *11(2) The employer must ensure that the assessment is undertaken-*
>
> *(a) by a person whom the employer ensures has, through a combination of training, education and experience, acquired knowledge and skills enabling the person to correctly perform the assessment*

The person carrying out the assessment should have a thorough understanding of:

(a) the objectives of the assessment
(b) the correct way to use noise measuring instruments
(c) the limitations of noise measuring instruments
(d) the limitations of the noise exposure assessment strategy
(e)the interpretation of the results
(f) the recording of the results
(g) Australia Standards AS 1269, AS 2659, AS *2399* and AS 1259 (see clause 18 below)
(h) the regulations and this code.

The knowledge and skills that a person competent to perform risk assessment-should have acquired is described in detail in Appendix l.

Examples of individuals who may possess the necessary competence or who may readily gain it through a combination of education and experience are acoustic engineers, acoustic scientists and occupational hygienists.

24. PROCEDURE FOR UNDERTAKING NOISE MEASUREMENTS AND ASSESSMENT OF EXPOSURE

Noise measurements and exposure assessments should be undertaken in accordance with AS 1269 Section 2. The instruments selected depend on the circumstances and purpose of the noise assessment. All sound level meters should comply with the specifications laid down in AS 1259 and noise dosemeters should comply with AS2399.

AS1269 describes two stages in the carrying out of noise assessments: preliminary assessment and detailed assessment. A preliminary assessment should be undertaken to obtain an indication as to whether an employee's noise exposure may exceed the exposure standard. All factors required to be considered when carrying out an assessment (see regulation 11(3)) must be addressed when carrying out the preliminary assessment.

Where a preliminary assessment indicates that an employee's exposure may exceed the exposure standard, a detailed assessment should be carried out. In some cases, preliminary assessments can provide an indication of noise sources or processes where simple engineering noise control solutions can be implemented to reduce the noise levels. In such cases, the employer should consider whether the preliminary assessment is sufficient to justify implementing such measures. A subsequent detailed assessment would then be performed to evaluate the effectiveness of the controls in place.

The detailed assessment should provide results in the form of a LAeq8h and peak noise level for each employee likely to be exposed.

A type 0, 1, 2 or 3 sound level meter is adequate for a preliminary assessment. A type 0 or type 1 sound level meter or at least a type 2 noise dosemeter should be used for a detailed assessment.

The assessment of noise exposure should generally be undertaken during the employees representative workday ie. a working day during which the noise exposure is representative of employees' long-term noise exposure. The representative workday should be made up of segments proportioned in accordance with employees' long-term noise exposure. Where employees' exposure differs markedly from day to day, the assessment should take such variability into account.

Where noise level exposure fluctuates within a range of 8dB, measurements of LAeq8h and peak noise should be taken as follows:

(a) With the person absent and the microphone of the sound measuring equipment as close as possible to the person's normal working position.

(b) With the microphone at the side, or above, the person's head and preferably within 300 mm of it. If the sound level is different on the two sides of the person's head, the measurement made on the side with the higher level should be recorded.

For employees without fixed working locations measurements should be representative of the employee's movements with respect to the major noise sources present. Noise dosemeters are a convenient way of making such measurements.

(c) The measurement should be taken with the microphone of a personal dosemeter located in accordance with the manufacturer's instructions. Generally, the microphone should be as close as possible to the ear.

The period over which measurements are made should be representative of the operation, process, or work pattern under assessment.

Where noise fluctuates more than 6 dB, exposure should be assessed by a full shift measurement of the LAeq8h. If the measurement period is over a full working day or major part thereof, the measurement period should represent a typical working day.

25. NOISE MEASUREMENTS IN HAZARDOUS ENVIRONMENTS

A person carrying out a risk assessment in any workplace should recognise that other hazards besides noise may be present. These may be explosive or flammable atmospheres, or hazards associated with confined spaces. Any risk assessment should be conducted in compliance with the health and safety procedures for that workplace and be compatible with the existing workplace conditions. These health and safety procedures may include special work permits specifying the conditions under which the assessment can be conducted. For example, before conducting an assessment of a worker using an angle-grinder inside a storage tank, special precautions would need to be developed to address risk of flammability and air quality before any work (including the noise survey) proceeds, to ensure that the environment was suitable for entry.

A person carrying out a risk assessment in a workplace where an explosive or flammable atmosphere is likely to exist should use sound measuring equipment designed for use in these environments (often referred to as "intrinsically safe").

Only intrinsically safe noise dosemeters should be used for personal noise exposure measurements on employees in areas where an explosive or flammable atmosphere is likely to exist.

26. WHEN CALIBRATION OF MEASURING EQUIPMENT SHOULD OCCUR

Equipment should be checked with an acoustic calibrator immediately before and after the measurements. These checks should be repeated periodically during measurements, for example, twice during an all-day survey (except for a noise dosemeter being used for at least a full-day measurement'). If a discrepancy of more than +1 dB in the reference dB is found then the results should be considered invalid and the tests repeated.

Meters and calibrators should be calibrated in accordance with the relevant standards at regular intervals by a suitably equipped National Association of Testing Authorities accredited laboratory, as specified in AS 1269.

Where noise fluctuates more than 6 dB, exposure should be assessed by a full shift measurement of the LAeq8h. If the measurement period is over a full working day or major part thereof, the measurement period should

represent a typical working day.

27. TONAL NOISE

Where hearing protection devices are relied upon to control employees' noise exposure, the regulations require employers to provide and maintain the devices to ensure that "...employees' exposure to noise, taking into account the effect of the device, does not exceed the exposure standard" (regulation 13(1)).

Where tonal noise is present, octave band measurements should be performed in order to ensure that the most suitable, hearing protection device is provided. These are additional to measurements of LAeq8h and peak noise level.

The octave band measurements are compared with the amount of sound reduction provided by the hearing protection device at each octave band. Manufacturers of hearing protection devices generally provide information on sound reduction at each octave band. Part 6 of the code gives further information on the sound reduction available from hearing protection devices.

28. ASSESSMENT DATA TO BE RECORDED

The written record of assessments should be kept at or near the premises to which it applies. Alternatively, if the nature of the work makes it inconvenient to keep the records at the workplace (eg. demolition work), the written records should be kept available at an appropriate office. The written records of the assessment should be kept until the next assessment is performed.

Information should be recorded on a suitable written record form such as Form 2. The time pattern of exposure, operating conditions of plant and equipment during the assessment and description of the work environment may also be recorded. Where employees are exposed to noise, which varies over the working day, noise exposure should be estimated using the personal noise exposure section of Form 2.

See Appendix 4

29. HOW ASSESSMENTS ARE INITIATED

The regulations require that assessments must be performed under the following circumstances:

(a) At least every five years (regulation 11(5))

(b) As soon as practicable after there has been a change in the work place likely to affect an employee's exposure to noise (regulation 11(4)(b)).

Changes likely to alter employees' noise exposure include:

(i) installation or removal of plant and equipment;

(ii) a change in workload or machine speed likely to cause a significant change in noise level;

(iii) a change in building structure likely to cause a significant change in noise level;

(iv) 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 and short term changes such as non-routine maintenance work or inspections.

In many cases, for short term changes a preliminary assessment would provide sufficient information to indicate whether employee's noise exposure exceeds the exposure standard and to justify the implementation of the hierarchy of control measures.

(c) If an employer has conducted a previous assessment which meets the requirements of the regulations within the 4 years before 1 July 1992, the employer is not required to perform an additional assessment under regulation 11 until five years after that earlier assessment (regulation 11(7)).

(d) Where reasonably requested by the health and safety representative for the designated work group. A reasonable request would be one made where no other assessment has been performed as required by the regulations or this code(regulation 11(4)(c)).

(e) Where requested by an inspector (regulation 11(4Xd)).

30. PROVISION OF ASSESSMENT RESULTS TO HEALTH AND SAFETY REPRESENTATIVES EMPLOYEES

The regulations state:

11(6) *The employer must make the results of an assessment dealing with a particular designated work group available to the health and safety representative and employees of that designated work group.*

The employer should provide a copy of the results in a written form, for example, using similar to Form 2 in Appendix 4.

31. PRINCIPLES OF NOISE CONTROL

31.1 Every noise problem has three parts:

a source - from which the noise originates and radiates

- a path - along which the noise travels which could include either 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

Noise exposure may be controlled by:

- modifying the noise source to reduce the noise output, and or altering or blocking the transmission path of the noise to reduce the noise level reaching the receiver (engineering controls)
- removing the receiver from the area
- preventing exposure of the receiver by providing hearing protection 31.2 The regulations and the hierarchy of controls

31.2 The regulations and the hierarchy of controls

Regulation 13 sets out the hierarchy of measures to control employees' noise exposure:

13.(1) The employer must ensure that employees' exposure to noise is controlled so as to minimise risk to health and safety and must ensure that -

(a) until 1 July 1997 that the exposure to noise of any employee does not exceed the exposure standard by -

(i) implementation of administrative controls to the extent which is practicable; and

(ii) if administrative controls do not reduce employees' exposure to noise to the exposure standard, by providing and maintaining hearing protection devices to employees which will ensure the employees' exposure to noise, taking into account the effect of the device, does not exceed the exposure standard; and

(b) on 1 July 1997, that the exposure to noise of any employee does not exceed the exposure standard by -

(i) implementation of engineering controls to the extent which is practicable; and

(ii) if engineering controls do not reduce the exposure of employees to the exposure standard, by implementation of administrative controls to the extent which is practicable; and

(iii) if engineering and administrative controls do not reduce employees' exposure to noise to the exposure standard, by providing and maintaining hearing protection devices to employees which will ensure the employees' exposure to noise, taking into account the effect of the device, does not exceed the exposure standard; and

(c) any engineering and administrative controls implemented in accordance with this Regulation are retained despite these controls failing to reduce noise levels to the exposure standard.

The regulations require employers to take action to control noise exposure if either one of the exposure limits are exceeded (ie. LAeq8h 85dB(A) or peak noise 140 dB(linear)). The regulations effectively contain two control hierarchies. The first provides that until 1 July 1997 an employer may rely solely on administrative controls and hearing protection devices to protect employees from noise in excess of the exposure standard. The 30 June 1997 is the last date that an employer can solely rely on administrative controls and hearing protection devices. The 1 July 1997 is the date on which the process of implementing the second hierarchy must be completed. The second hierarchy requires an employer to determine and implement engineering controls to ensure workers are not exposed to noise in excess of the exposure standard, provided that this method of control is practicable.

Administrative controls and hearing protection devices may only be considered appropriate if engineering

controls can be shown to be impracticable or if engineering controls alone do not reduce noise to below the exposure standard. In effect, the employer must have implemented engineering controls to the extent practicable before 1 July 1997 if this deadline is to be met. The written plan of control that must be developed within six months after the assessment is completed, requires the employer to address engineering control measures and timeframes for the implementation (see regulation 13(2). Note that this control hierarchy has been structured to emphasis the value of using engineering control solutions to noise control problems. Note also that engineering controls must be implemented 'to the extent, which is practicable'. This means that even if noise exposure cannot be reduced to the exposure standard by engineering controls alone, those engineering controls, which are practicable, must be put in place.

32. WRITTEN PLAN OF HOW NOISE TO BE CONTROLLED

Regulation 13 states:

> *13 (2) If an assessment as referred to in regulation 11 shows that the noise in any part of the workplace is likely to cause employees exposure to noise to exceed the exposure standard, the employer must, within 6 months of the completion of the assessment develop a written plan of the actions proposed for control of the noise in accordance with this Regulation.*
>
> *13 (3) In the case of a workplace existing immediately before 1 July 1992, the employer must ensure the written plan is developed before 1 January 1994.*

Regulation 13(2) requires that a written plan of control measures to be implemented be prepared. This is required to be done in consultation with employees and relevant health and safety representatives (see regulation 12).

The circumstances for which a control plan has been developed may change prior to implementation. New technology may permit easier solutions. The practicability of a planned action may change. Accordingly, a plan should be kept under review, and where a different control strategy becomes more appropriate, the plan should be amended to reflect the changed circumstances.

For example, the plan could include:

- a summary of temporary measures to be used immediately to control noise exposure until engineering controls are implemented
- a description summarising the measures proposed
- the reduction in noise levels and exposure estimated to result
- agreed times by which the measures proposed will be implemented
- names of employer representatives responsible for performing and overseeing the development and implementation of agreed control measures
- a follow up phase to assess effectiveness of implemented controls which should include checks, where necessary, of the noise levels to ensure that hidden defects are not causing higher noise exposure.

The written plan should also address the following:

- selection and purchase of quiet plant in preference to noisy plant (information made available by manufacturers/importers/suppliers should be reviewed); commissioning of new plant should include a check of noise emission (ie. take noise measurements)
- design of new work areas to include engineering noise controls for the plant and the building where practicable
- ensuring adequate noise control measures in temporary work areas or operations
- procedures for preventive maintenance for existing plant and workplaces, which should include procedures for ensuring that measures used to control noise levels, such as silencers or enclosures, are kept in good order and in position during the operation of noisy machines
- procedures for monitoring usage of hearing protectors
- the identification of hearing protection areas (see Clause 40, Marking of Zones)
- the protection of employees visiting other employer's premises (eg. maintenance crews).

33. ASSISTANCE OF A SKILLED PERSON

In some cases, the assistance of a person with expertise in noise control may be needed when prioritising, developing and implementing engineering controls, including in the development of the written plan.

At the planning stage the assistance of such a person is useful if the solutions are unclear or not easily determined.

This person should understand:

- the principles of acoustics
- the principles of noise control engineering
- the requirements of the regulations and this code

Examples of persons who may possess the necessary skills or may readily gain through a combination of education, training and experience are acoustic engineers, acoustic scientists and occupational hygienists.

34. ENGINEERING CONTROLS

Control measures that can be used to reduce workplace noise may involve a variety of engineering principles. Determination of the most effective technique involves consideration of the noise sources, transmission pathways and receiver.

For any noise problem there will often be several sources, which will need to be tackled. It is necessary to establish the contribution that each makes to the total noise generated.

When seeking an engineering solution to a noise problem, an understanding of the operation of the machine or process is necessary to consider the possible treatment of the noise at its source. Engineering measures can be specifically targeted at the machinery and its parts, or towards the actual processes, including material handling systems.

Use should be made of references (see Bibliography) on noise control engineering for detailed information on techniques that could prove suitable. Some of the specific measures that should be considered and implemented have been outlined in the code. However, these techniques may not be effective in every case. A logical approach, willingness to experiment and the advice of a competent person is necessary for effective engineering control.

New developments in noise control are occurring all the time and employers should keep up to date. Where technical difficulties prevent immediate reduction of noise by engineering means, regular reviews should be made taking into account new developments in technology.

When deciding which noise sources or in which areas noise exposure should first be controlled by engineering means, the following factors should be considered:

- the magnitude of LAeq8h and peak noise level,
- the number of exposed employees who will benefit from control measures,
- where necessary, the results of any engineering appraisal of the problem performed by a competent person,
- any factor that makes the use of hearing protection devices unsuitable, for example - work that is hot and dirty.

35. ENGINEERING CONTROL AT SOURCE

35.1 Plant

Noise control solutions, and examples of particular engineering measures which can be carried out on plant are provided below.

(a) Eliminate or replace the plant or its operation by a quieter operation.
(b) Replace the noisy plant by installing newer equipment designed for operating at lower noise levels.
(c) Correct the specific noise source by minor design changes.
(d) 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 (see Figure 5).
(e) 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 mounting, lagging to damp vibrating surfaces, mufflers or silencers for air and gas flows, or reducing air velocity of free jets. These may be considered as solutions for the individual noise-producing elements of the total operation (see Figure 6).

(f) Move the noisy elements which need not be an integral part of the basic plant (see Figure 5). For example, move pumps, fans and air compressors that service the basic machine.

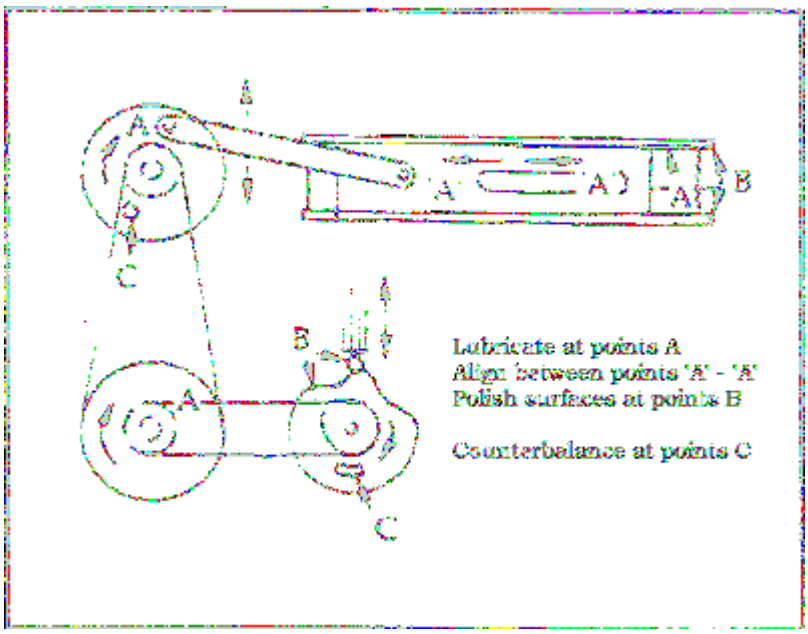
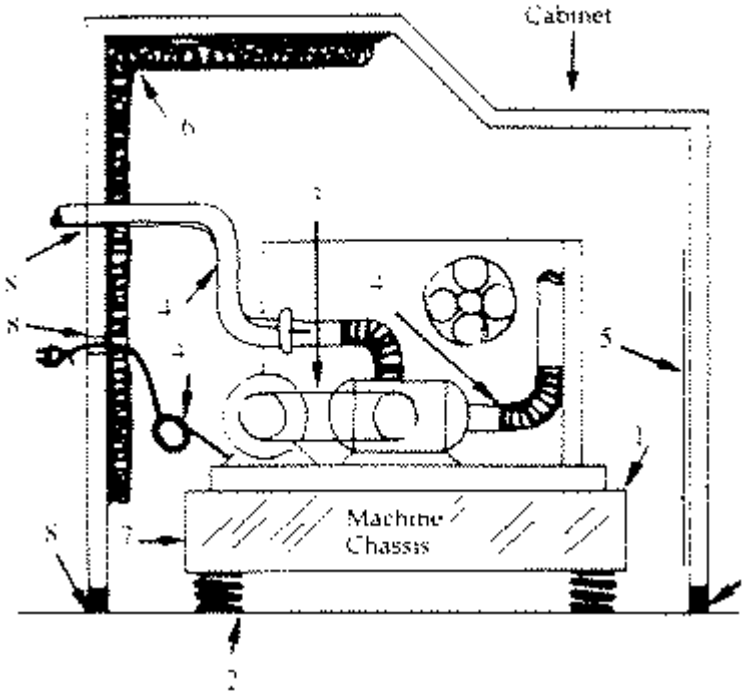


Figure 5: Examples of good maintenance (from U.S. Department of Commerce. National Bureau of Standards. "Queiting: A Practical Guide to Noise Control" (Publication No NBS HB-119) (1976)



1. Install motors, pumps, fans, etc. on most massive part of the machine.
2. Install such components on resilient mounts or vibration isolators.
3. Use belt drive or roller drive systems in place of gear trains.
4. Use flexible hoses and wiring instead of rigid piping and soft wiring.
5. Apply vibration damping materials to surfaces undergoing most vibration.
6. Install acoustical lining to reduce noise buildup inside machine.
7. Minimise mechanical contact between the cabinet and the machine chassis.
8. Seal openings at the base and other parts of the cabinet to prevent noise leakage.

Figure 6: Solutions for reducing noise caused by specific plant elements (from U.S. Department of Commerce. National Bureau of Standards. "Quieting: A Practical Guide to Noise control" (Publication No. NBS HB-119) (1976)).

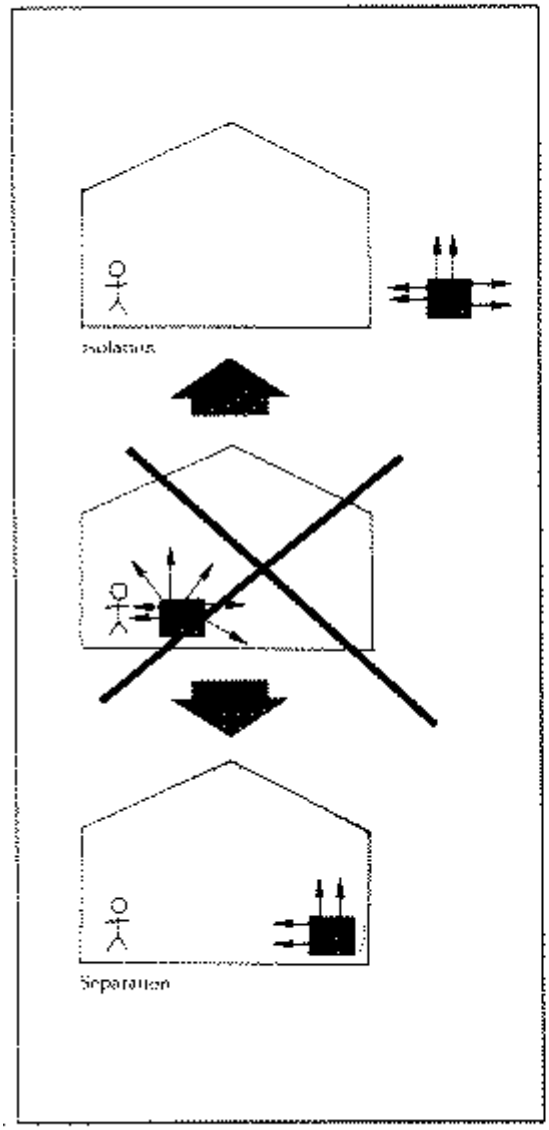


Figure 7: Reducing noise exposure by isolation and separation. Note that separation is only effective where room surfaces tend to absorb sound (from a publication on noise control prepared in Sweden for the Swedish Work Environment Fund).

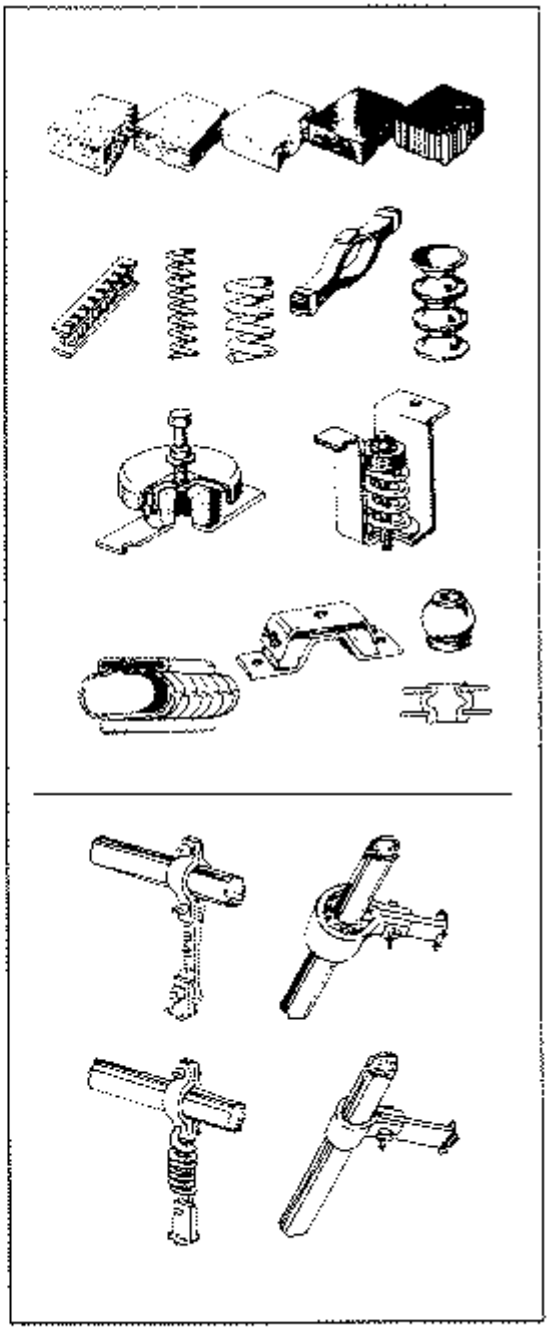


Figure 8: Various types of isolators (from a publication on noise control prepared in Sweden for the Swedish Work Environment Fund).

35.2 Process modification

In addition to engineering changes to plant, processes 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

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

- minimising the fall height of the product onto hard surfaces (see Figure 9)
- stiffening and/or fixing damping materials to tables, walls, panels or containers where they are struck by materials or items during processing (see Figure 10)
- absorbing shocks through the provision of wear resistant rubber or plastic coatings (see Figure 10)
- using conveyor belts, rather than rollers which are more likely to rattle
- controlling the speed of processes to maintain a much smoother work flow and less likelihood of noise generation due to stop-start impact noise
- matching of 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 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 may only need to be on during that part of the cycle when the product is ejected
- using air nozzles and blow-off cleaning guns constructed on aerodynamic principles (see Figure 11) - however, where possible, these devices should be avoided

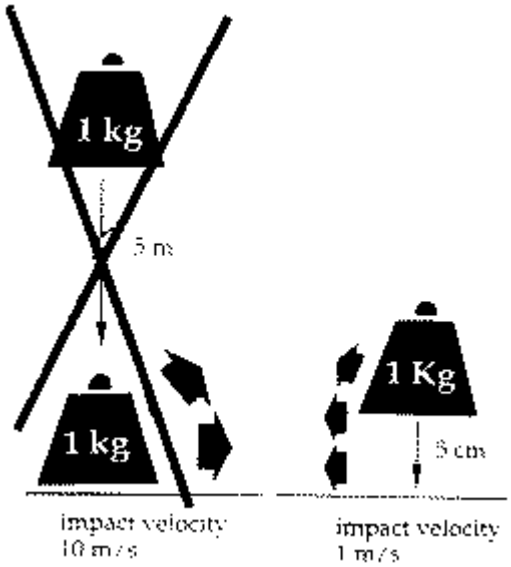


Figure 9: Lesser fall distance tends to lessen impact noise (from a publication on noise control prepared in Sweden for the Swedish Work Environment Fund).

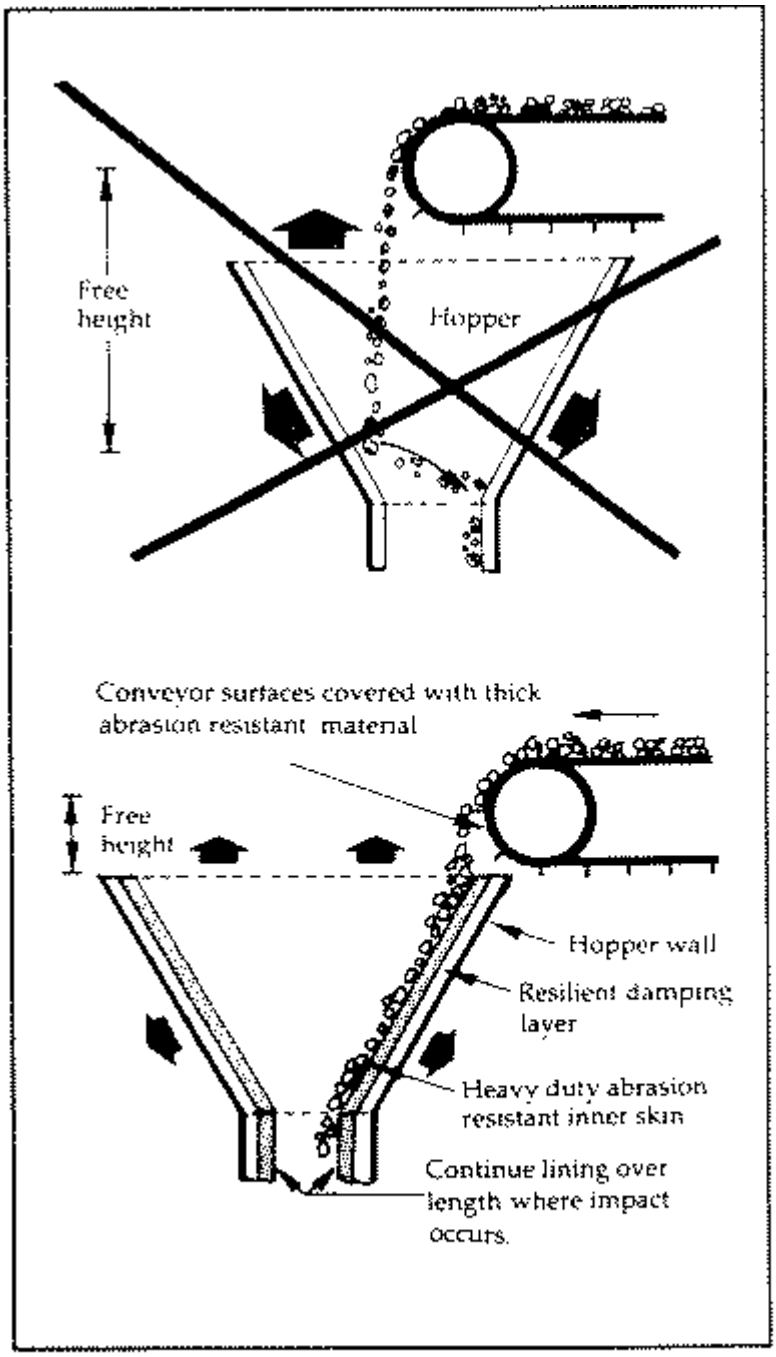
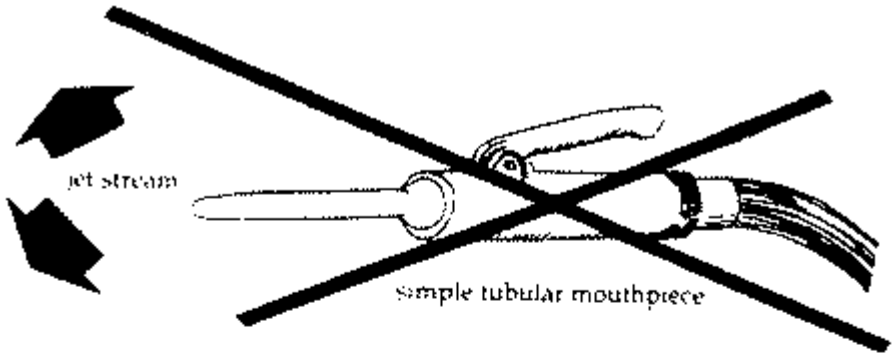
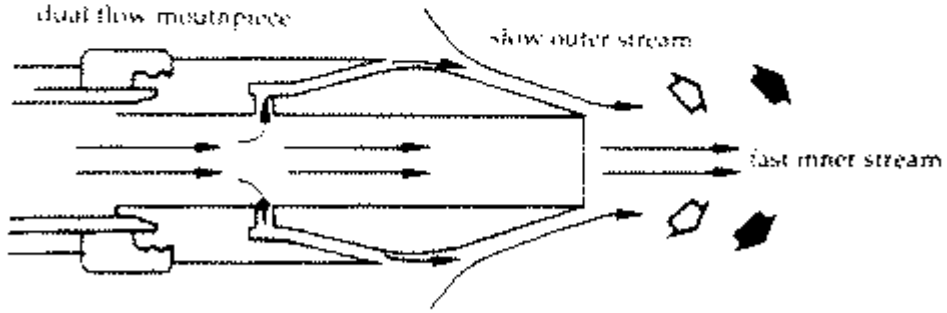


Figure 10: Height of fall into hopper has been reduced layer of damping material also reduces impact (from a publication on noise control prepared in Sweden for the Swedish Work Environment Fund).



Example
The cleaning of machine parts with compressed air after processing is often carried out with simple tubular mouthpieces. Very high exit speeds are required, and a strong high frequency noise develops.



Control measure
The simple tubular mouthpiece can be replaced by mouthpieces which produce less noise, such as a dual flow mouthpiece. In this mouthpiece, part of the compressed air moves at a lower speed outside the central stream.

Figure 11: (from a publication on noise control prepared in Sweden for the Swedish Work Environment Fund)

36. ENGINEERING TREATMENT OF THE NOISE TRANSMISSION PATH

36.1 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 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 are listed below.

(a) Distance is often the cheapest solution but it may not be effective in reverberant conditions (ie where there are hard reflective surfaces) (see Figure 12)

(b) Walls and machine enclosures should be designed to minimise resonances which will transmit acoustic energy at the resonant frequency to the unprotective ear of the employee. This can be achieved by placing reinforcement or bracing in strategic areas during construction or modification.

(c) 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.

(d) Once the acoustical barrier is erected, further treatment such as the addition of absorbing material on surfaces faring the noise source, might be necessary (see Figure 13).

(e) 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.

(f) Good sound absorbers – for example, certain open cell foams, fibreglass, rockwool and thick pile carpet - are very poor barriers to the transmission of sound.

(g) The reverberation in the room due to hard reflective surfaces should be reduced by the introduction of acoustically absorbent material(s).

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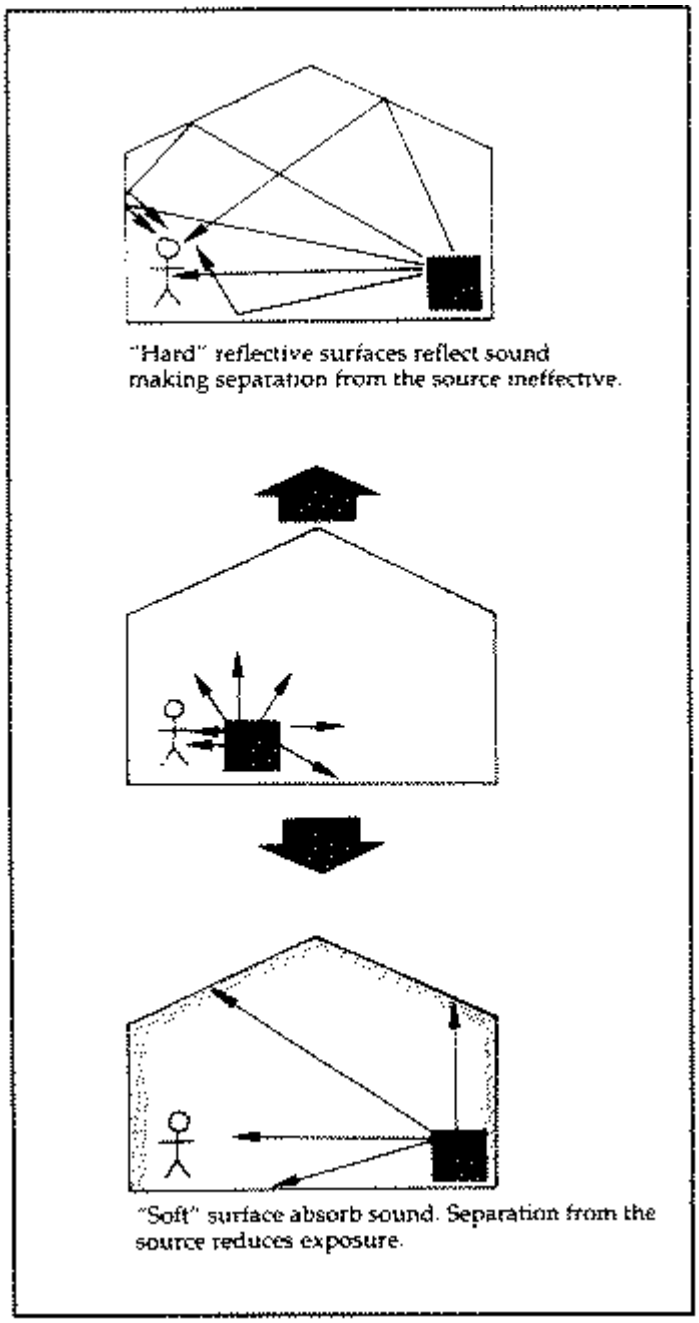

Figure 12: Separation from the source is only effective if sound is not reflected from surfaces

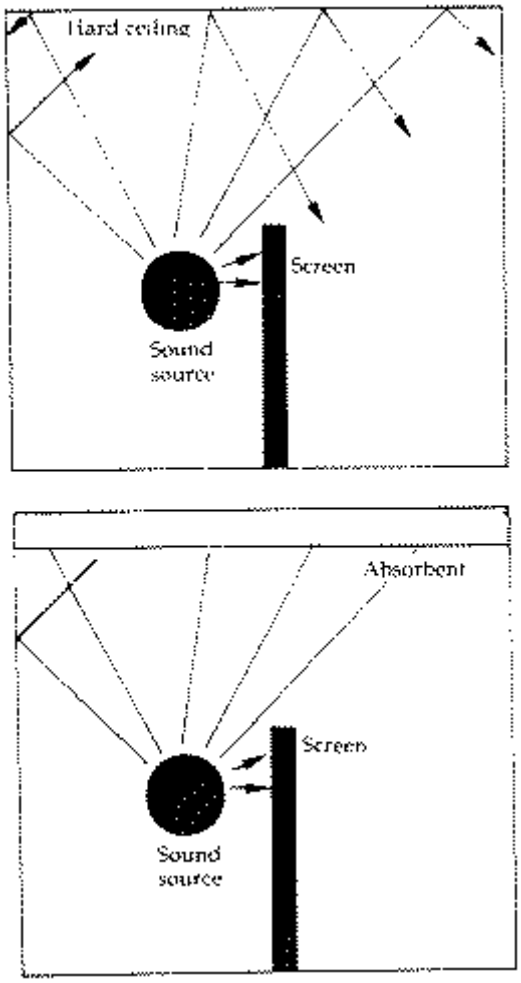

Figure 13: Where screens or partial barriers are used, surfaces facing the source may need to be treated with absorbent material (from a publication on noise control prepared in Sweden for the Swedish Work Environment Fund)

36.2 Implementation

These principles can be applied in a number of ways:

(a) Using a sound-reducing enclosure, which fully encloses the machine.

For a completely effective enclosure the joints should be sealed airtight. Cement rendering the inside of a brick wall c mastic sealing the joints of a sheet metal panel enclosure should be undertaken. Sound rated doors should always b 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 materia feed and product delivery chutes with absorbent lining. This will limit the amount of noise escaping through thes openings.

However, the provision of adequate ventilation should be considered when designing noise-tight enclosures for plar such as au compressors and diesel generators. Ventilation openings can be fitted with absorptive type silencers and a flow should be assisted by motorised fans.

An example of an effective enclosure is given in Figure 14.

(b) Separating the noisy areas and area to be quietened by a sound-reducing partition which follows thes principles.

(c) Using sound-absorbing material on floors, ceiling and/or walls to reduce the sound level due to reverberation.

(d) Using acoustical silencers in intake and exhaust systems associated with gaseous flow activity, for exampl 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 duct or pipe
reactive type silencers, for reducing low frequency engine exhaust noise. Noise is attenuated by reflecting th noise energy back to its source
combined reactive absorptive silencers, where a wide range of frequency response is required, or
resonant silencing where a noise is comprised of one single pure tone.

Examples of various types of silencers is given in Figure 15.

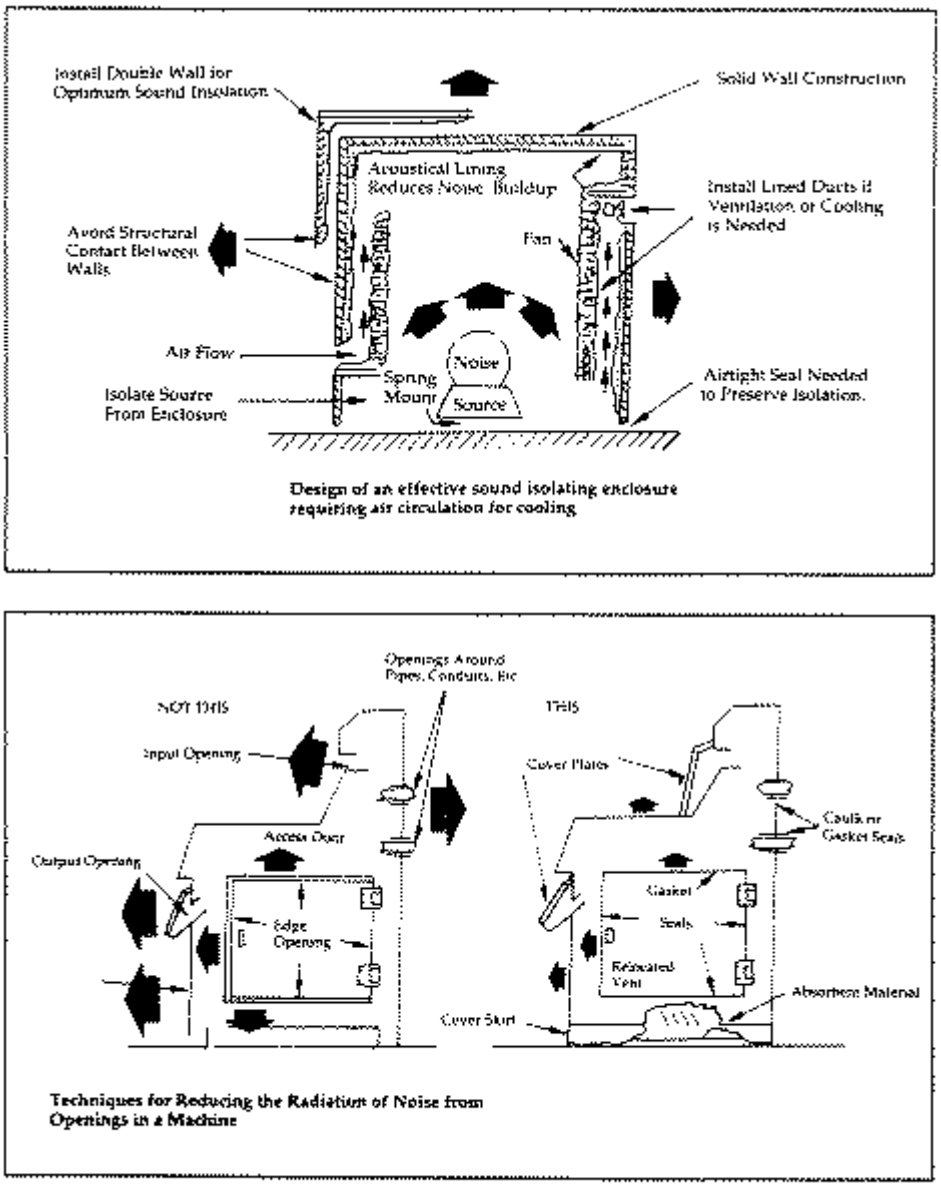

Figure 14: Examples of enclosures and factors to be considered in their design (from U.S. Department of Commerce National Bureau of Standards. "Quieting: A Practical Guide to Noise Control" (Publication No. NBS HB-119 (1976)).

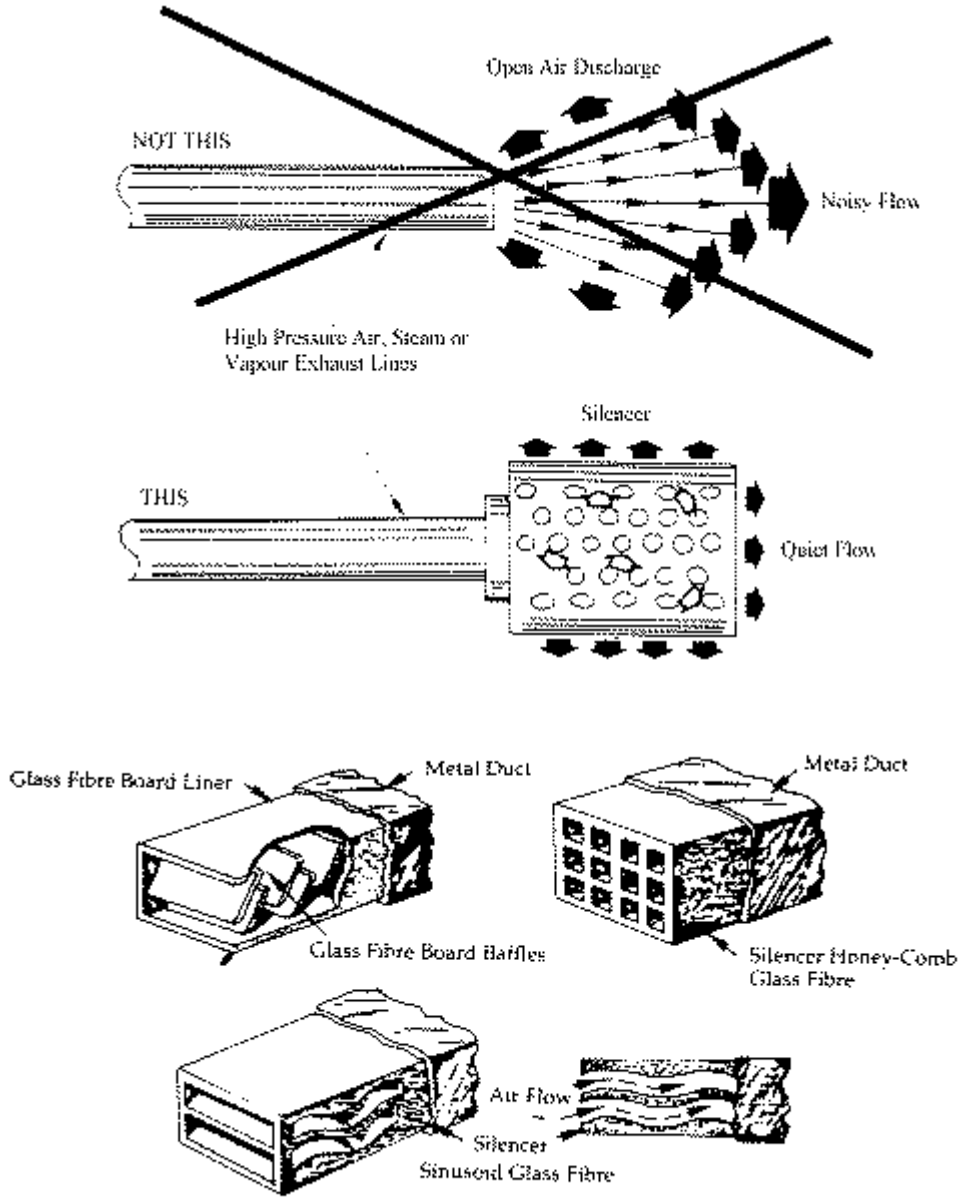

Figure 15: Various types of silencers (from U.S. Department of Commerce. National Bureau of Standards. "Quieting: A Practical Guide to Noise Control" (Publication No NBS HB-119) (1976)).

37. ACTIVE NOISE CONTROL (”ANTI-NOISE")

”Active noise reduction" is the reduction or cancellation of one sound by the introduction of a second sound having equal amplitude but with reversed phase. The second sound is usually derived electronically from the original, with the aid of a microphone signal processing system and loudspeaker.

At present worthwhile improvements are likely to be obtained only at frequencies below a few hundred Hertz, though with the continuing development of more advanced systems this limitation should be reduced.

Active cancellation systems are not at the time of publishing generally available, although there is developing commercial interest. Where used, they are likely to need more care and maintenance than conventional passive noise control systems. They also tend to be much more expensive than passive systems.

38. ADMINISTRATIVE CONTROL MEASURES

Administrative controls are modifications to the systems of work to reduce either the duration of exposure or the magnitude of exposure. (This is sometimes possible with high frequency noise as it is directional and task redesign may be used to reduce exposure).

Other examples of administrative controls include:

- organising schedules so that noisy work is done when as few employees as possible are present
- planning to even out the work load and avoid busy times when machines are operating for longer hours
- keeping employees out of noisy areas if their job does not require them to be there
- reducing the magnitude of exposure by increasing separation from the noise source
- job rotation, which is the rotation of employees out of noise affected areas for periods to reduce noise exposure.

39. HEARING PROTECTION DEVICES

39.1 When engineering and administrative noise control measures, as described above, do not reduce the noise exposure to the exposure standard or below, employees must be supplied with, and wear, effective hearing protection devices (regulation 13(1)).

The function of a hearing protection device is to reduce the amount of noise reaching the inner ear of the wearer. This is achieved by completely covering the ear with an earmuff or helmet, by covering the entrance of the ear canal with a cap, or by completely occluding the ear canal with an earplug. The various kinds of protection devices include: earplugs (premoulded, individually moulded, adaptable), ear canal caps, earmuffs and hearing-protective helmets.

The removal of hearing protectors for even short periods of time can significantly reduce their effectiveness and lead to the exposure standard being exceeded (see figure 16). Due to the difficulties of wearing hearing protectors for long periods of time in certain environments, regular brief periods in quiet areas without hearing protection, should be provided. These quiet areas should be less than 80 dB(A) to be effective.

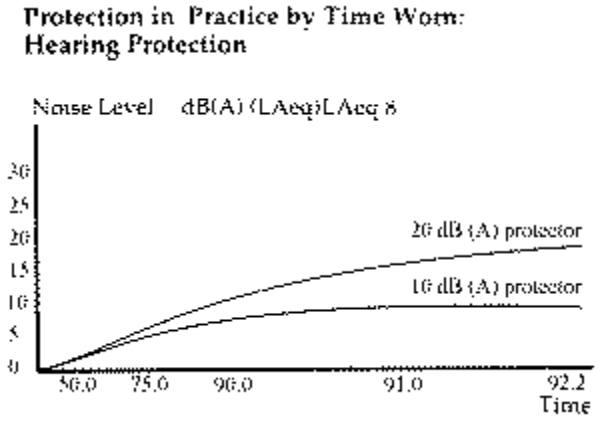

Figure 16: Graph shows protection provided by 10dB(A) and 20dB(A) hearing protection devices, and the effect of percentage of time worn on the protection provided. For example if 20dB(A) protection is worn 99.9% of exposure time it provides 20 dB(A) reduction in noise exposure. However, if it is only worn 75% of exposure time, it provides only 5dB(A) reduction (from Else, D (1981). Personal Protection, Chapter 21 from Occupational Health Practice, 2nd Edition, R.S.F. Schilling (Ed), Butterworths, England)

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39.2 Education and training

Before hearing protectors are issued, the need for their use must be fully explained to the people that have to wear them. Regulation 17(1) states:

> *17 (1) If an employee's exposure to noise is likely to exceed the exposure standard, the employer must provide appropriate training regarding – ...*
> *(d) the selection, use, fit and maintenance of hearing protection devices.*

Instruction in their fit use, care and maintenance must be repeated at least once in every 4 years. Managers and supervisors should encourage the use of hearing protectors by explanation and personal example. Reluctance by employees to wear hearing protection devices could be addressed by the provision of information and training on the hazards associated with excessive noise and its effect on hearing, including the implications of hearing loss on personal life. Involving employees in the selection of suitable hearing protection devices where employees are able to personally trial and choose their own device, may assist in preventing reluctance in their use. See Part 6 *Training* for details. It should be noted that the regulations do place an obligation on an employee to use control measures provided "to the extent [they are] capable" (regulation 18).

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39.3 Selection of hearing protectors

It is important to ensure that protectors will provide wearers with reliable and adequate protection. Suppliers should be instructed to provide full information on the sound reduction likely to be provided, the methods used for testing the protectors and details of the laboratory carrying out the test. Suppliers' reports are to be made available, through employers, to employees and their representatives. The provision of this information by suppliers is a requirement under Section 24 of the **Occupational Health and Safety Act 1985**. Additional information is available to employers in the National Acoustic Laboratories' (NAL) publication *Sound reduction of Hearing Protectors.* This document provides a list of hearing protection devices on the market and information on their sound reduction (attenuation). Information to assist the calculation of required protection is provided in Australia Standard *AS 1269.*

Hearing protectors should conform with the specifications of Australian Standard *AS 1270* and their sound reduction should be measured in accordance with that standard.

The regulations require employers to consult with relevant employees and health and safety representatives before taking any action under the regulations (regulation 12). This includes the selection of a suitable hearing protection device. Involving the proposed user during selection, and allowing a choice between suitable devices, is more likely to give employees the feeling of ownership and encourage its use. Once chosen, hearing protectors should be retained by that employee for exclusive use.
Individual selection of hearing protectors should be based on:

- the degree of protection required in the employees' environment
- 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 required 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 hearing protector
- 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. Where hearing protectors are likely to mask warning sounds expert advice as to the appropriate measures required should be sought.

39.4 Estimating sound reduction

Hearing protection devices provide differing levels of sound reduction. It is necessary to calculate the potential sound reduction of hearing protectors to ensure the wearer's sound exposure will fall below the exposure standard.

Australian Standard 1269 gives two methods for calculating the potential sound reduction of a hearing protector.

The first, which is more accurate, requires that the octave band frequency spectrum (between 125Hz and 8kHz) of the noise is determined.

The second requires only a single measurement of the C-weighted sound pressure level and hence is much quicker

For most noise encountered in the workplace, these two methods give results that do not differ significantly and so the shorter method can be used. However, if the noise contains a lot of low or high frequencies or prominent tones, then the two methods may give results that differ by four or five decibels. In these cases the octave band method should be used.

In a few cases, very low frequency noise (in the 31.5 or 63Hz octave bands) or very high frequency noise (in the 16kHz octave band) may be present in significant amounts. As protectors are often provided by manufacturers with sound reduction figures only from 125Hz to 8kHz it is necessary to measure the noise in the 31.5 H. to 125 H. and 8k. to 16kHz bands. The sound reduction figures of the protector should then be estimated by assuming the sound reduction figure for the 31.5Hz and 63 H. bands equals that of the 125 H. band, and the sound reduction figure for the 16kHz band equals that of the 8kHz band.

39.5 Earplugs and earmuff combinations

It is not possible to add the reduction provided by a plug and a muff to calculate the nett sound reduction provided by both. The National Acoustic Laboratories provides a table of the sound reduction provided by combinations.

39.6 Inspection and maintenance

Employers should ensure that hearing protectors are regularly inspected and maintained. Employees should also inspect hearing protectors regularly to detect damage or deterioration.

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. Hearing protection devices should be cleaned and disinfected according to the manufacturer's instruction.

40. MARKING OF ZONES

Regulation 14 provides that:

> *The employer must clearly identify by signs, labelling of machines, or other appropriate means when and where hearing protection devices should be worn.*

Areas where persons may be exposed to noise levels exceeding the exposure standard should be identified as "hearing protection areas", and the boundaries clearly defined. Additional signs within the areas may also be necessary. The signs used to identify these areas should conform with specifications laid down in Australian Standard AS 1319 (see Figure 17).

Figure 17: Standard Hearing Protection Warning Symbol (from AS1319)

The construction, location, maintenance and use of signs should conform with Section 5 of AS 1319.

The meaning of signs should be explained to employees as part of training (Part 6 *Eduction and Training).*

Alternative arrangements to signposting should be made in consultation to ensure that employees and other persons can recognise circumstances in which hearing protectors are required.

Methods of achieving this include:

- attaching prominent warning notices to tools and equipment indicating that hearing protectors must be worn when operating them
- providing written and oral instructions in appropriate languages on how to recognise circumstances in which hearing protectors are needed and
- effective supervision of the specified high noise areas.

41. MANUFACTURERS, IMPORTERS AND SUPPLIERS OF HEARING PROTECTION DEVICES

Section 24(1) of the Occupational Health and Safety Act 1985 places an obligation on manufacturers, importers and suppliers of hearing protection devices to ensure that all purchasers of hearing protection devices are provided with information that will enable the devices to be used in a manner that is safe and without risk to health.

The following information should be provided in writing as labels or technical literature:

(a) the information on selection, fitting, use, maintenance and replacement specified in Section L of Australian Standard AS 1270.

(b) the SLC80 and Octave Band attenuation values obtained by the test method specified in AS1270.

Note: data for many hearing protection devices is listed in the National Acoustic Laboratories'Attenuation of Hearing Protectors (see Bibliography).

Information provided by a manufacturer importer or supplier of hearing protection devices should be consistent with the hierarchy of control specified in regulation 13.

42. INTRODUCTION

Regulations 15 and 16 provide that:

15. Audiometric testing

(1) In this Regulation "audiometry" means the measurement of the hearing threshold level of persons by means of a bilateral pure tone air conduction threshold test.

(2) The employer must provide for the audiometric testing of an employee where hearing protection devices are required to control the exposure to noise of the employee.

(3) The employer must ensure that audiometric testing is conducted by a trained person approved by the Chief Executive Officer of the Occupational and Health and Safety Authority under regulation 16.

(4) Subject to sub-regulation (11), audiometric testing where required must be provided-
- *(a) within three months after an employee commences employment; and*
- *(b) at any time when reasonably requested by a health and safety representative; and*
- *(c) in any other case at least every two years.*

(5) The employer must ensure that the results of the audiometric test of an employee is provided in writing to the employee and a copy of the audiogram is provided to the employee on his or her request.

(6) The employer must retain the employee's audiometric records on a confidential basis for the period of his or her employment and for a period of twenty years thereafter.

(7) If the audiometric testing indicates -
- *(a) that an employee has a hearing threshold level at 4000 Hz which equals or exceeds:*
  - *(i) 25 dB at 30 years of age or less; or*
  - *(ii) 35dB at 45 years of age or less; or*
  - *(iii) 50 dB at any age in either ear; or*

(b) a difference in hearing levels of any employee between an audiogram and any subsequent audiogram equal to or exceeding 15dB at 3000. 4000 or 6000 Hz in either ear -

the employer must recommend that the employee undertake a medical or audiological examination, if that employee has not previously been recommended for a medical or audiological examination at the same hearing level.

(8) The employer must pay for the medical or audiological examination.

(9) The employer must provide the health and safety representative on request with the aggregate results of audiometric testing for the representative's designated work group.

. *(10) If an employer is required to carry out audiometric testing in accordance with this regulation, the employer must notify the Chief Executive Officer of the Occupational Health and Safety Authority of the testing in the form of the Schedule within one month after the completion of the testing.*

(11) If no testing program consistent with this regulation has been previously undertaken, the audiometric testing must be provided before 1 October 1992.

16. Approval of audiometric testers

(1) The Chief Executive of the Occupational Health and Safety Authority may approve, in writing, persons to carry out audiometric testing.

(2) The Chief Executive may issue an approval subject to conditions.

(3) The Chief Executive may revoke an approval.

(4) A person affected by a decision of the Chief Executive under this Regulation has a right to be heard by the Chief Executive in regard to the decision and may appeal against the decision to the Minister.

(5) If a person has appealed against a decision of the Chief Executive under this Regulation, the decision is stayed until the determination of that appeal.

(6) A person who wishes to be approved as a trained person must apply in writing and must pay a fee of $70.00.

It is important to note that audiometric tests only give an estimate of hearing loss. Where hearing loss is due to noise exposure, there is usually a lag of months or years between exposure and hearing loss. The absence of hearing loss on an audiogram may be false reassurance. However if' the results of audiometric tests do indicate that hearing loss due to noise exposure has occurred then exposure assessments and controls should be reviewed to determine what changes are needed.

43. PROVISION OF AUDIOMETRY

The regulations require (regulation 15(2)) audiometric testing to be provided where hearing protective devices are required to reduce noise exposure to below the exposure standard.

44 FREQUENCY OF TESTING

The regulations make certain requirements in regard to the frequency of audiometric tests (see regulation 15(4) and 15(11)).

Audiometric tests must be provided by the employer:

- by 1 October 1992 if no testing program consistent with the regulation has been conducted.
- within 3 months of the time an employee starts work and then at 2 yearly intervals.
- where reasonably requested by a health and safety representative

45. RESULTS TO BE PROVIDED TO EMPLOYEE

The regulations state:

15 (5) The employer must ensure that the results of the audiometric test of an employee is provided in writing to the employee and a copy of the audiogram is provided to the employee on his or her request.

The results of the audiometric test must be provided in writing to the employee. Where an employee later requests a copy of his or her audiogram this must be provided to the employee.

46. RECORD KEEPING

The regulations require that the employer must retain the employee's audiometric test records. The records must be held for the period of the employee's employment and at least 20 years after the employee has ceased working for the employer. The employer must hold the records on a confidential basis. The employer may choose to arrange for the audiometric records to be kept in a place other than the workplace eg. by the audiometric testing company engaged to carry out the testing.

47. PROVISION OF AGGREGATE RESULTS TO HEALTH AND SAFETY REPRESENTATIVE

15 (9) The employer must provide the health and safety representative on request with the aggregate results of audiometric testing for the representative's designated work group

The regulations require (see regulation 15(9)) that the employer provide the aggregate results of audiometric tests to the health and safety representative on request. This should consist of the number of employees in the designated work groups who have been tested and those that have hearing loss as prescribed in regulation 15(7).

The employer should also provide the health and safety representative with the name or names of the approved person who performed the tests.

48. ACTIONS TO BE TAKEN WHERE RESULTS OF MEDICAL EXAMINATION INDICATE HEARING LOSS DUE TO NOISE AT WORK

Where an employee's audiometric test indicates a result described under regulation 15(7), the employer must recommend to the employee that he or she undertake a medical or audiological examination.

The employer would be expected to make the recommendation on the advice of the audiometric tester who conducted the audiometric test.

If there has been a subsequent change in an employees hearing threshold since the employee was last recommended for an audiological or medical examination, the employer is required to recommend that employer for a further examination (regulation 15(7)). However, in examining the change in the employees hearing threshold consideration should be given to the inherent variability in audiometric testing.

If the result of the medical examination indicates that the cause of the hearing loss is exposure to noise at work then the employer should give consideration to what remedial action should be taken. Such action should include a review of any assessment of exposure performed for the purposes of these regulations. Where no assessment has been performed an assessment should be performed as required by regulation 11 and described in this code (see Part 4).

49. CONDUCT OF AUDIOMETRIC TESTS

Audiometric tests should be conducted in accordance with AS1269 unless otherwise specified in this code.

The test frequencies in every case should be 500, 1000, 2000, 3000, 4000 and 6000Hz.

Employees should not be exposed to noise levels above 80dB(A) for 8 hours prior to audiometry.

Eight hours quiet before audiometry may be achieved by:

- testing before work and explaining to the employee the need to avoid loud noise in the night and morning prior to the test
- testing at the end of the shift and placing the employee in a quiet job or providing hearing protection that results in exposure to less that 80dB(A) for 8 hours prior to the test.

The test must 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 l.

50. APPROVED AUDIOMETRIC TESTER

Audiometric testing for the purposes of the regulations should only be carried out by a trained person approved by the Occupational Health and Safety Authority. Persons seeking approval are expected to have a knowledge of the regulations, this code and AS1269.

The approved tester should make the arrangements necessary to ensure that:

- all tests are carried out according to AS1269
- where appropriate employees are recommended for medical referral (see regulation 15(7))
- the information in the Schedule is provided to the Occupational Health and Safety Authority.

Regulation 19 indicates that people who have current approvals to carry out audiometric testing under the Health (Hearing Conservation) Regulations 1978 are deemed to be approved under these regulations.

	Maximum Acceptable Background Noise Levels						
	Type of earphone/cushion or earphone/enclosure			Octave band levels. dB re 20 u Pa			
	Combination connected to audiometer			Octave band centre frequency, Hz			
	125	250	500	1000	2000	4000	8000
TDH39 or TDH29 earphone in MX41AR cushion	52	35	15	14	29	36	28
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	45
TDH39 or TDH49 earphone in Auraldome AR-200 enclosure	59	47	33	26	41	47	38

Notes

1 The values set out in this Table permit the measurement of OdB hearing threshold level for test frequencies 500 Hz and above.

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 OdB hearing threshold levels are 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.

4 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. In this determination, the value of the mean headset attenuation minus one standard deviation must be used

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 audiometrists's own hearing will disclose any gross discrepancy which might occur between formal calibrations

51. NOTIFICATION OF SUMMARY DATA TO OCCUPATIONAL HEALTH AND SAFETY AUTHORITY

The regulations require that the employer notify the Occupational Health and Safety Authority if audiometric testing is required, by providing summary information arising from audiometric testing required under regulation 15.

The employer is required to notify the Authority of this summary data within 1 month of completion of testing of employees. Therefore summary data would be expected to be forwarded to the Authority at least every 2 years. This data must be provided in the form of the schedule contained in the regulations.

By making use of all of the available information, over time the effectiveness of control measures can be reviewed. Table 2 sets out a way in which the comparison can be made.

Noise Exposure Data Summary						
Summary of all noise exposure data as assessed under regulation 11;						
Task of Job Assessed	Date of Assessment	Reason for[1] Assessment	LAeq.8h[2] LHA	Peak Noise[2] LHA	No. of Employees with Notifiable Hearing Loss Under Reg. 15(7)(a)	No. of Employees with Notifiable Hearing Loss Under 15(7)(b)

Table 2 Noise exposure data summary .			
(1)			Specify reason for carrying our assessment as required in regulation 11:
	(i)		five yearly assessment
	(ii)		within 12 months of regulations coming operation for existing workplaces
	(iii)		change in workplace or work processes likely to affect noise exposure
	(iv)		within 3 months of establishment of new workplace
	(v)		requested by a health and safety representative
	(vi)		requested by an inspector
(2)	L = Lower	H = Highest	A = Average

52. DUTIES OF EMPLOYERS

Regulation 17 requires:

17 (1) If an employee's exposure to noise is likely to exceed the exposure standard, the employer must provide appropriate training regarding -

(a) the effects of exposure to noise; and
(b)the control measures implemented to reduce exposure to noise; and
(c)the purpose and nature of audiometric testing; and
(d)the selection, use, fit and maintenance of hearing protection devices.

17 (2) The employer must ensure that the training is provided to employees, including employees -

(a) with supervisory responsibility for other employees; and
(b)employees responsible for the acquisition and maintenance of hearing protection devices and other control measures.

17 (3) The training must be provided -

(a) to a new employee, on commencing employment; and
(b) to an employee required to use hearing protective devices, prior to that use.

17 (4) The employer must ensure that further training is provided to an employee at least once in every 4 year period after that employee was last provided with training.

17 (5) If an employee was employed immediately before 1 July 1992, the training must be provided to that employee before 1 July 1993.

Circumstances where noise exposure "is likely to exceed" the exposure standard are when failure to implement control measures correctly or as intended may potentially lead to noise exposure in excess of the exposure standard. This would be the case where administrative controls have been implemented, when hearing protection devices are relied upon to control noise exposure, and for some engineering noise control solutions.

53. PURPOSE OF TRAINING

The purpose of training is to provide employees and other target groups with the skills and knowledge necessary to effectively use the control measures implemented for their protection, and to give them an appreciation of the hazards associated with excessive noise and how noise-induced hearing loss can effect their lives.

54. OUTCOMES OF TRAINING

The employer should ensure that the outcome of training for employees include the ability to demonstrate an understanding of:

- the effect of noise on hearing
- the reasons for, and nature of, the general noise control measures which are in use or are planned
- the nature and location of noise hazards in the workplace
- the specific control measures which are necessary in relation to each employee's own job (as appropriate, this should include instructions in the correct use and maintenance of exhaust silencers, enclosures and other measures which minimise noise levels)
- where appropriate, the arrangements for reporting defects likely to cause excessive noise
- when and how to use hearing protectors provided, including proper care and the arrangements for maintenance, cleaning and replacement (NOTE: *regulation 17(3) requires that an employee be trained before being provided with hearing protection)*
- responsibilities of employers and employees under the regulations and this code.

55. TRAINING METHODS

When developing and providing training programs the employer should consider any special needs the employees being trained may have. Special needs may be specific skills, work experience, gender, physical disability (including injury), intellectual disability, ethnicity and first language, literacy and age. These special needs should be taken into account in the structure, content and delivery of the training. This may take the form of oral, or highly graphic training methods, or use of a language other than English. It may also be appropriate for the trainer to share a first language, culture or gender with the target group. The employer should refer to any relevant regulations and guidance on training in multilingual workplaces.

The employer should ensure that the content of the training is clearly understood by the employees. Training on the job should be undertaken by a person familiar with the plant being operated and the tasks being performed. People involved in training should have the necessary skills, knowledge and experience.

The employer should ensure that employees who are being trained are not required to carry out any procedure which could cause risks to their health and safety or the health and safety of other employees.

56. REVIEW OF TRAINING

The regulations require employers to provide training at least every 4 years (regulation 17(4)). To ensure the training remains effective, the employer should review training and identify and provide further training when changes occur in the work place, which may affect the health and safety of employees. Such changes may include:

- a change in the noise exposure due to alterations, or the introduction of new plant
- changes in the layout of the work place, work practices or control measures which relate to noise exposure.

57. RECORDS OF TRAINING

Although the regulations have no specific requirement for the employer to record training activity it is considered a useful thing to do. Recording the training program provides evidence that the regulations have been complied with.

Records of training may include:

- the names of employees receiving training and dates of attendance

- the title of the training course and an outline of its contents
- the duration of training
- the names, qualifications and experience of the person providing the training, and
- whether the training program is registered or accredited by any statutory body, government department, educational institution or other association or organisation.

Such records could be kept for the term of the employee's employment and be made available to Occupational Health and Safety Authority inspectors on request.

58. TARGET GROUPS REQUIRING TRAINING

17 (2) The employer must ensure that the training is provided to employees, including employees -
(a) with supervisory responsibility for other employees;
(b) and employees responsible for the acquisition and maintenance of hearing protection devices and other control measures.

This would include groups such as:

operators
employees who are exposed to a noise hazard

managers and supervisors
employees who manage and/or supervise persons exposed to a noise hazard
employees who select or purchase plant should also be included if different from managers and supervisors

maintenance employees
employees who inspect, maintain, alter, service and repair the plant likely to create a noise hazard

employees in the vicinity
employees who work in the vicinity of a noise hazard

employees who plan layout
employees who plan the layout of the workplace where the noise exposure may occur

monitors
employees who carry out daily monitoring and assessment of the workplace location where the noise hazard may occur

hearing protection devices and other control measures
employees who select, distribute, use and maintain hearing protection devices and other control measures

APPENDIX 1

GUIDELINES FOR KNOWLEDGE GENERALLY NEEDED BY PERSONS PERFORMING NOISE SURVEYS AND ASSESSMENTS

The topics below describe the type of knowledge generally needed to properly perform noise assessments. People with qualification such as occupational hygienists, acoustic engineers and acoustic scientists would ordinarily possess the appropriate knowledge.

Basic Acoustics

Revision of basic physics and mathematics; the nature of sound; physical properties of sound propagation - reflection, diffraction refraction, absorption, transmission; sound intensity; sound power; sound pressure; pure tones; sound spectra; noise.

Analysis of Sound Waves

The dB scale; frequency weighting; octave and 1/3 octave bands; RMS, peak; LAeq; LAeq8h; relationship between sound power an sound pressure.

Sound Measurement Equipment

Use and limitations of sound level meters, integrating sound level metres, dosemeters, auxiliary equipment; meter characteristics calibration standards; noise measurement procedures including daily checks and periodic calibration.

Need for Hearing Conservation

Mechanism of hearing; effects of noise on hearing; work and social implications of noise induced hearing loss; other effects of noise eg interference with communications, masking of warnings.

Evaluation of Noise

Conduct of noise surveys and assessments of noise exposure; noise control; monitoring identification of sources and areas whic contribute to exposure; standing waves in rooms and their effect on measurement accuracy; recording of results.

Other Noise Measurements

Measurements for assessment of personal hearing protectors and audiometric booths. Ways of identifying hearing protection zones.

Noise Reduction

An appreciation of:

ranking noise sources, engineering approach to noise reduction - reduction at source, transmission path, receiver vibration, isolation noise information needed for specifications on new plant and buildings; work techniques; maintenance; outside expertise.

Noise Regulations and Guidance Literature

Understanding of Regulations: general knowledge of code of practice: Australian Standards AS 1269, 2659, 1259, 2399

APPENDIX 2

FACTORS TO BE CONSIDERED BY MANUFACTURERS, IMPORTERS AND SUPPLIERS WHEN DEVELOPING AND IMPLEMENTING TEST PROCEDURES

The regulations require manufacturers, importers or suppliers to ".. ensure, as far as practicable, that...plant is tested for sound power and sound pressure level". The following provides guidance on factors that should be considered when developing and implementing test procedures.

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 obtain representative data.

The test should be carried out in an environment where the test conditions are known and reproducible.

The background level at measurement points should be checked at all relevant frequencies to ensure that it is at least 10 decibels 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 skilled person who is able to correctly perform such measurements and achieve consistent and accurate results.

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

Sound level meters used should be at least type 1 and comply with AS1259. Dosimeters should comply with AS2399.

Many of the *test conditions specified* above *can often* be *met by following* a relevant and recognised standard (eg. AS1217, AS1269).

Where no standard test is available a new test may need to be developed to obtain noise information to supply to purchasers.

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

that it adequately addresses all potentially noisy components of the machine
the reproducibility and repeatability of the result.

APPENDIX 3

GUIDELINES FOR EXPOSURE TO ULTRASOUND AND INFRASOUND

1. Ultrasound

Airborne ultrasound can be generated by a number of industrial processes including cleaning, drilling, welding plastics, mixing and emulsification.

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 the latest edition)

(see Bibliography).

2. Infrasound

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 4: FORMS AND CHARTS FOR USE WITH THIS CODE

Form 1 Noise Information from Manufacturers/Suppliers

1. Subject:

Manufacturer: .....

Address: .....

.....

.....

.....

Model: ..... Date: .....

Serial No.: .....

Power: .....

.....

3. Sound Power

Sound power is not a noise level and cannot directly be compared with noise exposure standards. A competent person should be able to use sound power to calculate noise levels generated by plant in any given situation.

Conditions	Result	
	Mean	Range
☐ A weighting		
☐ C weighting		

2. Noise Levels

LAeq and Peak noise level can be used to estimate likely noise exposure. A method is given in the Code of Practice on Noise (See Part 4).

Conditions	Octave Band (H_z)
	31.5 63 125 250 500 1k 2k 4k 8k

Condition/Location	Result	
	Mean	Range
☐ LAeq at operator's position(s)		
☐ LAeq workstation(s) absent		
Peak noise level		
☐ operator's position		
☐ no work station		
Condition	Octave Band (H_z)	

Test Conditions and Instrumentation:

4. Method of Construction, Installation and Use.

(e.g. Noise reducing attachments, methods to minimise noise during operation, situations or factors that would result in a noise hazard

Attach details

APPENDIX 4: FORMS AND CHARTS FOR USE WITH THIS CODE

Table 1: Risk Identification Checklist

Description of Work Location

Date

Task Workstation

Assessed by

Health and Safety Representative

The existence of any one of the following key risk factors indicates the need for further assessment as required by regulation 10(1)(b) and outlined in Part 4 of the *Code of Practice on Noise*.

1. Is there difficulty in communication between two employees at 2 metre distance? Difficulty means that the speaker must raise his or 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 any of the following:

   (a) Ringing in the ears (tinnitus)?
   (b) The same sound having a different tone in each ear (displacement)?
   (c) Blurred hearing?

   Yes ☐ No ☐

4. Are any long term employees hard of hearing?

   Yes ☐ No ☐

5. Are hearing protection devices provided?

   Yes ☐ No ☐

6. Are signs indicating that hearing protective devices should be worn, posted at the entrance or in the work area?

   Yes ☐ No ☐

7. Does the noise in any part of the workplace sound as loud or louder than 85 decibels using the scale in Figure 4?

   Yes ☐ No ☐

8. Do results of past noise measurements or surveys indicate noise levels equal to or greater than any of the following:

   (a) Surveys performed after 1/7/92

   (i) 85 dB(A) Slow or Fast? Yes ☐ No ☐
   (ii) 85 dB(A) L_{Aeq}? Yes ☐ No ☐
   (iii) 140 dB(Lin) Peak Noise? Yes ☐ No ☐
   (iv) daily noise dose of greater than 0.3 i.e. $L_{Aeq,8}$ 85dB(A)? Yes ☐ No ☐

   (b) Surveys performed prior to 1/7/92

   (i) 115 dB(A) Slow? Yes ☐ No ☐
   (ii) daily noise dose greater than 1.0 i.e. $L_{Aeq,8}$ 90dB(A)? Yes ☐ No ☐

9. Have there been any industrial deafness claims? Yes ☐ No ☐

10. Does any equipment have noise information including labels that indicate noise levels equal or greater than any of the following:

    (a) 80dB(A) L_{Aeq}? Yes ☐ No ☐
    (b) 130dB(Lin) Peak Noise? Yes ☐ No ☐
    (c) 90dB(A) Sound Power? Yes ☐ No ☐

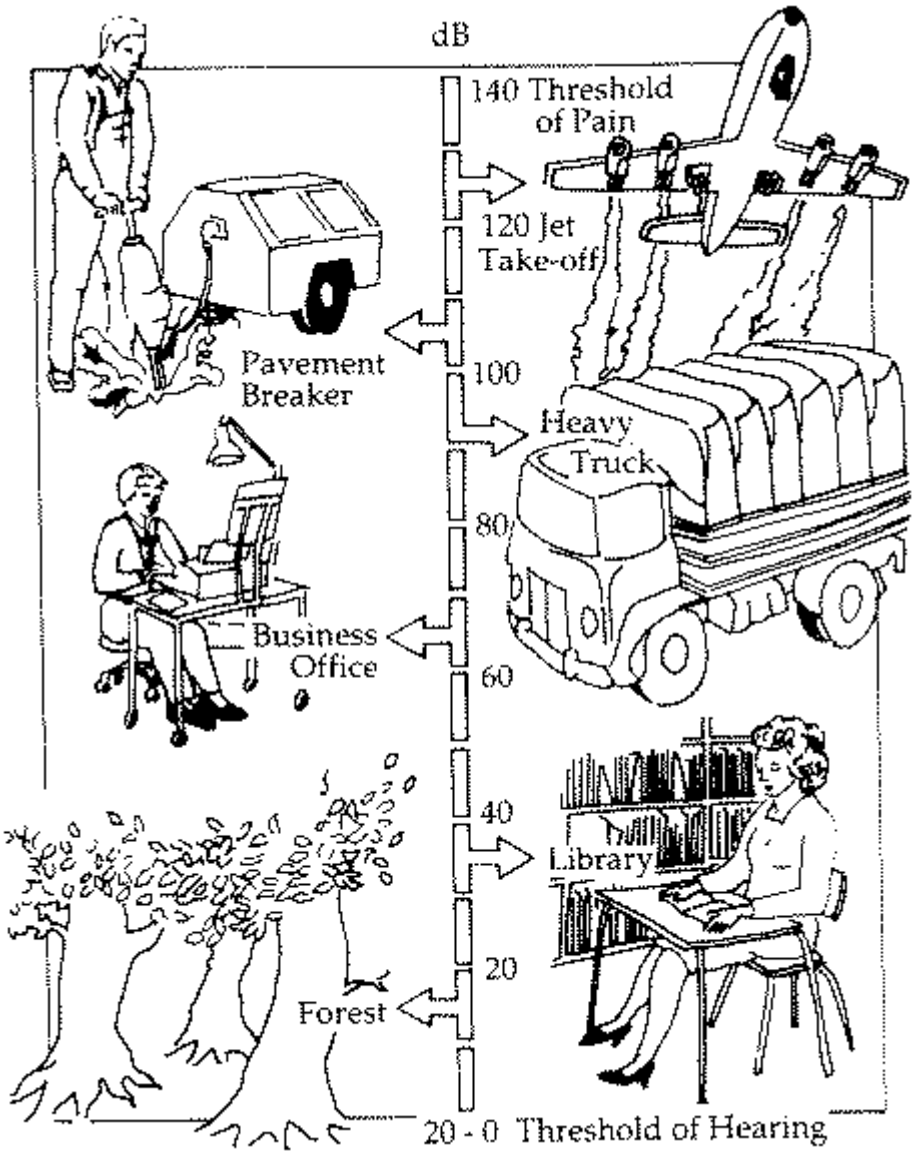
    Note
    1. The L_{Aeq} or dBLin measurement supplied may, for a variety of reasons, under estimate noise levels that actually result. The levels in (a), (b) and (c) are thus noise symbols below the standard.
    2. Sound Power is not a noise level. Under some circumstances, equipment generating a sound power of 90 dB may result in a noise level of L_{Aeq} 85dB(A) or higher.

11. Do the results of audiometry indicate that any past or present employee have hearing loss?

    Yes ☐ No ☐

Figure 4: Decibel level of common sounds

A further copy of this form can be found in Appendix


dB
140 Threshold of Pain
120 Jet Take-off
100
80
60
40
20
20 - 0 Threshold of Hearing
Pavement Breaker
Heavy Truck
Business Office
Library
Forest

APPENDIX 4: FORMS AND CHARTS FOR USE WITH THIS CODE

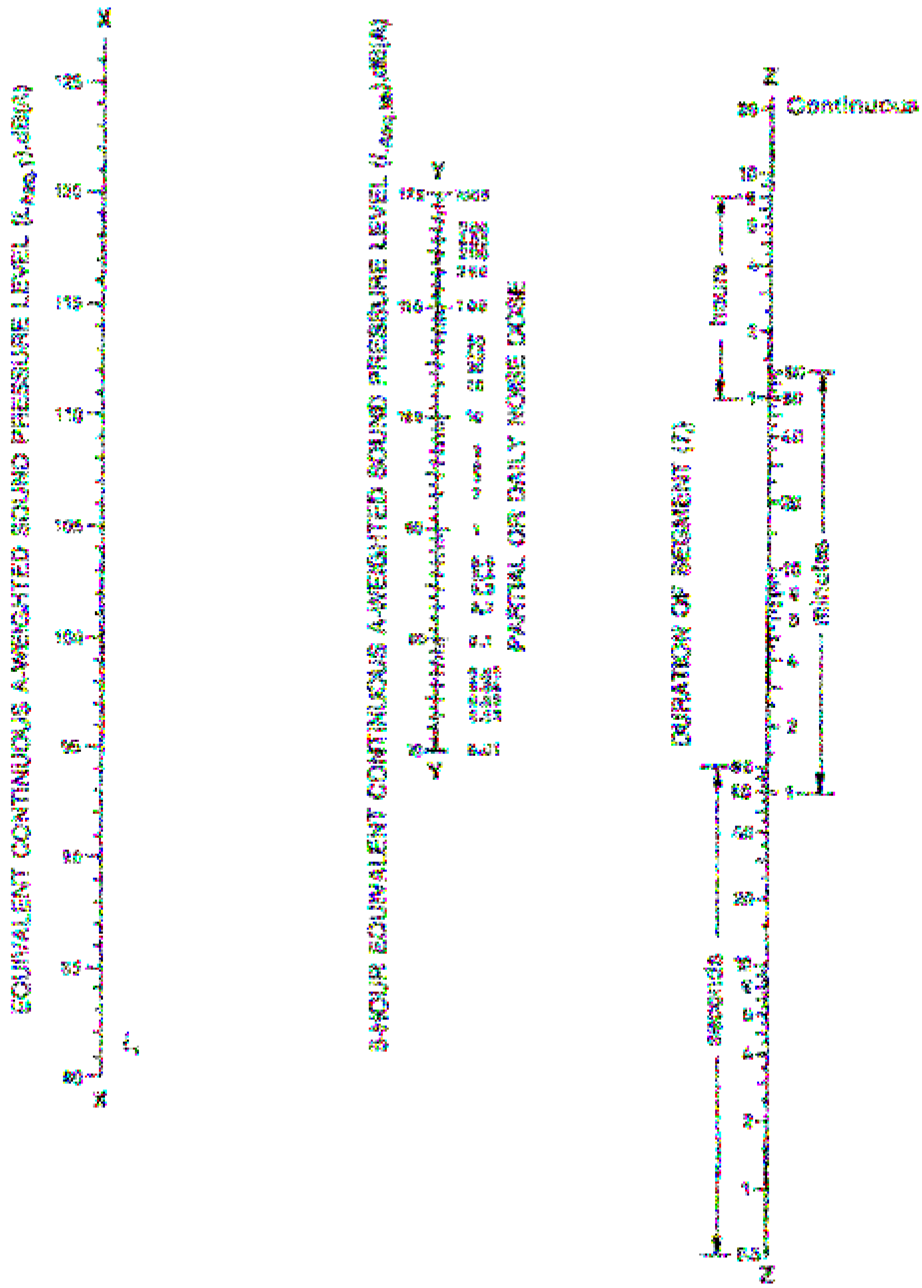
FORM 2: Data for Personal and Area Noise Exposure

Location	Work Area
	Date
Noise sources	
Personal Noise Exposure Data	
Employee name	
Job title	Shift hours
Dosemeter make/model/serial no.	Date calibrated by mfr./lab.
Baseline criterion dB(A) Hrs	Amplitude weighting dB(A)
Calibration check before Yes ☐ No ☐	Calibration check after Yes ☐ No ☐
Calibrator make/model/serial no.	Date calibrated by mfr./lab.
Stop time	Reading
Stop time	% Exposure for an 8 hour day
Total time Min	Hearing protection used make/model/type Yes ☐ No ☐
Is the measure typical of the employees exposure during a workshift? Yes ☐ No ☐ If no, explain:	
Brief description of work activity	
Additional comments	
Reported by (signature of person nominated by employer to conduct the assessment):	

Area Noise Exposure Data

Sound Level Meter make/model/serial no.	Date calibrated by mfr./lab.
Octave Band Analyser make/model/serial no	Date calibrated by mfr./lab
Calibrator make/model/serial no	Date calibrated by mfr./lab.
Calibration check before Yes ☐ No ☐	Calibration check after Yes ☐ No ☐
Time period of sample	
Sketch Area or use this area to record reading	

Time of day	dB(A) slow	LAeq	Time	dB (linear)	Comments


EQUIVALENT CONTINUOUS A-WEIGHTED SOUND PRESSURE LEVEL
8-HOUR EQUIVALENT CONTINUOUS A-WEIGHTED SOUND PRESSURE LEVEL
PARTIAL OR DAILY NOISE DOSE
DURATION OF SEGMENT (T)
Continuous
hours
minutes
seconds

APPENDIX 5 - DEFINITIONS OF TECHNICAL TERMS USED IN THE CODE

"Acoustics" means the science of sound.

"Acoustic calibrator" means a device for applying a sound pressure of known level to the microphone of a sound measuring system for the purposes of calibration.

"Attenuation" means a reduction in sound.

"A-weighted" sound pressure levels are those where the sound signal has been passed through a frequency filter network which approximates the response of the human ear. These "A-weighted" sound pressure levels are identified by units of dB (A).

"dB" an abbreviation for the decibel (see decibel).

"dB(A)" means A-weighted decibel. The A-weighting is a filter, which has a frequency response similar to the human ear.

"dB(C)" means a C-weighted decibel.

"Decibel" typical sound pressures vary over a very large range and are measured using a logarithmic scale. The decibel is the unit used on this scale and is abbreviated to "dB". A detailed explanation of the decibel is contained in Appendix 6.

"Frequency" means the number of vibrations per second and is expressed in units of Hertz (Hz). Sound exists over a very wide frequency range. Audible sounds for healthy, young people lies between 20 Hertz and 20,000 Hertz.

"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.

"LAeq" means that steady noise level measured in A-weighted decibels referenced to 20 micro pascals which, when present for the same period of time as the actual noise, causes the same A-weighted noise energy to be received. The time interval is sometimes included in the abbreviation ie LAeqT (eg LAeq2 is a LAeq over 2 hours).

"LAeq8h" represents the 8 hour equivalent, continuous sound pressure level measured in A-weighted decibels referenced to 20 micropascals.

"Octave band" means a filter that attenuates all noise except that which lies between two close frequencies. Octave band filters are used to measure which frequencies are mainly present in a given noise.

"Peak noise level" means the linear (unweighted) peak hold sound pressure level reading in decibels referenced to 20 micropascals determined by sound measuring equipment with a P time-weighting function.

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

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

APPENDIX 6

EXPLANATION OF THE DECIBEL (dB)

This Appendix is for the purpose of explanation only and is oversimplification of a complex concept.

The range of sound pressures commonly encountered is very wide. Sound pressures well above the threshold of pain (about 200 x 10‘ pascals) are found in many work areas; also of interest, particularly to audiologists, are pressures down to the threshold of human hearing (about 0.00002 pascals). These values represent pressure changes that the ear perceives as sound.

This large pressure range cannot be scaled linearly with a practical instrument, because to obtain the desired accuracy, such a scale would have to be many miles long. To cover this wide range of sound pressures with a reasonable number of scale divisions and to provide a means to obtain the required measurement accuracy at extreme pressure levels, the logarithmic decibel scale is used. By definition, the decibel is a dimensionless unit: the logarithm of the ratio of measured quantity to a reference quantity.

The decibel is commonly used to describe levels of sound intensity, sound power, hearing thresholds, and so on, as well as sound pressure levels. Thus it has no meaning unless a specific reference quantity is specified.

Most sound-measuring instruments are calibrated to provide a reading of RMS* sound pressures on a logarithmic scale in decibels. The reading taken from such an instrument is called the sound pressure level. The term "level" is used because the measured pressure is a particular level above a given pressure reference. For sound measurements in air 0.0002 pascals (20 micropascals) commonly serves as the reference sound pressure because it approximates the normal threshold of human hearing at 1000 Hertz (Hz). Therefore a sound pressure level of OdB represents a sound pressure of 0.00002 pascals the threshold of human hearing.

* The root-mean-square value of changing quantity.

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AS1191-1985 Acoustics - Method for laboratory measurement of airborne sound transmission loss of building partitions.

AS1217-1985 Acoustics - Determination of sound power levels of noise sources parts 1-7.

AS1259 Acoustics - Sound level meters.
Part 1 1990 Non-integrating
Part 2 1990 Averaging
AS1269-1989 Acoustics - Hearing conservation.

AS1270-1988 Acoustics - Hearing protectors.

AS1276-1979 Methods of determination of sound transmission class and noise isolation class of building partitions.

AS1277-1983 Acoustics - Measurement procedures for ducted silencers.

AS1359.51-1986 Noise level limits.

AS1469-1983 Acoustics - Methods for the determination of noise rating numbers.

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Part 1 1979 Engineering method for measurement of airborne sound emitted by compressor/primermover units intended for outdoor use
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