Australian/New Zealand Standard™

Occupational noise management

Part 1: Measurement and assessment of noise immission and exposure

STANDARDS
Australia

STANDARDS
NEW ZEALAND
Paerewa Aotearoa

STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

RECONFIRMATION

OF
AS/NZS 1269.1:2005
Occupational noise management
Part 1: Measurement and assessment of noise immission and exposure

RECONFIRMATION NOTICE

Technical Committee AV-003 has reviewed the content of this publication and in accordance with Standards Australia procedures for reconfirmation, it has been determined that the publication is still valid and does not require change.

Certain documents referenced in the publication may have been amended since the original date of publication. Users are advised to ensure that they are using the latest versions of such documents as appropriate, unless advised otherwise in this Reconfirmation Notice.

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The following are represented on Technical Committee AV-003:

Accident Compensation Corporation (New Zealand)
Association of Australian Acoustical Consultants
Australian Acoustical Society
Australian Chamber of Commerce and Industry
Australian Council of Trade Unions
Department of Defence (Australian Government)
Engineers Australia
Ministry of Health (NZ)
National Acoustic Laboratories
New South Wales Nurses' Association
New Zealand Audiological Society
Worksafe Division, Department of Commerce, Western Australia
WorkSafe Victoria

NOTES

Australian/New Zealand Standard™

Occupational noise management

Part 1: Measurement and assessment of noise immission and exposure

PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee AV-003, Acoustics, Human Effects, to supersede AS/NZS 1269.1:1998, *Occupational noise management*, Part 1: *Measurement and assessment of noise immission and exposure*.

This Standard incorporates Amendment No. 1 (September 2005). The changes required by the Amendment are indicated in the text by a marginal bar and amendment number against the clause, note, table, figure or part thereof affected.

This is Part 1 in a series of Standards as follows:

AS/NZS
1269   Occupational noise management
1269.0   Part 0:   Overview and general requirements
1269.1   Part 1:   Measurement and assessment of noise immission and exposure (this
                      Standard)
1269.2   Part 2:   Noise control management
1269.3   Part 3:   Hearing protector program
1269.4   Part 4:   Auditory assessment

The objective of this series of Standards is to provide requirements and guidance on all facets of occupational noise management. It is recommended that the reader refer to all Parts of AS/NZS 1269 to better understand all relevant terminology and objectives of occupational noise management.

The objective of this Part is to provide requirements and guidance on the types of noise assessment which may be required, the general objectives of an assessment and the

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STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

Australian/New Zealand Standard

Occupational noise management

Part 1: Measurement and assessment of noise immission and exposure

1 SCOPE

This Standard sets out requirements for, and provides guidance on, the types of noise assessments which may be necessary and suitable noise measuring instruments to carry them out. The procedures for noise measurement are also included.

The type and detail of assessments carried out will depend on the use that is to be made of the information obtained.

The type of measuring instruments and procedures to be used for the measurement of noise levels will depend on such factors as the type of workplace, type of noise, work patterns and information required.

2 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS
1259   Acoustics—Sound level meters*
1259.1   Part 1:   Non-integrating
1259.2   Part 2:   Integrating—Averaging

1591   Acoustics—Instrumentation for audiometry
1591.5   Part 5:   Wide band artificial ear

2533   Acoustics—Preferred frequencies for measurement

2680   Acoustics—Performance for tape recording equipment for use in acoustical measuring systems

AS IEC
61672   Electroacoustics—Sound level meters
61672.1 Part 1:   Specifications
61672.2 Part 2:   Pattern evaluation tests

AS ISO
1999   Acoustics—Determination of occupational noise exposure and estimation of noise-induced hearing impairment

AS/NZS
1269   Occupational noise management
1269.0   Part 0:   Overview and general requirements
1269.2   Part 2:   Noise control management
1269.3   Part 3:   Hearing protector program

2243   Safety in laboratories
2243.5   Part 5: Non-ionizing radiations—Electromagnetic, sound and ultrasound

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* The AS 1259 series has been superseded by AS IEC 61672, Parts 1 and 2 but remains available for existing users. Following the completion of the AS IEC 61672 series, the AS 1259 series will be withdrawn.

2399   Acoustics—Specifications for personal sound exposure meters

4476   Acoustics—Octave-band and fractional-octave-band filters

IEC

60711   Occluded—ear simulator for the measurement of earphones coupled to the ear by
            ear inserts

60942   Electroacoustics—Sound calibrators

60959   Provisional head and torso simulator for acoustic measurements on air conduction
            hearing aids

61672   Electroacoustics—Sound level meters
61672.1 Part 1:   Specifications
61672.2 Part 2:   Pattern evaluation tests

ISO

266   Acoustics—Preferred frequencies

1999   Acoustics—Determination of occupational noise exposure and estimation of
            noise-induced hearing impairment

3 DEFINITIONS

For the purpose of this Standard, the definitions given in AS/NZS 1269.0 and those below
apply.

3.1 A-weighted noise exposure

The time integral of the squared, instantaneous A-weighted sound pressure over a particular
time period 'T' in pascal-squared-hours (Pa^{2}h) (Symbol: $E_{A,T}$).

It is given by the following equation:

$$E_{A,T} = \int_{t_1}^{t_2} p_A^{\,2}(t)\,dt \qquad \ldots 3(1)$$

where

$E_{A,T}$ = the A-weighted noise exposure

$p_A^{\,2}(t)$ = the square of the A-weighted sound pressure as a function of time for an
integration period T starting at t_1 and ending at t_2. p_A is in pascals and T is
in hours.

NOTE: For practical purposes a noise exposure of 1.0 Pa^{2}h corresponds to $L_{Aeq,8h}$ of 85 dB(A).

3.2 Eight-hour equivalent continuous A-weighted sound pressure level

In decibels, is that steady sound pressure level which would in the course of an 8 h period
deliver the same A-weighted sound energy as that due to the actual noise on any particular
representative working day. (Symbol: $L_{Aeq,8h}$).

NOTES:

1   For the basis of $L_{Aeq,8h}$ calculations, see Clause 9.3.

2    $L_{Ceq,8h}$ is a similar quantity, but refers to the C-weighted sound energy.

3    $L_{Aeq,8h}$ is numerically equal to $L_{EX,8h}$ as defined in ISO 1999 and AS ISO 1999.

3.3 Equivalent continuous weighted sound pressure level

In decibels, is the value of the steady continuous frequency-weighted sound pressure level
that, within a measurement time interval, T, has the same mean square sound pressure as the
sound under consideration whose level varies with time during the interval T. The
frequency weightings used shall be A, C or unweighted as appropriate. (Symbol: $L_{Xeq,T}$)

The time interval for every $L_{\mathrm{Xeq},T}$ measurement should be stated.

$L_{\mathrm{Xeq},T}$ is given by the following equation:

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$$L_{\mathrm{Xeq},T} = 10\log_{10}\left[\frac{1}{T}\right]\int_{t_1}^{t_2}\left(\frac{p_{\mathrm{X}}(t)}{p_o}\right)^2 dt \qquad \ldots 3(2)$$

where

T =   the period in hours over which the average is taken starting at t_1 and ending at t_2

p_{x} =   the frequency-weighted sound pressure in pascals

p_o =   the reference sound pressure 20 μPa

NOTES:

1   The above definition for $L_{\mathrm{Xeq},T}$ is commonly referred to as L_{eq}.

2   For steady continuous sound, L_{Xeq} is numerically equal to $L_{p\mathrm{X}}$.

3.4 Exposure to noise

Exposure to noise is determined at the person's ear position without taking into account any protection that may be afforded by personal hearing protectors.

3.5 Partial noise exposure

The exposure of a person to noise over a specified time interval, typically the time spent at a specified workstation, or while performing a specified task.

3.6 Peak sound pressure level

In decibels, is 10 times the logarithm to the base 10, of the ratio of the square of the maximum instantaneous sound pressure to the square of the reference sound pressure (20 μPa). (Symbol: L_{peak})

NOTE: L_{peak} is not the same as the maximum r.m.s. level and is either unweighted or C-weighted according to the appropriate legislation.

3.7 Reference sound source

A device which generates a sinusoidal sound pressure of specified level and frequency when used with a particular model of microphone in a specified manner.

3.8 Representative working day

A working day during which the noise exposure is representative of the person's long-term occupational noise exposure.

NOTE: The representative working day should be made up of segments proportioned in accordance with the person's long-term occupational noise exposure in such a manner that where the exposures differ markedly from day to day, the segments utilized should take such variability into account.

3.9 Sound level or weighted sound pressure level

In decibels, is 10 times the logarithm to the base 10 of the ratio of the square of a given sound pressure, obtained with a standardized frequency-weighting and a standardized exponential time-weighting during a stated time period, to the square of the reference pressure. (Symbol: $L_{\mathrm{X,F}}$ or $L_{\mathrm{X,S}}$ (see Note)).

NOTE: X is one of the standardized frequency weightings A, C or unweighted and F and S are standardized exponential time weightings as defined in AS 1259.1 and AS IEC 61672.1.

3.10   Sound pressure level (Lp)

Sound pressure levels, in decibels, is 10 times the logarithm to the base 10 of the square of the ratio of the sound pressure to the reference sound pressure. In air the reference pressure is 20 μPa. The sound pressure level is defined by the following equation:

$$L_\mathrm{p} \;=\; 10\log_{10}\left(\frac{p}{p_\mathrm{o}}\right)^2 \qquad\qquad \ldots 3(3)$$

where

p =   the r.m.s. sound pressure in pascals,

p_o =   The reference sound pressure, 20 μPa

3.11   Total daily noise exposure

Is the total of a person's partial noise exposures over a working day.

4   MEASURES OF NOISE EMISSION, IMMISSION AND EXPOSURE

4.1   Measures of emission (of a source)

The acoustic energy emitted by a sound source is measured either in absolute terms as *emission sound power* in units of watts (or milliwatts, microwatts or similar), or in relative terms as *emission sound power level* in units of decibels relative to a reference quantity of 1 picowatt.

Another common emission measure is *emission sound pressure level*, the sound pressure level measured at a specified location (such as the operator position in the case of a machine) in precisely defined acoustical conditions.

In practice, emission sound power level and emission sound pressure level are commonly used to indicate the noise emitted by items of industrial equipment. It is becoming increasingly common for manufacturers to include noise emission details of their products in product specifications. This is now required by law in several jurisdictions.

Standardized noise emission quantities are valuable to purchasers because they enable specific noise limits to be stated in tender specifications. Noise emission information provided by manufacturers and suppliers enables purchasers to assess the potential noisiness of competing items prior to purchase and has fundamental value in making and justifying a final purchasing decision.

4.2.3 *Exposure (of a person)*

Exposure measures indicate the amount of noise to which people are exposed in the course of their daily work.

NOTE: Exposure magnitude is not reduced by the wearing of personal hearing protectors. A person wearing hearing protectors in a sound field is in a situation of protected exposure, not of non-exposure. The term 'effective exposure level' is defined in AS/NZS 1269.3 and can be used to estimate the reduced level of risk when hearing protectors are worn.

TABLE 1

KEY TERMS AND UNITS USED TO INDICATE EMISSION, IMMISSION AND EXPOSURE

Event	Related absolute quantities and units		Related relative quantities and units	
	Absolute quantities	Absolute units	Relative quantities	Relative units
Emission	Emission sound power	W (watts), pW (picowatts)	Sound power level, L_{WX}	dB re 1 pW
	Equivalent continuous emission sound pressure over time interval T	Pa (pascals)	Equivalent continuous emission sound pressure level, $L_{Xeq,T}$	dB re 20 µPa
	Peak emission sound pressure	Pa	Peak emission sound pressure level, L_{peak}	dB re 20 µPa
Immission	Weighted sound pressure	Pa	Weighted sound pressure level, $L_{X,F}$ or $L_{X,S}$	dB re 20 µPa
	Equivalent continuous sound pressure over time interval T	Pa	Equivalent continuous sound pressure level, $L_{Xeq,T}$	dB re 20 µPa
	Peak sound pressure	Pa	Peak sound pressure level, L_{peak}	dB re 20 µPa
Exposure	Partial noise exposure	Pa²h	Partial noise exposure level, $L_{Xeq,Ti}$	dB re $4 \times T_i \times 10^{-10}$ Pa²h
	Total daily noise exposure	Pa²h	Total daily noise exposure level, $L_{Xeq,T}$	dB re $4 \times T \times 10^{-10}$ Pa²h
			Normalized total daily noise exposure level, $L_{Xeq,8h}$	dB re 3.2×10^{-9} Pa²h
	Peak exposure pressure	Pa	Peak exposure level, L_{peak}	dB re 20 µPa
Protected exposure			Effective exposure level, $L(eff)_{Aeq,8h}$	dB re 3.2×10^{-9} Pa²h

NOTES:

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1 The letter X in a symbol above stands for one of the standardized frequency weightings A, C or unweighted as defined in AS IEC 61672.1 for Australia and IEC 61672-1 for New Zealand. Where X is not included, unweighted is implied. The letters F and S refer to standardized time-weightings defined in the same Standard.

2 The reference quantity for normalized total daily noise exposure level is 3.2×10^{-9} Pa²h [$(20$ µPa$)^2 \times 8$ h].

3 Exposure level as used in this Standard is not the same as the standardized quantity sound exposure level (SEL), which is not used in this Standard. SEL is based on a reference quantity of 1 Pa²s. The following are all exposure measures:

(a) *Partial noise exposure* If a person is exposed to different noises at different workstations or tasks over the day, each exposure is referred to as a partial noise exposure. The sum of all partial noise exposures is the person's total daily noise exposure.

The magnitude of a partial noise exposure in Pa^2h may be measured directly with a personal sound exposure meter but in practice is often derived from a measurement of immission sound pressure level made with a sound level meter. In this case the Pa^2 value corresponding to the measured immission level is obtained and multiplied by T_i, the number of hours of exposure to that level, to obtain the Pa^2h value.

(b) *Partial noise exposure level* The magnitude of partial noise exposure may also be expressed as a partial noise exposure level in decibels relative to a reference noise exposure value of $4 \times T_i \times 10^{-10} \ Pa^2h$.

(c) *Total daily noise exposure* Adding the Pa^2h values of a person's partial noise exposures gives the Pa^2h value of their total daily noise exposure.

(d) *Total daily noise exposure level* As with partial noise exposure, the magnitude of total daily noise exposure may be expressed as a level in decibels relative to a reference noise exposure value of $4 \times T \times 10^{-10} \ Pa^2h$.

(e) *Normalized total daily noise exposure level* This is that steady sound pressure level which would, over a specified 'normal' duration (typically 8 h), deliver the same sound energy as that delivered by an actual total daily noise exposure.

NOTE: Normalizing is the process of converting the level of an exposure incurred over an actual duration to a level of equal exposure incurred over a specified 'normal' duration, such as a 'normal' 8 h shift. The purpose is to enable exposure levels incurred over different durations to be referred to a common time base for direct comparison with one another and with regulated exposure levels (see Item 4.2.3(f)).

6 TYPES OF NOISE ASSESSMENT

6.1 Assessment of exposure to noise

6.1.1 *General*

An assessment of exposure to noise is necessary where exposure to excessive noise is known or likely to occur. The form of assessment required will depend on such factors as whether previous assessments have been carried out, whether new plant or engineering noise controls have been introduced (causing changes in noise levels) and the use to which the information obtained will be put.

6.1.2 *Preliminary assessment*

If no previous assessment has been carried out or previous assessments are more than 5 years old then a preliminary assessment shall be carried out. The aims of this assessment are to document the noise environment, or changes to the noise environment and to establish whether or not the workplace is considered to contain excessive noise. If the workplace is considered not to be noisy then the areas of the workplace covered should be noted. If high noise levels are noted then the noise sources should be documented and, where practicable, simple noise controls should be introduced. A detailed assessment is required where more complex noise sources are present, if there is any doubt about whether the noise levels are excessive or if the noise levels are excessive. In all cases the method of evaluation shall be stated to allow for comparison with other reports and the report shall be signed off by senior management.

NOTE: A preliminary assessment is often referred to as a walk-through audit.

6.1.3 *Detailed assessment*

A detailed assessment is required in areas where there is a likelihood of exposure to excessive noise. The detailed assessment shall provide results in the form of $L_{Aeq,8h}$ or $E_{A,T}$ and the L_{peak} for persons likely to be subject to exposure to excessive noise. The measurements and evaluations of noise exposure shall be carried out by a competent person

6.2 Assessment for noise reduction

Where the results of an assessment indicate the likelihood of exposure to excessive noise, then further investigations are needed to identify the sources of noise and to determine priorities for noise reduction. These investigations shall be carried out by a competent person preferably with appropriate expertise in engineering noise control and may require the use of special instrumentation. Upon identification of the major sources of excessive noise, reference shall be made to AS/NZS 1269.2.

6.3 Assessment for personal hearing protector program

Where an assessment of noise exposure (see Clause 6.1) indicates exposure to excessive noise and where legislation or the organization's noise policy requires the issue of hearing protectors, measurements shall be carried out by a competent person in those areas where people are exposed to excessive noise, with a view to establishing sound attenuation requirements for hearing protectors.

This shall involve measurement as described in Clause 8.5 and calculation of sound attenuation requirements in accordance with AS/NZS 1269.3.

In general, if the noise can be described as broadband noise, then the classification method is suitable. However, if the noise is narrowband in character with significant tonality or has significant high or low frequency components or where $L_{Aeq,8h}$ exceeds 110 dB(A), then the octave-band method shall be used. If the noise has significant impulsive components, then the peak sound pressure level shall be measured in order to select appropriate hearing protectors (see AS/NZS 1269.3).

6.4 Assessment of noise exposure from headphones or insert earphones

It may be necessary to measure the noise exposure of a person wearing headphones or insert earphones.

NOTE: Appendix C provides a procedure for measuring the noise exposure of a person wearing headphones or insert earphones.

PSEMs are specifically designed to be worn on the person, and shall comply with the requirements of AS/NZS 2399. Methods of calculating $L_{Aeq,8h}$ or $E_{A,T}$ from the noise exposure data provided by a PSEM are given in Clause 9.

Hand held sound level meter measurements made by competent people are preferred to measurements using PSEMs. PSEMs are inherently affected by confounding effects. These include—shouting across microphones, tapping the microphones, taking the meter off for short periods, not directing the microphone at the noise source. PSEMs also rely on employees who are untrained and unskilled carrying out their own noise measurements, often in uncontrolled and unreported areas.

Despite these potential confounding effects, the information provided by modern PSEMs can be a useful component in identifying noise exposure of the person.

Where PSEMs are used, for example in small spaces or in single cab vehicles, the operator should be carefully monitored by a competent person to ensure confounding effects are not introduced or at least minimized.

7.4 Non-integrating sound level meter

Non-integrating sound level meters shall comply with the requirements of AS IEC 61672 series (or available superseded AS 1259 series) for Australia, or IEC 61672 series for New Zealand. They provide a reading of the A-weighted sound pressure level. Such instruments shall only be used for a preliminary assessment and where the range of fluctuation of sound levels does not exceed 6 dB(A) when measured in the 'S' time-weighting mode at the measurement location.

7.5 Instruments for the measurement of peak sound pressure level

Peak sound pressure level measurements shall be performed with at least Class 2/Type 2 instruments for preliminary assessments. A Class 1/Type 1 or better instrument shall be

7.10 Calibration

Complete measuring systems to be used for detailed or follow-up assessments shall be calibrated in accordance with the relevant Standards at regular intervals not exceeding two years. Such calibrations shall be performed by a suitably equipped and independently audited laboratory with full traceability to national measurement standards.

8 NOISE MEASUREMENT PROCEDURES

8.1 General

The type of instrumentation, the measurement methodology, and the analysis techniques should be determined according to the type of problem involved. When carrying out any form of measurement there is always an uncertainty in the value of the reading obtained.

8.2 Field reference level checking

The reference level setting of measuring instruments shall be checked using a reference sound source immediately before and after a sequence of measurements, and after the instrument has been switched on and before being switched off. If a discrepancy of more than ±0.5 dB in the reference level, or ±10% in the reference noise exposure reading is found between two successive checks, then the results of the measurements taken between the two checks shall be considered invalid.

Where an instrument displaying a discrepancy of greater than ±0.5 dB is identified, the tester shall ascertain the reasons for the discrepancy.

In all cases the manufacturer's operating instructions for the instrument shall be followed.

> NOTE: Common causes for reference level changes are—
> (a) changing instrument supply voltage (battery check);
> (b) changes in ambient pressure; and
> (c) field reference level checking performed in different sound environments may be influenced by the presence of high external noise levels.

8.3 Procedures for assessment of noise exposure

8.3.1 *General*

The preferred basic measurement quantities are $L_{Aeq,T}$ or $E_{A,T}$ during a representative time

(a)   Integrating-averaging sound level meters shall be set to A-frequency weighting and L_{eq} in accordance with the manufacturer's instructions.

(b)   For preliminary assessments a non-integrating sound level meter may be used, in which case the meter shall be set to A-frequency weighting and 'S' time-weighting. The average meter reading may be taken as approximately equal to $L_{Aeq,T}$. Where the observed sound pressure level fluctuates over a range of more than 6 dB(A) at the measurement location, an integrating-averaging sound level meter shall be used.

8.3.3   Measurement of $E_{A,Ti}$

Measurement of $E_{A,Ti}$ shall be carried out over a representative time period (see Clause 8.4). Where time periods are short, more accurate measurements may be made using the accelerated count rate settings of the PSEM, if available.

8.3.4   Measurement of peak sound pressure level

The measuring instrument shall be set to 'linear', 'flat', 'unweighted' or 'C' frequency weighting and 'P' time weighting and 'hold' (where applicable). The frequency weighting should be chosen in accordance with relevant occupational health and safety legislation.

8.3.5   Microphone locations

With the person in their work location, the microphone should be located, whenever practicable, approximately 0.1 m, but not more than 0.2 m horizontally from the entrance of the external canal of the ear receiving the higher noise level.

When it is impracticable to have a person in attendance, the microphone shall be positioned approximately where a person's head could be expected to be.

For convenience, a microphone worn on a person may be mounted on the top of the shoulder.

Care should be taken not to disturb the person's performance. The person's safety shall not be prejudiced.

If the head position at a work location is not well defined, the following microphone heights should be used:

3   Where the noise exposure is from headphones or insert earphones the recommended measurement procedure is given in Appendix C.

8.4 Measurement period

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

Measurement time intervals shall be chosen so that all significant variations of noise levels at the workplace are taken into account. The choice of the measurement time intervals shall be such that the measurement result is determined with the desired accuracy, and is representative of the person's long-term noise exposure.

NOTE: Where the exposure differs markedly from day to day, the assessment should take such variability into account.

The noise which is characteristic of the specific work location shall be present during the measurement time interval.

The measurement duration of an individual activity shall be sufficiently long for the resulting noise exposure level to be representative of the activities performed by the individual. The duration shall be either the entire length of an activity or a portion thereof, as required to obtain an L_{eq} reading which has stabilized within ±0.5 dB.

Any of the following four measurement times may be used to determine the representative noise exposure:

(a)   When the measurement is extended over the total workshift, the total exposure to noise is determined directly.

(b)   The measurement duration should be selected so that the representative noise exposure is measured.

(c)   The duration of exposure to each different noise level is determined to obtain the partial noise exposure value. The partial noise exposure values are then summed for the full working day to provide the total daily noise exposure.

(d)   Any of the procedures above may be extended to several workshifts.

The measurement time interval may be subdivided into part-time intervals within which the exposure to noise is of the same type, e.g. corresponding to the different activities at the workplace or in its environment.

The measurement duration shall take into account any fluctuations and periodicity of the noise level and where it shows a pronounced periodicity, the minimum measurement period shall be two cycles.

8.5 Measurement procedure for selection of hearing protectors

The following measurement procedures are required for the specified hearing protector selection method:

(a)   *Classification method* The instrument or measurement system shall be set to A-

NOTES:

1   In taking octave-band readings, longer averaging times are required to achieve an accurate reading in the low-frequency ranges than in the high-frequency ranges.

2   When measuring in the low-frequency octave-bands, 'space averaging' should be carried out by moving the meter through an arc at arm's length in order to take account of possible sound pressure level variations due to standing waves.

3   An alternative procedure to provide octave-band data is to record the noise on tape and then to post-analyse the recorded noise at each octave-band frequency.

4   If a preliminary assessment indicates that sound levels are excessive then the results of the assessment should be used as an indication that hearing protectors should be worn.

(c)   *Method for high peak sound pressure levels*   If people are exposed to high peak sound pressure levels the peak sound pressure level shall be measured in accordance with Clause 8.3.4 and instrumentation shall comply with Clause 7.5.

8.6   Frequency analysis

If information on the frequency distribution of the noise at the person's position is required, e.g. to design sound barriers for sound absorption, a frequency analysis should be made using octave or one-third octave filters.

Depending on the purpose of the frequency analysis the measurement time shall be chosen appropriately, e.g. the time interval of highest $L_{\text{Aeq},T}$, the time interval of specific operating conditions and the time interval with the noise containing prominent tones.

To prevent erroneous results in frequency analysis, averaging a number of repeated and independent measurements is recommended.

8.7   Infrasound and ultrasound

If there is a suspicion that infrasound of less than 20 Hz is a significant component of the noise at the person's position, it is recommended that additional measurements be made using appropriate instrumentation. The need for this is normally indicated by comparison of unweighted and A-weighted noise level measurements.

If there is a suspicion that ultrasound (above 16 kHz) is present at the person's position, measurements should be made with one-third octave filters or narrow-band filters with the centre frequencies covering the frequency range of interest, but at least for the centre frequencies from 16 kHz to 40 kHz. The non-integrating sound level meter or integrating-averaging sound level meter should be a Class1/Type 1 instrument in accordance with AS IEC 61672 series (or superseded AS 1259 series) for Australia, or IEC 61672 series for

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9 NOISE EVALUATION

9.1 Determination of $E_{A,T}$

The preferred method for determination of $E_{A,T}$ is to use a PSEM or an integrating-averaging sound level meter (see Clause 7.1).

$E_{A,T}$ is related to $L_{Aeq,T}$ by the following equation:

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$$E_{A,T} = 4 \times T \times 10^{0.1\left(L_{Aeq,T} - 100\right)} \qquad \ldots 9(1)$$

where T is in hours.

If the time T is subdivided into part-time intervals T_i for which the values $E_{A,Ti}$ are determined, $E_{A,T}$ can be calculated by using the following equation:

$$E_{A,T} = \sum_i E_{A,T_i} \qquad \ldots 9(2)$$

In other words, the partial noise exposures are simply added together arithmetically to obtain the total daily noise exposure, $E_{A,T}$ (see Paragraphs E2 and E7.3.1 of Appendix E).

9.2 Determination of $L_{Aeq,T}$

The preferred method of measurement is to use an integrating-averaging sound level meter to measure $L_{Aeq,T}$ during the stated time interval.

If the measurement time interval T is subdivided into part time intervals T_i for which the values L_{Aeq,T_i} are measured, $L_{Aeq,T}$ is calculated by using either—

(a) the method described in Paragraph E3 and Paragraph E7.3.2 of Appendix E; or

(b) the following equation:

$$L_{Aeq,T} = 10\log_{10}\left(\frac{1}{T}\sum_{i=1}^{n}\left(T_i \times 10^{\left(L_{Aeq,T_i}\right)/10}\right)\right) \qquad \ldots 9(3)$$

where

$L_{Aeq,Ti}$ = the equivalent continuous A-weighted sound pressure level occurring over the time interval T_i, in decibels.

$$T = \sum_{i=1}^{n}T_i$$

n = the total number of part-time intervals

9.3 Determination of $L_{Aeq,8h}$

In order to compare the effect of noise exposures during a workday of other than 8 h it is necessary to normalize this exposure to an equivalent 8 h exposure, $L_{Aeq,8h}$.

The following methods can be used for determining the noise exposure level, normalized to a nominal 8 h day:

(a) The method described in Paragraph E4 of Appendix E.

(b) The following equation:

$$L_{Aeq,8h} = L_{Aeq,T} + 10\log_{10}\left[\frac{T}{8}\right] \qquad \ldots 9(4)$$

where T is the actual time of exposure in hours.

An example of the use of Equation 9(4) is given in Paragraph E7.3.3 of Appendix E.

(c)   A noise exposure level normalized to a nominal 8 h working day may be calculated from $E_{A,T}$ using the following equation:

$$L_{Aeq,8h} = 10\log_{10}\left[\frac{E_{A,T}}{3.2 \times 10^{-9}}\right]$$ . . . 9(5)

For illustration, some selected values of $L_{Aeq,8h}$, with their corresponding values of $E_{A,T}$, derived from Equation 9(5), are tabulated in Appendix F.

9.4   Extended workshifts

Shift durations of 10 h or longer involve a degree of risk greater than that indicated by the noise exposure level normalized to an equivalent 8 h exposure, $L_{Aeq,8h}$. This increase in risk arises because of the additional damaging effect of continued exposure once maximum temporary threshold shift is reached, which occurs after about 10 h of exposure. The risk may be further increased if there is reduced recovery time between successive shifts. Consequently, where the shift duration equals or exceeds 10 h, organizations should add the adjustment listed in Table 2 to the normalized noise exposure level for that shift before comparing that level with the noise exposure criterion.

TABLE   2

ADJUSTMENTS TO NORMALIZED NOISE EXPOSURE LEVEL $L_{Aeq,8h}$ FOR EXTENDED WORKSHIFTS

Shift length, h	Adjustment to $L_{Aeq,8h}$, dB
< 10	+0
≥ 10 to < 14	+1
≥ 14 to < 20	+2
≥ 20 to 24	+3

Example

A person works a 16 h shift in an equivalent continuous noise level $L_{Aeq,T}$ (T=16) of 87 dB(A). The normalized total daily noise exposure level $L_{Aeq,8h}$ is therefore 90 dB(A) (i.e. 87 + $10\log_{10}(16/8)$). Adding the 2 dB adjustment given in Table 2 for a 16 h shift gives an adjusted $L_{Aeq,8h}$ of 92 dB(A). This value should be used when planning noise management action for this person.

NOTE: Some industries currently operate with extended shift and a 'working week' longer than five days. In these cases some care may need to be taken as the assumptions applied for the equal energy model of exposure/hearing damage may no longer be applicable. Extra precautions may need to be taken and expert advice sought.

A1

For further reading see 'Adjustment of noise exposure level for extended workshifts' by J Macrae and R Waugh. *Journal of Occupational Health and Safety Australia & NZ.* 1998. Vol. 14, No. 4, p 383.

9.5   Determination of $L_{(Aeq,8h)n}$

If the average noise exposure level for a number of working days is required, the averaged value of $L_{Aeq,8h}$, in decibels, for the whole period may be determined from the values of $L_{(Aeq,8h)i}$ for each working day, using either—

(a)   the method described in Paragraph E5 of Appendix E; or

(b)   the following equation:

$$L_{(Aeq,8h)n} = 10\log_{10}\left[\frac{1}{n}\sum_{i=1}^{n}10^{0.1\left(L_{(Aeq,8h)_i}\right)}\right]$$ . . . 9(6)

where n is the number of working days.

An example of the use of Equation 9(6) is given in Paragraph E8.3 of Appendix E.

If the noise exposure is averaged over a number of working days the worst-case daily noise exposure shall also be reported (see Clause 8.3.1).

9.6 Determination of $L(\text{norm})_{\text{Aeq,8h}}$

If the noise exposure level normalized to a five day working week is required, the $L(\text{norm})_{\text{Aeq,8h}}$ for the whole period may be determined from the values of $L_{(\text{Aeq,8h})i}$ for each working day, using either—

(a) the method described in Paragraph E6 of Appendix E; or

(b) the following equation:

A1

$$L(\text{norm})_{\text{Aeq,8h}} = 10\log_{10}\left[\frac{1}{5}\sum_{i=1}^{n}10^{0.1\left(L_{(\text{Aeq,8h})_i}\right)}\right] \qquad \ldots 9(7)$$

where n is the number of working days.

An example of the use of Equation 9(7) is given in Paragraph E9.3 of Appendix E.

If the noise exposure is normalised to a five day working week, the worst-case daily noise exposure shall also be reported (see Clause 8.3.1).

9.7 Noise exposure of groups

Where a number of people work in an area of approximately uniform sound pressure level, measurements should be made at no fewer than four locations which are representative of the working positions of the people and are well distributed over the area to be tested. The microphone should be 1.5 m above the floor, except for people in seated working positions for which the preferred microphone height is 0.8 m above the middle of the plane of the seat with the seat set at or as near as possible to the midpoint of its horizontal and vertical adjustment.

The measured $L_{\text{Aeq},T}$ values shall be arithmetically averaged to obtain the representative $L_{\text{Aeq},T}$ for the area. If, however, the difference between the highest and lowest $L_{\text{Aeq},T}$ levels measured in the area is greater than 2 dB, individual measurements shall be taken for each work location or the group area restricted to a smaller area with more consistent $L_{\text{Aeq},T}$ levels.

The L_{peak} for the group area shall be taken as the highest of the readings at the locations within the area.

9.8 Assessment data to be recorded

A1

The records of the assessment shall be kept. They shall be made available to relevant people when requested. These records should be kept at or near the premises to which they apply. Where this is not practical, e.g. because of the nature of the work (or the site), the records should be kept at an appropriate location.

The following data shall be recorded:

(a) Details of operation and work location, including address.

(b) Description of working environment, including—

(i) detail of noise sources;

(ii) nature of activity and work processes;

(iii) acoustic characteristics of the work location;

(iv) working hours for a representative day;

(v)   number of people involved with the various processes;

(vi)   changes which may have occurred since the last assessment in terms of work procedures, introduction or removal of plant and implementation of noise control measures;

(vii) where applicable, definition of the working position which is representative of a given group's job descriptions; and

(viii) details of any hearing protectors used or issued.

(c)   Details of measuring instruments used (manufacturer's name, model, Type or Class (e.g. 0, 1, 2, 3), serial number, and date when last calibrated).

(d)   Measuring procedure, comprising—

(i)   operating conditions of plant and equipment during the period of assessment;

(ii)   measurement locations;

(iii)   work time history for a representative day; and

(iv)   the time periods considered if the sampling technique is used, the number and duration of the samples and the total period considered.

(e)   Results of measurements and comparison to criteria levels.

(f)   Name and signature of the assessor.

(g)   Date of assessment.

NOTE: An example of a noise assessment report proforma is provided in Appendix G.

10 CHECKLISTS

Figures 1 and 2 provide checklists that should be used to help in meeting the requirements of this Standard.

Item no.	Item	Clause	Yes	If no: Reason	Action needed
1	Is the noise measuring equipment appropriate for the type of assessment to be conducted?	7.1 to 7.5			
2	Does the reference sound source comply with at least a Class 2 specifications in accordance with IEC 60942 for New Zealand and AS IEC 60942 for Australia?	7.6			
3	Does the octave-band filter comply with the requirements of AS/NZS 4476?	7.7			
4	Does any auxiliary instrument used maintain the relevant precision requirements?	7.8			
5	Have all instruments used been calibrated within the previous two years at an audited laboratory?	7.10			
6	Have all instruments used been checked both before and after a sequence of measurements using a reference sound source?	8.2			
7	Have all procedures for assessment of noise been followed?	8.3			
8	Are measurement periods representative?	8.4			
9	Have exposures to noise been evaluated?	9			
10	Has all the assessment data been recorded?	9.8			

FIGURE 1   NOISE MEASUREMENT AND ASSESSMENT CHECKLIST FOR ASSESSORS

Item no.	Item	Clause	Yes	If no: Reason	Action needed
1	Are exposures to noise likely to be in excess of noise exposure criteria (set by relevant regulatory authority) ?	5(a)			
2	Has a preliminary assessment been carried out?	6.1.2			
3	Does the preliminary assessment indicate the need for a detailed assessment?	6.1.2			
4	Has a detailed assessment been carried out?	6.1.3			
5	Does the person conducting the detailed assessment have the appropriate competencies?	Appendix A			
6	Has an assessment for noise reduction been carried out?	6.2			
7	Has an assessment for a hearing protector program been carried out?	6.3			
8	Has an assessment for exposure from headphones or insert earphones been carried out?	6.4			
9	Does the measuring instrumentation for a particular type of assessment meet the appropriate requirements?	7			
10	Has an evaluation of the exposures to noise been made?	9			
11	Has a record of the assessment been filed for future action?	9.8			

FIGURE 2 NOISE MEASUREMENT AND ASSESSMENT CHECKLIST FOR MANAGERS

APPENDIX A

COMPETENCY REQUIREMENTS FOR PEOPLE UNDERTAKING DETAILED NOISE ASSESSMENTS

(Normative)

Detailed noise assessments shall be carried out by people who, through a combination of training and experience, have acquired the knowledge and skills to competently perform the assessments and to present the results in a manner which will enable the people in the workplace to make the correct decisions on what measures to take to reduce noise.

In particular, people carrying out assessments shall be able to demonstrate a thorough understanding of—

(a)   the objectives of the assessment;

(b)   the basic physics of sound;

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

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

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

(f)   the normal operating conditions of the workplace;

(g)   the method for evaluating personal hearing protectors;

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

(i)   the relevant statutory requirements, Codes of Practice and Standards used in Australia and New Zealand.

They shall also have a basic understanding of—

(i)   the mechanisms of hearing;

(ii)   the harmful effects of noise; and

(iii)   the principles of engineering noise control and noise management measures.

APPENDIX B

TOPICS RECOMMENDED FOR INCLUSION IN A TRAINING COURSE FOR NOISE ASSESSMENT

(Informative)

B1 GENERAL

The Paragraphs below describe a basic curriculum for a training course on noise assessment.

B2 BASIC ACOUSTICS

The course should include—

(a)   revision of basic physics and mathematics;

(b)   the nature of sound;

(c)   physical properties of sound;

(d)   propagation, e.g. reflection, diffraction, refraction, absorption and transmission;

(e)   sound intensity;

(f)   sound power;

(g)   sound pressure;

(h)   pure tones;

(i)   sound spectra; and

(j)   noise.

B3 ANALYSIS OF SOUND WAVES

A section on the analysis of sound waves should include—

(a)   the dB scale;

(b)   frequency weightings;

(c)   octave-bands;

(d)   r.m.s.;

(e)   peak, 'F' and 'S' weighting;

(f) $L_{Aeq,T}$, $L_{Ceq,T}$, $L_{Aeq,8h}$;

(g) $E_{A,T}$;

(h)   impulsive noise, L_{max}, L_{peak}; and

(i)   the relationship between sound power and sound pressure.

B4 SOUND MEASUREMENT INSTRUMENTATION

A section on instrumentation should include the following:

(a)   Use and limitations of sound level meters, integrating-averaging sound level meters, personal sound exposure meters, auxiliary equipment and meter characteristics.

(b)   The need for calibration standards and noise measurement procedures including daily checks and periodic calibration by laboratories with traceability to national standards.

B5   NEED FOR NOISE CONTROL

A section on the need for noise control should include—

(a)   mechanism of hearing;

(b)   effect of noise on hearing;

(c)   work and social implications of noise induced hearing loss; and

(d)   other effects of noise, e.g. interference with communication, masking of warnings, tinnitus and other physiological effects.

B6   EVALUATION OF NOISE

A section on the evaluation of noise should include—

(a)   noise assessments, i.e. preliminary assessments, detailed noise exposure assessments, measurements for noise control and monitoring;

(b)   identification of sources and areas which contribute to exposure;

(c)   standing waves in rooms and their effect on measurement accuracy;

(d)   recording of results; and

(e)   explanation of results.

B7   PRACTICAL NOISE ASSESSMENTS

A section on practical noise assessments should include—

(a)   measurements;

(b)   evaluation; and

(c)   reports for the workplace.

B8   OTHER NOISE MEASUREMENTS

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

B9   NOISE REDUCTION

A section on noise reduction should include—

(a)   ranking noise sources;

(b)   engineering approach to noise reduction, i.e. reduction at source, transmission path and receiver;

(c)   vibration isolation;

(d)   noise information needed for specifications on new plant and buildings;

(e)   work techniques;

(f)   maintenance; and

(g)   outside expertise.

B10   STATUTORY REQUIREMENTS AND GUIDANCE LITERATURE

The course should include tuition which results in an understanding of the relevant statutory requirements, Codes of Practice and Standards used in Australia and New Zealand.

APPENDIX C

RECOMMENDED PROCEDURES FOR MEASUREMENT OF SOUND PRESSURE LEVELS FROM HEADPHONES OR INSERT EARPHONES

(Informative)

C1   RECOMMENDED MEASUREMENT PROCEDURE

On a day when a person is using headphones or insert earphones, an identical type of headphone or earphone with similar response characteristics should be connected in parallel, with an appropriate impedance matching network, to the same signal source to which the headphones or earphones used by the person are connected. The signal received by the person can then be duplicated in a wide-band artificial ear (AS 1591.5) or an acoustical manikin (IEC 60959) in the case of headphones, or an occluded-ear simulator (IEC 60711) in the case of insert earphones. The microphone of the wide-band artificial ear, acoustical manikin or occluded-ear simulator should be connected to a Class 1/Type 1 integrating-averaging sound level meter complying with the relevant requirements of AS IEC 61672 series (or available superseded AS 1259 series) for Australia, or IEC 61672 series for New Zealand or an equivalent measuring instrument. A microphone that can handle peak sound pressure levels of at least 140 dB (at not more than 1% distortion) should be used in the measurements.

The values of $L_{Aeq,T}$ and L_{peak} that occur in the artificial ear, acoustical manikin or occluded-ear simulator should then be measured by means of procedures specified in Clause 8. These values must be converted into equivalent diffuse field values by subtraction of appropriate corrections before they are compared with noise exposure criteria specified by statutory authorities.

C2   CONVERSION OF MEASURED LEVELS TO EQUIVALENT DIFFUSE FIELD LEVELS

Any measured value of $L_{Aeq,T}$ or L_{peak} should be converted to its equivalent diffuse field value, using the appropriate correction from Table C1, before it can be used to assess the person's noise exposure.

TABLE   C1

CORRECTIONS TO CONVERT SOUND PRESSURE LEVELS MEASURED IN DESIGNATED TEST DEVICES TO EQUIVALENT DIFFUSE FIELD LEVELS

Test device	Correction to $L_{Aeq,T}$, dB	Correction to L_{peak}, dB
Wide-band artificial ear	−8	−4
Acoustical manikin	−5	−3
Occluded-ear simulator	−5	−3

Example: A headphone connected in parallel with an operator's headphone according to the method described in Paragraph C1 produces an $L_{Aeq,T}$ value of 88 dB in a wide-band artificial ear. Correcting the measured value by the relevant correction factor from Table C1 yields an equivalent diffuse field $L_{Aeq,T}$ value of 80 dB.

C3   ALTERNATIVE METHOD OF MEASUREMENT FOR HEADPHONES

An alternative method of measurement of occupational noise exposure from headphones, published by Van Moorhem, Woo, Liu and Golias (1996), may be used. This method is indirect, in that the electrical signal to the headphone is measured after the transfer functions of the headphone, ear and the microphone of a sound level meter are applied to the signal. If this method is used, the relevant transfer functions should be measured using an acoustical manikin (IEC 60959) and the electrical signal to the headphone should be applied, after passing through a filter which applies the appropriate combined transfer function, to a Class 1/Type 1 integrating-averaging sound level meter complying with the relevant requirements of AS IEC 61672 series (or available superseded AS 1259 series) for Australia, or IEC 61672 series for New Zealand or an equivalent measuring instrument. The values of $L_{\mathrm{Aeq},T}$ and L_{peak} should then be measured by means of procedures specified in Clause 8.

C4   PROBE-TUBE MICROPHONE MEASUREMENTS

The sound pressure levels occurring at the eardrums of people who use headphones or insert earphones in the course of their work can be measured by means of a probe-tube microphone system, with the tip of the probe tube about 1 mm from the eardrum. If this procedure is used, the measured values of $L_{\mathrm{Aeq},T}$ and L_{peak} should be converted into equivalent diffuse field values by subtraction of 5 dB from the value of $L_{\mathrm{Aeq},T}$ and 3 dB from the value of L_{peak} before they are compared with noise exposure criteria specified by statutory authorities. However, this procedure is both technically difficult and hazardous so, although it is the procedure with the highest validity, it is not recommended.

NOTES:

1   If the level of ambient noise entering the artificial ear, acoustical manikin or ear simulator during the measurements is such that it is likely to have a significant effect on the results, then it is advisable to acoustically isolate the artificial ear, acoustical manikin or ear simulator from the ambient noise.

2   There are errors and variability associated with the transfer functions used to derive the corrections for the three methods of measurement. In particular, the corrections for the wideband artificial ear involve errors and variability associated with more than one transfer function. Therefore, when setting headphone or insert earphone output levels, it is advisable to ensure that the measured level of sound is such that the estimated diffuse field level is at

ISO 11904-1. Acoustics—Determination of sound immission from sound sources. Part 1: Technique using a microphone in a real ear (MIRE Technique)

APPENDIX D

GENERAL INFORMATION ON AUXILIARY MEASURING DEVICES

(Informative)

D1   AUXILIARY EQUIPMENT

In some circumstances auxiliary equipment such as windscreens, random incidence correctors and microphones with particular characteristics may be required.

D2   GRAPHIC LEVEL RECORDER

This type of recorder makes a graphic (paper) recording of the output from a sound level meter. For noise exposure measurements it would normally be used to record the variations of sound level in dB(A) with time.

The time of exposure at the various dB(A) levels can be determined using this type of instrument (and hence the $L_{Aeq,T}$), although this operation can be performed with much less effort by using a Statistical Distribution Analyser or L_{eq} meter.

This type of recorder can also be used with a frequency analyser to record noise spectra.

D3   TAPE RECORDER

D3.1   General characteristics

Three types of tape recorders are commonly used for field noise measurements in workplaces. Two of these classifications are analogue tape recorders with Type 'A' performance as specified in AS 2680. The third classification of recorders is digital, with the DAT format currently being the preferred and most commonly used. The relevant characteristics of these tape recorders are summarized in Table D1. Tape recorders (analogue or DAT) should not be used for impulse noise measurement.

D3.2   Precautions when selecting or using a tape recorder

Prior to selecting a tape recorder for medium to short term measurements of noise, the following factors should be noted and addressed:

(a)   The microphone should be suitable for mounting on the shoulder, collar or helmet of the person for whom the noise exposure recording is required.

(b)   The microphone should be provided with appropriate shock protection, and with a windscreen whose insertion loss has been measured or is accurately known.

(c)   The microphone should respond uniformly to sound, irrespective of its source direction.

(d)   The upper dynamic limit of the tape recorder should be set so that it is not less than +6 dB (and is preferably +10 dB) above the maximum sound level anticipated.

(e)   Where the working environment exhibits background sound levels with superimposed maximum levels which are not more than 40 dB relative to the background, an analogue recorder may be used (with appropriate precautions).

(f)   Where the working environment exhibits transient peaks which exceed the background by more than +50 dB, then a digital recorder is preferred.

(g) Whilst measurements may be performed by using two channels of a recorder with differing sensitivities, i.e. one recorder with one channel's sensitivity set +20 dB relative to that of the other, that approach may only be adopted where the overload settling characteristics do not destabilize the input amplifiers and circuitry of the more sensitive channel.

(h) All periodic calibrations of the tape recorder should be supplemented by a calibration of either the SLM and the microphone normally used with that tape recorder.

(i) All such calibrations should determine the normal incidence or pressure frequency response of the microphone capsule and pre-amplifier, as well as the dynamic range or limitations imposed on the combination of microphone and tape recorder. It should also confirm that the overall combined frequency response/dynamic characteristics of the system are uniform at all levels.

(j) Other parameters which should be assessed include the A-weighted and unweighted signal-to-noise characteristics of the SLM/microphone/tape recorder and the equivalent A-weighted and unweighted noise threshold of the system. Those measurements should preferably be performed in an anechoic room, or in a place where the background noise level is at least 60 dB below the measured threshold of the system.

D4   FREQUENCY SPECTRUM ANALYSER

For the control of noise by engineering methods a frequency analysis of noise may be necessary. There may be other occasions, for example, when the noise exposure level is greater than 110 dB(A), requiring special consideration on the selection of appropriate hearing protectors and other circumstances.

Depending on the resolution required, a frequency spectrum analyser with discrete centre frequencies complying with AS/NZS 4476, or narrow band analysers should be used.

D5   SOLID STATE RECORDING INSTRUMENTATION

There are, on the market, many forms of solid state digital recording instruments. These include dedicated instrumentation and 'add-ons' to personal computers in the form of sound cards where the recorded sound is stored in a solid state memory device.

It is up to the user to ensure that the specifications of the instrumentation are sufficient to perform the task required. Such characteristics as the performance of the microphone, the sampling rate of the analog to digital conversion, the storage capability of the digital memory, the dynamic range and the impulse response of the total system should all be examined for suitability before use.

TABLE D1

TYPICAL TAPE RECORDER CHARACTERISTICS

Parameters	Analogue recorders		Digital audio tape
	Reel to reel	Compact cassette	(DAT)
Typical frequency Response at 3dB limits	20 Hz to 20 kHz (depends on selected tape speed and reels)	30 Hz to 16 kHz (depends on selected tape formulation)	2 Hz to 20 kHz
Dynamic range Signal-to-noise ratio	> 50 dB (unweighted) > 55 dB(A)	> 48 dB (unweighted) > 55 dB(A)	90 dB (unweighted) > 96 dB(A)
Wow and flutter	Significant function of tape speed	Significant increases with age of recorder	Normally unmeasurable
Distortion characteristics	High at high levels Low at low levels	High at high levels Low at low levels	Low at high levels High at low levels
Overload characteristics	Gradual increase up to saturation point	Gradual increase up to saturation point which is a function of the tape formulation	Total overload and unusable output when signal exceeds 0 dB limit
Transient performance	Reasonable below −10 VU recording range	Truncated frequency output which is generally poor in the −10 to +10 VU range	Good provided transient signals do not exceed the peak limit of 0 dB
Recording time	Function of reel size and tape speed	Typically 45–50 mins per side	Up to 2 h continuous recording
Fit for purpose	May exhibit some limits in frequency and dynamic range	May exhibit some limits in frequency and dynamic range	Exhibits few problems in terms of frequency response or dynamic range
Selection of SLM or microphones input to ensure compatibility	Critical interface requirements to ensure that signal is faithfully recorded	Critical interface requirements to ensure that signal is faithfully recorded	Problems frequently observed because of wide dynamic range of DAT, and lesser range of some microphones
Calibration requirements	Minimum calibration period 2 years with infrequent use. Shorter intervals with more frequent use	Minimum calibration period 2 years with infrequent use. Shorter intervals with more frequent use	Minimum calibration period 2 years with infrequent use. Calibration with microphone required to satisfy type 1 precision requirements

APPENDIX E

PROCEDURE FOR DETERMINATION OF $E_{A,T}$, $L_{Aeq,T}$ AND $L_{Aeq,8h}$

(Normative)

E1 PARTIAL NOISE EXPOSURE

A person may work at several different tasks, each with a different noise level, in the course of a working day. A partial noise exposure will be received from each task, depending on the amount of time spent on the task and the associated noise level. Adding the partial noise exposures together will give the person's total daily noise exposure.

Noise exposures shall be measured directly with a PSEM or determined indirectly from measurement of noise level and exposure duration. To determine exposures indirectly it is necessary to determine, over the whole period, the length of each period of time T_i therein, during which the person is exposed to each of the particular $L_{Aeq,Ti}$ i.e. all values of $L_{Aeq,Ti}$ are required.

The magnitude of the day's exposure may then be expressed either as $E_{A,T}$, $L_{Aeq,T}$, or in 'normalized' form (see Clause 9.3) as $L_{Aeq,8h}$.

E2 DETERMINATION OF $E_{A,T}$

If $E_{A,T}$ has not been measured directly it can be determined from $L_{Aeq,T}$ values as follows:

(a)   Use Table E2 to convert each $L_{Aeq,Ti}$ to a pascal-squared value.

(b)   Multiply each pascal-squared value by the respective exposure time, T_i in hours to obtain the partial noise exposure, $E_{A,Ti}$

(c)   Add the partial noise exposures, $E_{A,Ti}$, together, to obtain the total daily noise exposure, $E_{A,T}$.

This is the A-weighted noise exposure for the relevant period T in hours.

E3 DETERMINATION OF $L_{Aeq,T}$

Table E2 can be used to determine the $L_{Aeq,T}$ from the following method:

(a)   Convert each $L_{Aeq,Ti}$ to a pascal-squared value.

(b)   Multiply each pascal-squared value by the respective exposure time, T_i, in hours, to obtain the partial noise exposure, $E_{A,Ti}$.

(c)   Add these partial noise exposures, $E_{A,Ti}$ together to obtain the total daily noise exposure, $E_{A,T}$.

(d)   Divide $E_{A,T}$, by T to obtain the T-hour average pascal-squared value, where $T = \sum_i T_i$

(e)   Convert this T-hour average pascal-squared value using Table E2 to obtain the $L_{Aeq,T}$.

E4 DETERMINATION OF $L_{Aeq,8h}$

Table E2 and Appendix F can be used to determine the $L_{Aeq,8h}$ from the following method:

(a)   Convert each $L_{Aeq,Ti}$ to a pascal-squared value using Table E2.

(b)   Multiply each pascal-squared value by the respective exposure time, T_i, in hours, to obtain the partial noise exposure, $E_{A,Ti}$.

(c)   Add these partial noise exposures, $E_{A,Ti}$ together to obtain the total daily noise exposure, $E_{A,T}$.

(d)   Read the $L_{Aeq,8h}$ value from Appendix F.

E5   DETERMINATION OF $L_{(Aeq,8h)n}$

Appendix F can be used to determine the average $L_{Aeq,8h}$ over a number of working days (n), from the following method:

(a)   Convert each $L_{(Aeq,8h)i}$ to a pascal-squared hour value, $E_{A,T}$.

(b)   Add all these values together to obtain the total pascal-squared hour value.

(c)   Divide the total pascal-squared hour value by the number of days (n), to obtain the average pascal-squared hour value over n days.

(d)   Convert this n-day average pascal-squared hour value using Appendix F to obtain $L_{(Aeq,8h)n}$.

This is the person's average noise exposure level over n days, $L_{(Aeq,8h)n}$.

E6   DETERMINATION OF $L(norm)_{Aeq,8h}$

Appendix F can be used to determine $L(norm)_{Aeq,8h}$ from the following method:

(a)   Convert each $L_{(Aeq,8h)i}$ to a pascal-squared hour value, $E_{A,T}$.

(b)   Add all these values together to obtain the total pascal-squared hour value.

(c)   Divide the total pascal-squared hour value by five to normalize to an equivalent five day working week value of pascal-squared hours.

(d)   Convert this normalized pascal-squared hour value using Appendix F to obtain $L(norm)_{Aeq,8h}$.

E7   EXAMPLES

E7.1   General

The two methods mentioned in Clause 9 to calculate the noise exposure, equivalent continuous A-weighted sound pressure level and the total daily noise exposure level from a number of partial noise exposures during a day's work, are illustrated in Paragraphs E7.2 and E7.3.

Table E1 provides an example of noise exposure details.

TABLE   E1

NOISE EXPOSURE DETAILS

Machine/Process	Measured noise level $L_{Aeq,Ti}$ dB(A)	Duration of exposure, T_i h
Planer	102	0.5
Circular saw	98	4.0
Power drill	89	2.5
Hammering	92	2.0

TABLE E2

DECIBEL TO PASCAL-SQUARED CONVERSION

dB	Pa^2	dB	Pa^2	dB	Pa^2	dB	Pa^2	dB	Pa^2
75	0.013	85	0.13	95	1.3	105	13	115	130
75.5	0.014	85.5	0.14	95.5	1.4	105.5	14	115.5	140
76	0.016	86	0.16	96	1.6	106	16	116	160
76.5	0.018	86.5	0.18	96.5	1.8	106.5	18	116.5	180
77	0.020	87	0.20	97	2.0	107	20	117	200
77.5	0.023	87.5	0.23	97.5	2.3	107.5	23	117.5	230
78	0.025	88	0.25	98	2.5	108	25	118	250
78.5	0.028	88.5	0.28	98.5	2.8	108.5	28	118.5	280
79	0.032	89	0.32	99	3.2	109	32	119	320
79.5	0.036	89.5	0.36	99.5	3.6	109.5	36	119.5	360
80	0.040	90	0.40	100	4.0	110	40	120	400
80.5	0.045	90.5	0.45	100.5	4.5	110.5	45	120.5	450
81	0.050	91	0.50	101	5.0	111	50	121	500
81.5	0.057	91.5	0.57	101.5	5.7	111.5	57	121.5	570
82	0.063	92	0.63	102	6.3	112	63	122	630
82.5	0.071	92.5	0.71	102.5	7.1	112.5	71	122.5	710
83	0.080	93	0.80	103	8.0	113	80	123	800
83.5	0.090	93.5	0.90	103.5	9.0	113.5	90	123.5	900
84	0.10	94	1.0	104	10	114	100	124	1000
84.5	0.11	94.5	1.1	104.5	11	114.5	110	124.5	1100

NOTES:

1   The pascal-squared values in the table above have been rounded to two significant figures. This will result in an accuracy of at least ±5% or ±0.2 dB.

2   This Table can be extended to include both higher and lower sound pressure levels. A change of 10 dB results in a tenfold change in the Pa^2 value. For example, the 133 dB value will be 10 times the value of 123 dB, that is, 8000 Pa^2. Also, the 67 dB value will be one tenth the value of 77 dB, that is 0.002 Pa^2.

E7.2   CALCULATION USING TABLE E2

E7.2.1 $E_{A,T}$

The partial noise exposures are determined for each process by converting each L_{Aeq,T_i} to a pascal-squared value using Table E2 and then multiplying each of these pascal-squared values by the respective exposure time, T_i in hours, to obtain the partial noise exposure, E_{A,T_i}. The results are given in Table E3.

TABLE E3

EXAMPLE OF PROCEDURE FOR CALCULATING $E_{A,T}$

Machine/Process	Measured noise level, L_{Aeq,T_i} dB(A)	Duration of exposure, T_i h	Pascal-squared (using Table E2) Pa^2	Partial noise exposure, E_{A,T_i} Pa^2h
Planer	102	0.5	6.3	3.2
Circular saw	98	4.0	2.5	10
Power drill	89	2.5	0.32	0.8
Hammering	92	2.0	0.63	1.3
Total daily noise exposure time, h		9.0		
Total daily noise exposure for 9 h, $E_{A,T}$, Pa^2h				15.3

NOTE: The highest noise level does not necessarily produce the highest partial noise exposure.

The $E_{A,T}$, is simply the arithmetic sum of the partial noise exposures.

So, when rounded to two significant figures, $E_{A,T}$ = 15 Pa²h.

E7.2.2 $L_{Aeq,T}$

The average pascal-squared value for the 9 h of exposure is determined by dividing the total daily noise exposure determined above, by the 9 h in the actual working day.

The 9 h average pascal-squared value of this total daily noise exposure is therefore 15/9 which is equal to 1.7 Pa².

The $L_{Aeq,9h}$ is obtained by looking up 1.7 in Table E2.

The $L_{Aeq,9h}$, is therefore between 96.0 dB(A) and 96.5 dB(A), which is normally rounded to the nearest whole number.

So, $L_{Aeq,9h}$ = 96 dB(A).

E7.2.3 $L_{Aeq,8h}$

The 8 h average pascal-squared value is determined by dividing the total daily noise exposure determined above by the 8 h in a normalized working day.

The 8 h average pascal-squared value of this total daily noise exposure is therefore 15/8 which equals 1.9 Pa².

$L_{Aeq,8h}$, is obtained by looking up 1.9 in Table E2.

So, $L_{Aeq,8h}$ = 97 dB(A).

NOTE: In this example, the exposure to noise was over a 9 h period in the day. It does not matter whether the exposure duration is more than, or less than, 8 h. The 8 h equivalent of the actual exposure is determined automatically using this method.

E7.3   CALCULATIONS USING THE EQUATIONS IN CLAUSE 9

E7.3.1 $E_{A,T}$

The partial noise exposure (E_{A,T_i}) for each of the machine operations can be calculated using the following Equation (see Clause 9.1):

$$E_{A,T_i} = 4 \times T_i \times 10^{0.1\left(L_{Aeq,T_i}-100\right)} \qquad \qquad \text{. . . (E1)}$$

where T_i is in hours

$E_{A,T}$ is then the arithmetic sum of the partial noise exposures—

A1

$$E_{A,T_i} \quad = \quad \sum_i E_{A,T_i} \qquad\qquad \text{. . . (E2)}$$

Example E1:   Using the data from Table E1 the following calculation occurs:

$$E_{A,T} \quad = \quad 4\times\left[\left(0.5\times10^{0.1(102-100)}\right)+\left(4.0\times10^{0.1(98-100)}\right)+\left(2.5\times10^{0.1(89-100)}\right)+\left(2.0\times10^{0.1(92-100)}\right)\right]$$

$$= \quad 4\times\left[\left(0.5\times10^{02}\right)+\left(4.0\times10^{-0.2}\right)+\left(2.5\times10^{1.1}\right)+\left(2.0\times10^{0.8}\right)\right]$$

$$= \quad 4\times\left[0.79+2.52+0.20+0.32\right]$$

$$= \quad 15.32 \text{ Pa}^2\text{h}$$

This is rounded to 15 Pa^{2}h.

E7.3.2 $L_{Aeq,T}$

This can be determined by using the following equation (see Clause 9.2):

$$L_{Aeq,T} \quad = \quad 10\log_{10}\left[\frac{1}{T}\sum_{i=1}^{n}T_i\times10^{0.1\left(L_{Aeq,T_i}\right)}\right] \qquad\qquad \text{. . . (E3)}$$

Example E2:   Using the data from Table E1 the following calculation occurs:

$$L_{Aeq,9h} \quad = \quad 10\log_{10}\left[\frac{1}{9}\left[\left(0.5\times10^{0.1(102)}\right)+\left(4.0\times10^{0.1(98)}\right)+\left(2.5\times10^{0.1(89)}\right)+\left(2.0\times10^{0.1(92)}\right)\right]\right]$$

$$= \quad 10\log_{10}\left[\frac{1}{9}\left[\left(0.5\times10^{10.2}\right)+\left(4.0\times10^{9.8}\right)+\left(2.5\times10^{8.9}\right)+\left(2.0\times10^{9.2}\right)\right]\right]$$

$$= \quad 10\log_{10}\left[\frac{1}{9}\left[\left(7.92\times10^{9}\right)+\left(2.52\times10^{10}\right)+\left(1.99\times10^{9}\right)+\left(3.17\times10^{9}\right)\right]\right]$$

$$= \quad 10\log_{10}\left[4.26\times10^{9}\right]$$

$$= \quad 96.3 \text{ dB(A)}$$

So, $L_{Aeq,9h}$ is rounded to 96 dB(A).

E7.3.3 $L_{Aeq,8h}$

This can be determined by using the following equation (see Clause 9.3):

A1

$$L_{Aeq,8h} \quad = \quad L_{Aeq,T}+10\log_{10}\left[\frac{T}{8}\right] \qquad\qquad \text{. . . (E4)}$$

where T is the exposure time to noise in hours

Example E3:   The exposure time is 9 h and the $L_{Aeq,9h}$ is 96 dB(A), therefore—

$$L_{Aeq,8h} \quad = \quad 96+10\log_{10}\left[\frac{9}{8}\right]$$

$$= \quad 96+0.51$$

$$= \quad 97 \text{ dB(A)}$$

E8 EXAMPLE OF CALCULATION OF AVERAGE DAILY NOISE EXPOSURE FOR 5 WORKING DAYS OF VARYING DAILY EXPOSURES TO NOISE ($L_{(Aeq,8h)_5}$)

E8.1 Example levels

Because of the varying work pattern, the total normalized daily noise exposure levels of a person vary from day to day during the working week. Example levels are given in Table E4.

TABLE E4

EXAMPLE NORMALIZED TOTAL DAILY NOISE EXPOSURE LEVELS

Day	$L_{(Aeq,8h)_i}$ dB(A)
Monday	85
Tuesday	97
Wednesday	100
Thursday	102
Friday	85

E8.2 Calculation using conversion Appendix F

The daily $L_{(Aeq,8h)_i}$, are converted to pascal-squared hours and all these values are added together to obtain the total pascal-squared hour value for 5 working days. The result is then divided by the number of days (5 in this example), to obtain the average pascal-squared hour value over the number of working days. This average pascal-squared hour value is then converted, using Appendix F, to obtain the average $L_{Aeq,8h}$. This is illustrated in Table E5.

TABLE E5

EXAMPLE OF PROCEDURE FOR CALCULATING PASCAL-SQUARED HOUR VALUE FOR 5 WORKING DAYS

Day	$L_{(Aeq,8h)_i}$ dB(A)	Pascal-squared hours Pa^2h
Monday	85	1
Tuesday	97	16
Wednesday	100	32
Thursday	102	51
Friday	85	1
Total pascal-squared hours		**101**

The average pascal-squared hour value over 5 working days is therefore 101/5 which is equal to 20.2 Pa^2h.

Using Appendix F1, $L_{(Aeq,8h)_5}$, is 98 dB(A).

E8.3 Calculation using the equation in Clause 9.5

$L_{(Aeq,8h)5}$ can be calculated using the following equation:

$$L_{(Aeq,8h)n} = 10 \log_{10}\left[\frac{1}{n}\sum_{i=1}^{n}10^{0.1\left(L_{(Aeq,8h)_i}\right)}\right] \qquad \ldots (E5)$$

Example E4:   Using the data from Table E4 the following calculation occurs:

$$L_{(Aeq,8h)5} = 10\log_{10}\left[\frac{1}{5}\left[\left(10^{0.1(85)}\right)+\left(10^{0.1(97)}\right)+\left(10^{0.1(100)}\right)+\left(10^{0.1(102)}\right)+\left(10^{0.1(85)}\right)\right]\right]$$

$$= 10\log_{10}\left[\frac{1}{5}\left[\left(10^{8.5}\right)+\left(10^{9.7}\right)+\left(10^{10}\right)+\left(10^{10.2}\right)+\left(10^{8.5}\right)\right]\right]$$

$$= 10\log_{10}\left[\frac{1}{5}\left[\left(3.16\times10^{8}\right)+\left(5.01\times10^{9}\right)+\left(1\times10^{10}\right)+\left(1.58\times10^{10}\right)+\left(3.16\times10^{8}\right)\right]\right]$$

$$= 10\log_{10}\left[\frac{1}{5}\left[3.14\times10^{10}\right]\right]$$

$$= 10\log_{10}\left(6.28\times10^{9}\right)$$

$$= 98 \text{ dB(A)}$$

E9 EXAMPLE OF CALCULATION OF NOISE EXPOSURE LEVEL NORMALIZED TO A FIVE DAY WORKING WEEK

E9.1 Example levels

Because of the varying work pattern, the normalised total daily noise exposure levels of a person vary from day to day during a six day working week. Example levels are given in Table E6.

TABLE E6

EXAMPLE NORMALIZED TOTAL DAILY NOISE EXPOSURE LEVELS

Day	$L_{(Aeq,8h)_i}$ dB(A)
Monday	85
Tuesday	97
Wednesday	100
Thursday	102
Friday	85
Saturday	99

E9.2 Calculation using conversion Appendix F

The daily $L_{(Aeq,8h)i}$ for each day are converted to a pascal-squared hour value and all these values are summed to obtain the total pascal-squared hour value for the 6 working days. The result is then divided by 5 to obtain the pascal-squared hour value normalized to a five day working week. This pascal-squared hour value is then converted, using Appendix F, to obtain the value of $L(norm)_{Aeq,8h}$. This is illustrated in Table E7.

TABLE E7

**EXAMPLE CALCULATION OF PASCAL-SQUARED
HOUR VALUE NORMALIZED TO A
FIVE DAY WORKING WEEK**

Day	$L_{(Aeq,8h)i}$, dB(A)	Pascal-squared hour value, Pa^2h
Monday	85	1
Tuesday	97	16
Wednesday	100	32
Thursday	102	51
Friday	85	1
Saturday	99	25
Total Pascal-squared hours		126

The value of pascal-squared hours normalized to a five day working week is therefore 126/5 which is equal to 25.2 Pa^2h.

Using Appendix F $L(norm)_{Aeq,8h}$ is 99 dB(A).

E9.3   Calculation using the equation in Clause 9.6

$L(norm)_{Aeq,8h}$ can be calculated using the following equation:

A1

$$L(norm)_{Aeq,8h} \quad = 10\log_{10}\left[\frac{1}{5}\sum_{i=1}^{n}10^{0.1\left(L_{(Aeq,8h)_i}\right)}\right] \qquad \ldots (E6)$$

Example E5:   Using the data from Table E6 the following calculation occurs:

$$L(norm)_{Aeq,8h} \quad = 10\log_{10}\left[\frac{1}{5}\left[\left(10^{0.1(85)}\right)+\left(10^{0.1(97)}\right)+\left(10^{0.1(100)}\right)+\left(10^{0.1(102)}\right)+\left(10^{0.1(85)}\right)+\left(10^{0.1(99)}\right)\right]\right]$$

$$= 10\log_{10}\left[\frac{1}{5}\left[\left(10^{8.5}\right)+\left(10^{9.7}\right)+\left(10^{10}\right)+\left(10^{10.2}\right)+\left(10^{8.5}\right)+\left(10^{9.9}\right)\right]\right]$$

$$= 10\log_{10}\left[\frac{1}{5}\left[3.94\times10^{10}\right]\right]$$

$$= 10\log_{10}\left(7.89\times10^{9}\right)$$

$$= 99 \text{ dB(A)}$$

APPENDIX F

RELATIONSHIP BETWEEN $L_{\text{Aeq,8h}}$ AND $E_{\text{A},T}$ VALUES

(Normative)

$L_{\text{Aeq,8h}}$, dB	$E_{\text{A},T}$, Pa^{2}h
75	0.10
76	0.13
77	0.16
78	0.20
79	0.25
80	0.32
81	0.40
82	0.51
83	0.64
84	0.80
85	1.0
86	1.3
87	1.6
88	2.0
89	2.5
90	3.2
91	4.0
92	5.1
93	6.4
94	8.0
95	10
96	13
97	16
98	20
99	25
100	32
101	40
102	51
103	64
104	80
105	100

NOTES:

1   The values stated are to two significant figures. This will result in errors of not more than 5% in exposure values and therefore of ±0.2 dB in the calculated $L_{\text{Aeq,8h}}$.

2   The values for any level of $L_{\text{Aeq,8h}}$, higher than 105 dB can easily be determined by multiplying by 10 the value of $E_{\text{A},T}$ for the level 10 dB lower than the one required. For example, a $L_{\text{Aeq,8h}}$, of 107 dB corresponds to an $E_{\text{A},T}$ of 160 Pa^{2}h (16.0 × 10).

APPENDIX G

NOISE ASSESSMENT REPORT PROFORMA

(Informative)

NOISE ASSESSMENT REPORT

File reference	
Reported by	Date of assessment
	Officer's position
Company name	Postal name
A1	
Suburb	Suburb
City/Town	City/Town
Phone	Phone
Fax	Fax
No. persons (area)	Contact
Industrial classification	Position
Description of company's activity	
H & S committee	H & S contact

SOUND LEVEL METER

Serial number
Date of last calibration
Reference level check (before)
Reference level check (after)
Class/Type

REFERENCE SOUND SOURCE

Serial number
Date of last calibration
Class

PSEM

Serial number
Date of last calibration
Reference level check (before)
Reference level check (after)

Octave-band ANALYSER

Serial number
Date of last calibration
Reference level check (before)
Reference level check (after)

Area assessed

Building construction

Recommendation to client

Period of measurements

Reason for assessment

Sketch of area attached ☐   Letter with report attached ☐

SIGNATURE: _____   POSITION: _____   DATE: _____

AREA ASSESSMENT

	Machine/Area	Process/activity	Measurement position	Peak sound pressure level [dB]	LAeq,Ti reading [dB(A)]	Measurement time	Exposure time [h]	No. of people exposed	Comments/tasks
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									

44

ading)]	Exposure time [h]	Pascal squared [Pa^2]	Partial Exposure [Pa^{2}h]	$L_{Aeq,8h}$ [dB(A)]	Hearing protection worn

Number exposed to $L_{Aeq,8h}$ from 106 to 110 dB(A)

Number exposed to $L_{Aeq,8h}$ more than 110 dB(A)

Number exposed to L_{peak} more than 140 dB(C)

95 dB(A)

100 dB(A)

o 105 dB(A)

FREQUENCY ANALYSIS

| Position | $L_{Aeq,T}$ | $L_{Ceq,T}$ | SOUND PRESSURE LEVEL [dB re 20 µPa] |
| | | | $L_{eq,T}$ octave-band centre frequency(Hz) |
			63	125	250	500	1 k	2 k	4 k	8 k	16 k
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											

AMENDMENT CONTROL SHEET

AS/NZS 1269.1:2005

Amendment No. 1 (2005)

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CORRECTION

SUMMARY: This Amendment applies to Clauses 3.3 and 3.10, Table 1, Clauses 7.3, 8.7, 9.1, 9.4, 9.6, 9.8 and Appendices E and G.

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Standards Australia is an independent company, limited by guarantee, which prepares and publishes most of the voluntary technical and commercial standards used in Australia. These standards are developed through an open process of consultation and consensus, in which all interested parties are invited to participate. Through a Memorandum of Understanding with the Commonwealth government, Standards Australia is recognized as Australia's peak national standards body.

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The first national Standards organization was created in New Zealand in 1932. The Standards Council of New Zealand is the national authority responsible for the production of Standards. Standards New Zealand is the trading arm of the Standards Council established under the Standards Act 1988.

Australian/New Zealand Standards

Under a Memorandum of Understanding between Standards Australia and Standards New Zealand, Australian/New Zealand Standards are prepared by committees of experts from industry, governments, consumers and other sectors. The requirements or recommendations contained in published Standards are a consensus of the views of representative interests and also take account of comments received from other sources. They reflect the latest scientific and industry experience. Australian/New Zealand Standards are kept under continuous review after publication and are updated regularly to take account of changing technology.

International Involvement

Standards Australia and Standards New Zealand are responsible for ensuring that the Australian

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