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ISO 1999:1990

Australian Standard™

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

Standards Australia

This Australian Standard was prepared by Committee AV-003, Acoustics Human Effects. It was approved on behalf of the Council of Standards Australia on 8 July 2003 and published on 18 August 2003.

The following are represented on Committee AV-003:

Association of Australian Acoustical Consultants
Association of Consulting Engineers Australia
Australian Acoustical Society
Australian Chamber of Commerce and Industry
Australian Hearing
Department of Consumer & Employment Protection, WorkSafe Division, W.A.
Department of Labour, New Zealand
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Australian Standard™

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PREFACE

This Standard was prepared by the Australian members of the Joint Standards Australia/Standards New Zealand Committee AV-003, Acoustics Human Effects. After consultation with stakeholders in both countries, Standards Australia and Standards New Zealand decided to develop this Standard as an Australian, rather than an Australian/New Zealand Standard.

This Standard is identical with and has been reproduced from ISO 1999:1990, *Acoustics—Determination of occupational noise exposure and estimation of noise-induced hearing impairment.*

The objective of this Standard is to specify a method for calculating the expected noise-induced permanent threshold shift in the hearing threshold levels of adult populations due to various levels and duration of noise exposure.

AS/NZS 1269 series, *Occupational noise management* provides requirements and guidance of all facets of noise management.

It is the intention of Committee AV-003 that where there is a conflict between provisions of this Standard and the provisions of AS/NZS 1269, the AS/NZS 1269 series should prevail.

As this Standard is reproduced from an International Standard, the following applies:

(a) Its number does not appear on each page of text and its identity is shown only on the cover and title page.

(b) In the source text 'this International Standard' should read 'this Australian Standard'.

(c) A full point substitutes for a comma when referring to a decimal marker.

(d) The word 'handicap' should be replaced by the work 'impairment'.

(e) The symbol '$L_{EX,8h}$' should be replaced by the symbol '$L_{A\,eq,8h}$'.

This Standard provides for the use of the following Australian and Australian/New Zealand Standards as equivalents to particular International Standards referenced herein:

Reference to International Standard		*Australian/New Zealand Standard*	
ISO		AS/NZS	
389	Acoustics—Standard reference zero for the calibration of pure tone air conduction audiometers	1591	Acoustics—Instrumentation for audiometry
		1591.1	Part 1: Reference zero for the calibration of pure-tone bone conduction audiometers
1996	Acoustics—Description and measurement of environmental noise	1055	Acoustics—Description and measurement of environmental noise
1996-1	Part 1: Basic quantities and procedures	1055.1	Part 1: General procedures
1996-2	Part 2: Acquisition of data pertinent to land use	1055.3	Part 3: Acquisition of data pertinent to land use
IEC		AS	
651	Sound level meters	1259	Acoustics—Sound level meters
		1259.1	Part 1: Non-integrating
804	Integrating-averaging sound level meters	1259.2	Part 2: Integrating—Averaging

INTRODUCTION

This International Standard presents, in statistical terms, the relationship between noise exposures and the "noise-induced permanent threshold shift" (NIPTS) in people of various ages. It provides procedures for estimating the hearing impairment due to noise exposure of populations free from auditory impairment other than that due to noise (with allowance for the effects of age) or of unscreened populations whose hearing capability has been measured or estimated. (NIPTS is treated here as an additive term independent of other components of hearing threshold levels. It is usually zero in the absence of noise exposure, and, for any given noise exposure, it has a range of positive values representing the variability of noise-damage susceptibility between individuals of a population.)

Persons regularly exposed to noise can develop hearing loss of varying severity. Due to this hearing loss their understanding of speech, perception of everyday acoustic signals or appreciation of music may be impaired. With the exception of exposure to blast, high-impulse noise and extremely high levels of steady noise, permanent impairment of the hearing organ takes time and is progressive over months, years or decades of exposure. NIPTS is usually preceded by a reversible temporary effect on hearing, called noise-induced "temporary threshold shift" (TTS). The severity of TTS and recovery from it depend upon exposure level and time. For a single individual, it is not possible to determine precisely which changes in hearing threshold level are caused by noise and which changes are caused by other factors, although, in doubtful individual cases, the data in this International Standard might provide an additional means for estimating the most probable causes in audiological diagnosis. However, for a large population exposed to a specific noise, changes in the statistical distributions of hearing threshold levels can be determined. Parameters such as the mean NIPTS, the median NIPTS, etc., can be used to describe differences in hearing threshold levels between two populations that are similar in all relevant respects except that one population has had a well defined (usually occupational) noise exposure. Throughout this International Standard, the term "NIPTS" is applied to changes in the noise-induced permanent threshold shift of statistical distributions of groups of people; it is not to be applied to individuals.

This International Standard can be applied to calculation of the risk of sustaining hearing handicap due to regular occupational noise exposure or due to any daily repeated noise exposure. In some countries hearing handicap caused by occupational noise exposure can have legal consequences with respect to responsibility and compensation. The hearing threshold level at the various frequencies, at which a hearing handicap is deemed to exist ("fence"), depends not only on the impairment *per se*, but frequently on legal definitions and interpretations based on social and economic considerations. In addition, the definition of a hearing handicap depends on the quality of speech intelligibility desired, the average level of background noise and, with respect to the relative importance of the various frequencies, perhaps even on the language. Consequently, this International Standard does not stipulate (in contrast to the first edition of ISO 1999) a specific formula for assessment of the risk of handicap, but specifies uniform methods for the prediction of hearing impairment, which can be used for the assessment of handicap according to the formula desired or stipulated in a specific country. The results obtained by this International Standard may also be used for estimating the permanent effects of noise on the perception of everyday acoustic signals, the appreciation of music or the effect of one specific frequency not necessarily stipulated by a hearing handicap formula.

Since noise-induced hearing impairment is the result not only of occupational noise exposure but of the total noise exposure of the population, it may be important to take the non-occupational exposure of individuals (during commuting to and from their jobs, at home and during recreational activities) into account. Only if this non-occupational exposure is negligible compared with the occupational exposure does this International Standard allow prediction of the occurrence of hearing impairment due to occupational noise exposure. Otherwise, it should be used to calculate the hearing impairment to be expected from the combined (occupational plus non-occupational) total daily noise exposure. The contribution of the occupational noise exposure to the total hearing impairment can then be estimated, if desired.

The selection of maximum tolerable or maximum permissible noise exposures, and protection requirements as well as the selection of specific formulae for handicap risk assessment or compensation purposes, require consideration of ethical, social, economic and political factors not amenable to international standardization. Individual countries differ in their interpretation of these factors and these factors are therefore considered outside the scope of this International Standard.

For reasons given above this International Standard by itself does not comprise a complete guide for risk assessment and protection requirements, and for practical use it has to be complemented by national standards or codes of practice delineating the factors which are here left open.

AUSTRALIAN STANDARD

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

1 Scope

This International Standard specifies a method for calculating the expected noise-induced permanent threshold shift in the hearing threshold levels of adult populations due to various levels and durations of noise exposure; it provides the basis for calculating hearing handicap according to various formulae when the hearing threshold levels at commonly measured audiometric frequencies, or combinations of such frequencies, exceed a certain value.

NOTE 1 — This International Standard does not specify frequencies, frequency combinations or weighted combinations to be used for the evaluation of hearing handicap; nor does it specify a hearing threshold level (''fence'') which must be exceeded for hearing handicap to exist. Quantitative selection of these parameters is left to the user. All sound pressure levels stated in this International Standard do not consider the effect of hearing protectors which would reduce the levels effective at the ear.

The measure of exposure to noise for a population at risk is the averaged A-weighted sound exposure (time-integrated squared sound pressure), $E_{A,T}$, and the related equivalent continuous A-weighted sound pressure level, $L_{Aeq,T}$, over an average working day (assumed to be of 8 h duration), for a given number of years of exposure. This International Standard applies to audio frequency (less than approximately 10 kHz) noise which is steady, intermittent, fluctuating, irregular or impulsive in character. Use of this International Standard for instantaneous sound pressures exceeding 200 Pa (140 dB relative to 20 μPa) and for higher sound pressures should be recognized as extrapolation.

For the assessment of hearing impairment due to exposure to noise, formulae are presented to calculate the NIPTS for audiometric frequencies from 0,5 kHz to 6 kHz for 8 h per day daily A-weighted sound exposure of 364 $Pa^2 \cdot s$ to $1{,}15 \times 10^5$ $Pa^2 \cdot s$ (equivalent continuous A-weighted sound pressure level for a normal 8 h working day from 75 dB to 100 dB), and periods of exposure lasting from 0 to 40 years. Extrapolations to higher levels are not supported by quantitative data. The median values of NIPTS as well as the statistical distribution above and below the median value from the 0,05 to the 0,95 fractile are specified. The NIPTS data are the same for male and female populations.

NOTES

2 Although the NIPTS data are based on data assumed to stem from primarily occupationally noise-exposed populations, they may be used, with some caution, for estimating the effects of comparable non-occupational and combined exposures. (The length of the working day should be stated.)

3 The prediction method presented is based primarily on data collected with essentially broad-band steady non-tonal noise. The application of the data base to tonal or impulsive/impact noise represents the best available extrapolation. Some users may, however, wish to consider tonal noise and/or impulsive/impact noise about as harmful as a steady non-tonal noise that is approximately 5 dB higher in level.

To calculate hearing threshold levels and the risk of acquiring hearing impairment or handicap due to noise exposure, the threshold of hearing of a non-noise-exposed population of comparable age has to be known. Since different criteria can be applied to the selection of this population, this International Standard allows for two possibilities presented by two different data bases :

a) an otologically normal population, that is, ''highly screened'' (see ISO 7029);

b) any other population selected by the user of the International Standard as being appropriate.

NOTE 4 — All data and procedures presented in this International Standard are based on deliberate simplifications of experimental data where the daily sound exposure duration did not exceed 12 h. The resulting approximations restrict the validity to the stated ranges of the variables, fractiles, sound exposure levels and frequency ranges.

This International Standard is based on statistical data and therefore shall not be used to predict or assess the hearing impairment or hearing handicap of individual persons.

Annex A gives the procedure for calculating the age-related hearing threshold levels for an otologically normal population (''highly screened'') in accordance with ISO 7029.

Annex B gives as an example of the second data base the procedure for calculating the age-related threshold levels for an unscreened population of a typical industrialized society.

Annex C gives an example of selected values of the hearing threshold levels of a specific unscreened population, which, when used with the procedures of this International Standard, results in approximately the same risk of hearing handicap as the one predicted by the first edition of ISO 1999.

Annex D describes an example of hearing risk assessment using this International Standard.

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