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Acoustics — Estimation of noise-induced hearing loss

Acoustique — Estimation de la perte auditive induite par le bruit

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Foreword

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This document was prepared by Technical Committee ISO/TC 43, *Acoustics*.

This fourth edition cancels and replaces the third edition (ISO 1999:2013), which has been technically revised.

The main changes are as follows:

— The second and third editions of this standard were based on estimates of effect of noise, *N*, developed using the empirical models of two databases (see References ~~[2] and [22]).~~[0] and [0]). However, traceability of the derivation of those estimates has been lost and the Working Group of Technical Committee 43, ISO~~-~~/TC43~~-~~/WG1 "Threshold of Hearing," has been unable to assess its validity. The values of *N* in this technical specification were derived from the hearing threshold levels calculated from the same empirical models as the previous versions (see ~~Annex F~~). ~~.~~Annex F).

— In this edition, a recommendation for an adjustment is made to the noise exposure level to improve prediction of hearing threshold levels for people exposed to noise with substantial impulse/impact components (see ~~Annex E~~). ~~.~~Annex E).

— This revised version introduces a tabular representation of the effect of noise, *N*, with interpolation between tabled values to replace the formulae presented by previous editions.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at ~~www.iso.org/members.html~~.www.iso.org/members.html.

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Introduction

This document presents, in statistical terms, the relationship between noise exposure, unprotected unless otherwise stated, and its effect on hearing threshold levels in people of various ages. This document provides procedures for estimating the hearing loss due to noise exposure in populations by comparison to various non-noise exposed populations. For any given noise exposure, effect of noise, *N*, has a range of positive values reflecting the variability of susceptibility to noise-induced hearing loss among individuals.

Persons regularly exposed to noise can develop hearing loss of varying severity. Due to hearing loss, their understanding of speech, perception of everyday acoustic signals, or appreciation of music can be impaired. With the exception of traumatic damage to the ear caused by exposure to blast, high-impulse noise and extremely high levels of steady-state noise, permanent impairment of the hearing organ takes time and is progressive over months, years, or decades of exposure. 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. However, for a sufficiently large population exposed to a specific noise, changes in the statistical distributions of hearing threshold levels can be determined. Predictions from this technical specification 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.

Researchers have for many years found that noise with substantial impulse/impact components is more hazardous to hearing than noise at similar sound pressure levels without substantial impulse/impact components. In this edition, an adjustment is made to the noise exposure level to improve prediction of hearing threshold levels for people exposed to noise with substantial impulse/impact components. The adjustment is based on the distribution of values in the sound pressure waveform using the statistical measure kurtosis (see ~~Annex E).~~Annex E).

This document was derived from the hearing threshold levels calculated from the same empirical models as the previous versions (References ~~[2] and [22]; see Annex F).~~[0] and [0]; see Annex F). document uses the formula *H*' = *H* + *N* – (*H* x *N* /120) to calculate expected hearing threshold level (*H*') from the combination of components due to noise (*N*) and other factors, principally age (*H*). In order to derive the noise-induced component, this formula was rearranged to calculate the values of *N* shown in ~~Tables 1~~Tables 1 and 2of this revision: *N* = (*H*' – *H*)/(1- *H*/120), where each value of *N* was calculated using the unweighted arithmetic mean, or average, of the two values of *H*' and the two values of *H* in the two databases at each frequency, noise level, duration and percentile value shown in the table. Interpolation between values of *N* in ~~Tables 1 and 2~~Tables 1 and 2 enables calculation of values of *N* not included in the table. The formulation was validated by comparison with a broader set of published data on noise-induced hearing loss, as compiled in Reference ~~[26].~~[0]. A Hearing Threshold Level Calculator is also provided with this revision so that hearing threshold levels can be readily determined.

This document can be applied to the calculation of the risk of hearing impairment due to regular occupational noise exposure or due to any daily repeated noise exposure. In some countries, hearing loss 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 impairment is deemed to exist (fence), depends not only on the hearing loss per se, but frequently on legal definitions and interpretations based on social and economic considerations. In addition, the definition of a hearing impairment depends on the quality of speech recognition 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 document does not stipulate (in contrast to the first edition of ISO 1999) a specific formula for assessment of the risk of impairment, but specifies methods for the prediction of hearing threshold levels, which can be used for the assessment of impairment according to the formula desired or stipulated in a specific country.

The selection of maximum tolerable or maximum permissible noise exposures and protection requirements, as well as the selection of specific formulae for impairment risk assessment or compensation purposes, require consideration of ethical, social, economic and political factors not amenable to international

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