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Hearing protectors - Recommendations for selection, use, care and maintenance - Guidance document

Gehörschützer - Empfehlungen für Auswahl, Einsatz, Pflege und Instandhaltung - Leitfaden

Protecteurs individuels contre le bruit - Recommandations relatives à la sélection, à l'utilisation, aux précautions d'emploi et à l'entretien - Document guide

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Hearing protectors - Recommendations for selection, use, care and maintenance - Guidance document

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European foreword

This document (EN 458:2016) has been prepared by Technical Committee CEN/TC 159 “Hearing protectors”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by September 2016, and conflicting national standards shall be withdrawn at the latest by September 2016.

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Introduction

This European Standard is intended to guide employers, supervisors and safety advisors. Additionally, the standard gives information to all who need to use hearing protectors.

Hearing protectors are items of personal protective equipment (PPE) intended to reduce the harmful effects that sound and noise may have on the hearing.

Guidance is provided on how to best select, use and take care of such devices. Tools to estimate the noise exposure level, when a certain hearing protector is used, are also provided.

National bodies may develop national application documents based on this standard.

Hearing protectors are generally available in two main forms: earmuffs and earplugs. Both forms are available with additional features and functions. All have their advantages and disadvantages in terms of attenuation, comfort, ease of use, communication facilities and cost.

In hearing conservation programmes noise hazard areas are identified and the personal noise exposure is assessed. Before a suitable hearing protector is considered, priority should be given to reducing noise at source and/or reducing the exposure time.

If the use of a hearing protector is found necessary or advisable, choosing optimum devices is a complex task. The most important concern is for the protector to provide sufficient attenuation.

It is often desirable to retain the ability to hear speech and warning signals. To achieve this, the hearing protector should not overprotect. In particular, this needs attention at moderate noise levels.

Hearing protectors are supplied with attenuation data in various formats. The attenuation is expressed in decibels and has been derived from laboratory tests. It is important to note that these data have been achieved under controlled laboratory conditions using trained test subjects. Under real working conditions, the attenuation achieved by the user may be lower than that generated by the laboratory testing.

The performance of hearing protectors is subject to natural variability amongst users. Correct fitting, training, regular inspection and user motivation are important to obtain the desired protection. Due to the natural variability, it is not possible to calculate the exact attenuation that a certain hearing protector will give for an individual. If a more accurate prediction is required, some form of individual attenuation check can be made. At high noise level exposures it is advisable to seek expert advice. In some cases dual protection i.e. the use of an earmuff and an earplug combination, may be required.

For hearing protectors to be effective they should be used at all times when the user is in a potentially hazardous noise environment. When selecting hearing protectors, attention should be given to factors influencing comfort and user preference.

1 Scope

This European Standard gives recommendations for the selection, use, care and maintenance of hearing protectors.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 352-1, *Hearing protectors — General requirements — Part 1: Ear-Muffs*

EN 352-2, *Hearing protectors — General requirements — Part 2: Ear-plugs*

EN 352-3, *Hearing protectors — General requirements — Part 3: Ear-muffs attached to an industrial safety helmet*

EN 352-4, *Hearing protectors — Safety requirements and testing — Part 4: Level-dependent ear-muffs*

EN 352-5, *Hearing protectors — Safety requirements and testing — Part 5: Active noise reduction ear-muffs*

EN 352-6, *Hearing protectors — Safety requirements and testing — Part 6: Ear-muffs with electrical audio input*

EN 352-7, *Hearing protectors — Safety requirements and testing — Part 7: Level-dependent ear-plugs*

EN 352-8, *Hearing protectors — Safety requirements and testing — Part 8: Entertainment audio ear-muffs*

EN 24869-1, *Acoustics — Hearing protectors — Subjective method for the measurement of sound attenuation (ISO 4869-1)*

EN 61672-1, *Electroacoustics — Sound level meters — Part 1: Specifications (IEC 61672-1)*

EN ISO 4869-2, *Acoustics — Hearing protectors — Part 2: Estimation of effective A-weighted sound pressure levels when hearing protectors are worn (ISO 4869-2)*

EN ISO 7731, *Ergonomics — Danger signals for public and work areas — Auditory danger signals (ISO 7731)*

EN ISO 9612, *Acoustics — Determination of occupational noise exposure — Engineering method (ISO 9612)*

EN ISO 9921, *Ergonomics — Assessment of speech communication (ISO 9921)*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
daily noise exposure level ($L_{EX,8h}$)
A-weighted noise exposure level normalized to a nominal 8 h working day

3.2
peak sound pressure level ($L_{p,\mathrm{Cpeak}}$)
C-weighted instantaneous peak sound pressure level according to EN ISO 9612

3.3
national regulation level (L'_{NR})
daily noise exposure level ($L_{\mathrm{EX,8h}}$) effective to the ear according to national regulations

Note 1 to entry: National laws or regulations will stipulate at which levels of exposure hearing protectors shall be provided or used.

3.4
national peak regulation level ($L'_{\mathrm{NR,peak}}$)
peak pressure level $L_{p,\mathrm{Cpeak}}$ effective to the ear according to national regulations

Note 1 to entry: National laws or regulations will stipulate at which levels of exposure hearing protectors shall be provided or used.

3.5
effective attenuation
measure of protection afforded by the hearing protector for the user

3.6
over-protection
selection and use of a hearing protector with too high attenuation which may lead to a sense of isolation and difficulties with perception of sounds

3.7
A-weighted sound pressure level ($L_{p,\mathrm{A}}$)
sound pressure level with frequency weighting A according to EN 61672-1

3.8
A-weighted sound pressure level effective to the ear ($L'_{p,\mathrm{A}}$)
A-weighted diffuse field equivalent sound pressure level under the hearing protector for the external sound pressure level $L_{p,\mathrm{A}}$

3.9
C-weighted sound pressure level ($L_{p,\mathrm{C}}$)
sound pressure level with frequency weighting C according to EN 61672-1

3.10
A-weighted equivalent sound pressure level effective to the ear ($L'_{p,\mathrm{A,eq}T}$)
A-weighted diffuse field equivalent sound pressure level under the hearing protector for the external sound pressure level for time period T $L_{p,\mathrm{A,eq}T}$

Note 1 to entry: For simplicity of notation, the subscript T is omitted throughout the following text.

3.11
effective daily noise exposure level ($L'_{\mathrm{EX,8h}}$)
A-weighted diffuse field equivalent sound pressure level under the hearing protector for the external noise exposure level $L_{\mathrm{EX,8h}}$

3.12
peak sound pressure level effective to the ear ($L'_{p,Cpeak}$)
C-weighted peak sound pressure level under the hearing protector for the external sound pressure level $L_{p,Cpeak}$

3.13
flat frequency response
attenuation which is constant (or nearly constant) over the frequencies (H – L ≤ 9 dB)

Note 1 to entry: See A.1 for explanation of "H" and "L".

4 Symbols and abbreviations

For the purposes of this document, the following symbols and abbreviations apply.

f	centre frequency of the octave band in Hz
$L_{p,eq}$	equivalent sound pressure level
$L_{p,oct}$	sound pressure level for a single octave band
$L_{p,oct,eq}$	equivalent sound pressure level for a single octave band
PNR	predicted noise level reduction according to EN ISO 4869-2
APV_f	assumed protection value APV_{f84} according to EN ISO 4869-2
rms	root mean square
$L_{EX,8h}$	daily noise exposure level
$L_{p,Cpeak}$	C-weighted peak sound pressure level
L'_{NR}	national regulation level
$L'_{NR,peak}$	national peak regulation level
$L_{p,A}$	A-weighted sound pressure level
$L'_{p,A}$	A-weighted sound pressure level effective to the ear
$L_{p,C}$	C-weighted sound pressure level
$L_{p,A,eqT}$	A-weighted equivalent sound pressure level
$L_{p,C,eqT}$	C-weighted equivalent sound pressure level
$L'_{p,A,eqT}$	A-weighted equivalent sound pressure level effective to the ear
$L'_{EX,8h}$	effective daily noise exposure level
$L'_{p,Cpeak}$	peak sound pressure level effective to the ear

NOTE For simplification of notation, the subscript T is omitted throughout the following text.

5 Types of hearing protectors

5.1 Design forms

5.1.1 Earmuffs

Earmuffs consist of cups which fit over the ears and are sealed to the head with soft cushions, usually filled with foam and/or liquid. The cups are usually lined with sound absorptive material. They are connected by a tensioning band (head band), usually made of metal and/or plastic. When the earmuff is used behind-the-head or under-the-chin, a flexible head strap is sometimes fitted to each cup or to the

head band close to the cups to support the earmuff. Some earmuffs have one cup intended only for the left ear and the other only for the right ear. Earmuffs may be available in 'medium size range', 'small size range' and 'large size range' types. 'Medium size range' earmuffs will fit the majority of users. 'Small size range' or 'large size range' earmuffs are designed to fit users for whom 'medium size range' earmuffs are not suitable.

Earmuffs are available with head bands, neck bands, chin bands and universal bands. Earmuffs with neck bands and chin bands permit the simultaneous using of a safety helmet. Universal bands can be used over-the-head, behind-the-head or under-the-chin. Universal bands, neck bands and chin bands may be complemented by head straps to ensure a reliable fit of the earmuff.

Requirements for earmuffs are specified in EN 352-1.

5.1.2 Helmet mounted earmuffs

Helmet mounted earmuffs consist of individual cups attached to arms that are mounted to an industrial safety helmet or other equipment serving as carrier for the hearing protector. The arms are adjustable so that the cups can be positioned over the ears.

Requirements for earmuffs attached to a helmet are specified in EN 352-3.

5.1.3 Earplugs

5.1.3.1 General

Earplugs are hearing protectors that are designed to be inserted into the ear canal or to cover the ear canal entrance. They are sometimes provided with an interconnecting cord, head band or finger grips. Earplugs can be either disposable (intended for single use) or reusable (intended for repeated use).

Requirements for earplugs are specified in EN 352-2.

5.1.3.2 Pre-shaped earplugs

Pre-shaped earplugs can readily be inserted into the ear canal without prior shaping. Pre-shaped earplugs are available in a variety of materials. They may be available in a range of sizes.

5.1.3.3 User-formable earplugs

User-formable earplugs are made from compressible materials that the user forms before inserting them into the ear canal. After insertion, these earplugs are designed to expand and form a seal within the ear canal.

5.1.3.4 Banded earplugs

These are pre-shaped earplugs attached to a band which presses them into the ear canal or against the entrance of the ear canal. Some are intended to be used in more than one position, e.g. with the band under-the-chin.

5.1.3.5 Custom moulded earplugs

Custom moulded earplugs are individually moulded to fit the shape of the user's ear canals. They can be provided with different filters to offer a range of attenuation.

5.2 Function mode

5.2.1 Basic function mode

All hearing protectors have the characteristics of reducing noise by their design and type of material used, to absorb and/or reflect sound. Devices that have only this function are called passive devices. They constitute the basis for all other additional function modes as described in 5.2.2 to 5.2.4.

5.2.2 Level-dependent hearing protectors

5.2.2.1 General

Level-dependent hearing protectors are designed to provide different attenuation as the external sound level changes. Their main purpose is to protect against impulsive or intermittent hazardous noise while allowing situational awareness.

Requirements for level-dependent hearing protectors are specified in EN 352-4 (for earmuffs) and EN 352-7 (for earplugs).

5.2.2.2 Passive level-dependent hearing protectors

Passive level-dependent hearing protectors use the acoustic properties of carefully designed air ducts to give different protection at different noise levels. These types of protector are designed to be effective against very high level single-impulse noises, such as firearms, rather than the continuous noise or repetitive impulses found in most industrial situations.

5.2.2.3 Sound-restoration level-dependent hearing protectors

Sound-restoration level-dependent hearing protectors incorporate an electronic sound reproduction system. At low sound pressure levels the sound detected by an external microphone is amplified and relayed to a loudspeaker inside the earmuff or earplug. As the external sound pressure level increases, the electronics reduce the gain and control the level of reproduced sound inside the hearing protector.

5.2.3 Active noise reduction (ANR) protectors

These are hearing protectors which incorporate an electronic sound cancelling system to achieve additional noise attenuation where passive hearing protectors may be less effective. ANR is particularly effective at low frequencies (50 Hz to 500 Hz).

Requirements for active noise reduction earmuffs are specified in EN 352-5.

5.2.4 Hearing protectors with external audio input

5.2.4.1 General

These devices use a wired or wireless system through which working signals, alarms, messages or audio entertainment can be relayed. Some products incorporate a system to limit the sound pressure level.

5.2.4.2 Hearing protector with entertainment audio input

These devices may incorporate a radio receiver set or music player for entertainment or allow audio input from external devices. It also offers the possibility to communicate warning signals or messages.

Requirements for entertainment audio earmuffs are specified in EN 352-8.

5.2.4.3 Hearing protector with work or safety-related audio input

These devices include wired input or wireless radio receiver and/or two-way radio for work or safety-related communication. As the information to be received might be crucial for safety, the product standards impose no limitation on the reproduced sound pressure level at the ear.

Requirements for earmuffs with electrical audio input (for work or safety-related communication) are specified in EN 352-6.

6 Selection

6.1 Principles

Personal hearing protection should be selected so that, when used correctly and for the entire duration of exposure, it will eliminate or minimize the risk to hearing.

As there are many different hearing protectors intended for use in a wide range of noise environments it is important to choose a suitable type. The product shall be checked for regulatory conformance. Consideration should be given to the factors listed in a) to h). The list is neither exclusive nor exhaustive:

a) sound attenuation, see 6.2;

b) work environment, see 6.3;

c) essential work related communication, especially speech intelligibility, see 6.4;

d) compatibility with other personal protective equipment (PPE), such as helmets, spectacles, etc., see 6.5;

e) how the hearing protector will be used, see 6.6;

f) special user groups and medical factors, see 6.7;

g) user comfort; and ergonomic requirements, see 6.8;

h) conformity with relevant requirements for incorporated electronics, see 6.9.

The selection procedure should be reviewed at regular intervals to ensure that an effective attenuation is maintained. When considering all factors in the selection process the most important outcome is that the hearing protector will be used during the whole time of noise exposure.

6.2 Selection according to sound attenuation

6.2.1 Guide to protection rating

Hearing protectors should be chosen according to the sound attenuation they will provide. Methods to predict the sound attenuation of hearing protectors are given in 6.2.3.

NOTE It is generally accepted that the risk of hearing damage associated with occupational noise exposure is low where the daily noise exposure level ($L_{EX,8h}$) is below 80 dB, and insignificant where $L_{EX,8h}$ is below 75 dB.

National regulations or other guidelines may stipulate selection criteria for personal hearing protection and place limits on sound exposure. Such relevant criteria and limits should be taken into account in deciding what level of sound attenuation is required.

In general, a hearing protector which provides an effective sound level at the ear ($L'_{p,A,eq}$) of between 70 dB and 80 dB is considered suitable. If the chosen hearing protector provides excessive attenuation, users are at risk of failing to recognize warning signals and understand essential communications. Users may also feel isolated from their working environment. The perception of isolation increases as the sound level effective to the ear decreases.

Workers may be exposed to different noise environments during the working day. It may be possible to select a single hearing protector which is adequate for all situations likely to be encountered, or it may be necessary to select more than one type of hearing protector.

EXAMPLE 1 A worker's only significant noise exposure is to an $L_{p,A,eq}$ of 98 dB, for a total of 30 min per day. His $L_{EX,8h}$ is 86 dB. His employer wishes to minimize the risk to the worker's hearing, and so aims to provide a hearing protector that provides an effective sound pressure level at the ear of below 80 dB, ideally between 75 dB and 70 dB. The employer selects a protector that provides a sound attenuation of 26 dB.

EXAMPLE 2 A worker spends the majority of her working day (a total of 6 h) in an environment with an $L_{p,A,eq}$ of 94 dB. Her $L_{EX,8h}$ is around 93 dB. Her employer wishes to reduce the effective $L'_{EX,8h}$ to at least below 80 dB, and to minimize the risk to the worker's hearing. The employer rejects a protector that provides a sound attenuation of 32 dB, as this would reduce the effective sound pressure level at the ear to 62 dB and so risk over-protection. The employer selects a protector that provides a sound attenuation of 22 dB.

6.2.2 Sound attenuation in practice (Real-world attenuation)

The attenuation afforded by a hearing protector when used under normal working conditions may differ from that indicated on the device packaging or in the user information. This may be due to factors including incorrect selection and use (see Clause 7), misuse and poor maintenance. For remarks on improving field performance see Annex F.

These differences may be overcome by appropriate information, instruction and on-going training in the use of the product. There are tools available to make individual tests to check the correct fitting.

Some countries have published specific guidance on de-rating the published data in an attempt to address the issue of attenuation in practice. Refer to your national guidance for further information.

6.2.3 Acoustical selection methods

6.2.3.1 Methods for assessing the sound attenuation of a passive hearing protector for continuous noise exposure

When selecting a suitable hearing protector, consideration should be given to the characteristics of the noise and the attenuation data of potentially suitable hearing protectors. The attenuation of most hearing protectors varies with frequency. To determine if a hearing protector is (acoustically) suitable, it is necessary to estimate the sound pressure level effective to the ear when the hearing protector is used. There are four methods of estimating the sound pressure level effective to the ear. These are:

— Octave band method;

— HML method;

— HML check method;

— SNR method.

All four methods are explained in detail in Annex A including worked examples. Table 1 shows the type of information on workplace noise needed for each estimation method.

Table 1 — Information on workplace noise required for assessing sound attenuation

Estimation method	Information required
Octave band method (see A.2)	octave band sound pressure level; $L_{p,oct}$ / $L_{p,oct,eq}$
HML method (see A.3)	A and C-weighted sound pressure level; $L_{p,A}$ and $L_{p,C}$ / $L_{p,A,eq}$ and $L_{p,C,eq}$
HML check method (see A.4)	A-weighted sound pressure level, $L_{p,A}$ / $L_{p,A,eq}$ subjective decision between two noise classes (using lists of examples of noise sources, see A.4)
SNR method (see A.5)	C-weighted sound pressure level, $L_{p,C}$ / $L_{p,C,eq}$