SLOVENSKI STANDARD
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Varovala sluha - Preskušanje - 3. del: Dodatna akustična preskusna metoda

Hearing protectors - Testing - Part 3: Supplementary acoustic test method

Gehörschützer - Prüfung - Teil 3: Zusätzliche akustische Prüfverfahren

Protecteurs individuels contre le bruit - Essais - Partie 3 : Méthodes d'essais acoustiques supplémentaires

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Hearing protectors - Testing - Part 3: Supplementary acoustic test methods

Protecteurs individuels contre le bruit - Essais - Partie 3 : Méthodes d'essais acoustiques supplémentaires

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EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

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European foreword

This document (EN 13819-3:2019) 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of an identical text or by endorsement, at the latest by May 2020, and conflicting national standards shall be withdrawn at the latest by May 2020.

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Introduction

This standard is part of a set of standards for personal hearing protectors.

The EN 13819 series consists of three parts and deals with testing plans of hearing protectors.

— EN 13819-1, *Hearing protectors — Testing — Part 1: Physical test methods*

— EN 13819-2, *Hearing protectors — Testing — Part 2: Acoustic test methods*

— EN 13819-3, *Hearing protectors — Testing — Part 3: Supplementary acoustic test methods*

The product requirements are described in a family of standards:

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

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

— EN 352-3, *Hearing protectors — General requirements — Part 3: Earmuffs attached to head protection and/or face protection devices*

— EN 352-4, *Hearing protectors — Safety requirements — Part 4: Level-dependent earmuffs*

— EN 352-5, *Hearing protectors — Safety requirements — Part 5: Active noise reduction earmuffs*

— EN352-6, *Hearing protectors — Safety requirements — Part 6: Earmuffs with safety-related audio input*

— EN 352-7, *Hearing protectors — Safety requirements — Part 7: Level-dependent earplugs*

— EN 352-8, *Hearing protectors — Safety requirements — Part 8: Entertainment audio earmuffs*

— EN 352-9, *Hearing protectors — Safety requirements — Part 9: Earplugs with safety-related audio input*

— EN 352-10, *Hearing protectors — Safety requirements — Part 10: Entertainment audio earplugs*

This standard also provides informative spreadsheets with

— calculation examples for level-dependent earplugs

— calculation examples for ANR

to allow the user to make own calculations.

CEN is not responsible for errors that may arise or occur with the use of these spreadsheets.

An associated standard, EN 458, covers selection, use, care and maintenance of hearing protectors.

1 Scope

This document specifies supplementary acoustic test methods for hearing protectors with additional electronic functions. The purpose of these tests is to enable assessment of the hearing protector performance as specified in the appropriate product standards.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 352-2:2002, *Hearing protectors — General requirements — Part 2: Earplugs*

EN 352-8:-[1], *Hearing protectors — Safety requirements — Part 8: Entertainment audio earmuffs*

EN 352-10:-[2], *Hearing protectors — Safety requirements — Part 10: Entertainment audio earplugs*

EN 60318-4:2010, *Electroacoustics - Simulators of human head and ear - Part 4: Occluded-ear simulator for the measurement of earphones coupled to the ear by means of ear inserts (IEC 60318-4:2018)*

EN ISO 4869-1:2018, *Acoustics — Hearing protectors — Part 1: Subjective method for the measurement of sound attenuation (ISO 4869-1:2018)*

EN ISO 4869-2:2018, *Acoustics — Hearing protectors — Part 2: Estimation of effective A-weighted sound pressure levels when hearing protectors are worn (ISO 4869-2:2018)*

EN ISO 11904-1:2002, *Acoustics - Determination of sound immission from sound sources placed close to the ear - Part 1: Technique using a microphone in a real ear (MIRE technique) (ISO 11904-1:2002)*

EN ISO 11904-2:2004, *Acoustics - Determination of sound immission from sound sources placed close to the ear - Part 2: Technique using a manikin (ISO 11904-2:2004)*

IEC 60268-1:1985, *Sound system equipment - Part 1: General*

ITU-T P.50:1999, *SERIES P: TELEPHONE TRANSMISSION QUALITY, TELEPHONE INSTALLATIONS, LOCAL LINE NETWORKS, Objective measuring apparatus, Artificial voices. Appendix I: Test signals*

[1] Under preparation: Stage at time of publication: FprEN 352-8:2018.

[2] Under preparation: Stage at time of publication: FprEN 352-10:2018.

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
hearing protector
device, that can be an earmuff or an earplug, worn by a person to prevent harmful effects from noise and other loud acoustic stimuli

3.2
ear simulator
device for measuring the acoustic output of sound sources where the sound pressure is measured by a calibrated microphone coupled to the source so that the overall acoustic impedance of the device approximates that of the normal human ear at a given location and in a given frequency band

[SOURCE: EN 60318-4:2010, 3.4]

Note 1 to entry: The standard EN 60318-4:2010 has replaced HD 443 S1:1983.

3.3
occluded-ear simulator
ear simulator which approximates the acoustic transfer impedance of the inner part of the ear canal, from the tip of an ear insert to the eardrum

[SOURCE: EN 60318-4:2010, 3.5]

Note 1 to entry: The standard EN 60318-4:2010 has replaced HD 443 S1:1983.

3.4
insertion loss
algebraic difference in decibels between the one-third-octave band sound pressure level, measured by the microphone of the acoustic test fixture with the hearing protector absent, and the sound pressure level with the hearing protector present

[SOURCE: EN ISO 4869-3:2007, 3.5]

3.5
sound attenuation
difference, in decibels, between the threshold of hearing with and without the hearing protector in place for a test subject, for a given test signal

[SOURCE: EN ISO 4869-1:2018, 3.8, modified - ", in decibels," added after "difference" and "," added after "test subject"]

3.6
reference point
fixed spatial location within the test chamber at which the midpoint of a line connecting the test subject's or ATF's ear canal openings is located for MIRE or ATF measurements, and likewise the point to which all objective measurements of the sound field characteristics are referenced

3.7
acoustic test fixture
ATF
device that approximates certain dimensions of an average adult human head

[SOURCE: EN ISO 4869-3:2007, 3.4]

3.8
head simulator
acoustic test fixture with an occluded ear-simulator

3.9
level-dependent hearing protector
hearing protector fitted with an electronic circuit intended to reproduce lower level external sounds in the ear canal, while usually restricting reproduction of higher level sounds by means of a level-dependent gain function

3.10
active noise reduction hearing protector
hearing protector designed to provide additional attenuation of external sounds by means of a noise cancellation circuit

3.11
hearing protector with electrical audio input
hearing protector designed to provide speech information and warning signals, while providing attenuation of sounds in excess of limit levels

3.12
entertainment audio hearing protector
hearing protector additionally providing reproduced sound for entertainment purposes

3.13
crest factor
peak amplitude of the signal divided by its rms value in linear scale

3.14
decibel full scale
decibel with respect to digital full scale

Note 1 to entry: The full scale value (0 dB FS) is the rms value of a sine wave whose positive peak just reaches positive full scale.

4 Symbols and abbreviations

ANR	Active Noise Reduction
ATF	Acoustic Test Fixture
APV	Assumed Protection Value
DUT	Device Under Test
MIRE	Microphone In Real Ear
rms	root mean square
SNR	Single Number Rating
SPL	Sound Pressure Level
dB FS	decibel Full Scale

5 Test conditioning and equipment

5.1 Conditioning and testing atmosphere

All specimens shall be conditioned for 4 h and tested in an environment having a temperature of (22 ± 5) °C and a relative humidity of not more than 85 %.

5.2 Occluded-ear simulator

The occluded-ear simulator shall be used together with an ear canal extension and a pinna simulator, when necessary. Different ear canal extensions and pinna simulators may be used. When earplugs are tested the earplug end shall be positioned at the reference plane according to EN 60318-4:2010, Figure 1 and the diffuse-field frequency response of EN ISO 11904-2:2004, Table 1 shall be used as diffuse-field related transfer function.

5.3 Head simulator

The head simulator composed of an occluded-ear simulator built into an acoustic test fixture (ATF) shall be used to achieve sufficient acoustic attenuation of the test fixture. Different ear canal extensions and pinna simulators may be used. When earplugs with electronic level-dependent feature are tested (7.2.3) the individual diffuse-field related transfer function for the specific equipment shall be determined and used. When other earplugs are tested the earplug end shall be positioned at the reference plane according to EN 60318-4:2010, Figure 1 and the diffuse-field frequency response of EN ISO 11904-2:2004, Table 1 shall be used as diffuse-field related transfer function.

5.4 Microphone in Real Ear (MIRE)

The MIRE-technique as described in EN ISO 11904-1:2002 shall be used with the following modification: in the area of the concha the microphone, including supporting elements and electrical leads, shall occupy an area not exceeding 25 mm^2 in the plane perpendicular to the centre axis of the ear canal. The microphone position, as shown in EN ISO 11904-1:2002, Figure 1 a) shall be used, i.e. with an open ear canal and the microphone membrane showing towards the ear drum and positioned in between the ear canal entrance and the ear drum, preferably at a distance of a few mm from the ear canal entrance.

Test subject noise exposure shall be monitored. The microphone, its mounting and electrical leads shall not introduce leakage, e.g. between the hearing protector and the head.

Alternatively, for safety reason, the occluded ear canal can be used as specified in EN ISO 11904-1:2002, Figure 1 c).

The measurement and calculation of the diffuse-field correction shall be carried out according to EN ISO 11904-1:2002 for each test subject.

6 Test signals

6.1 General

Test signals can be realized acoustically as sound or transmitted by other means, for example electrically. The signal to noise ratio shall be 10 dB across the range of tested frequencies.

6.2 HML test sounds

The test sound at the reference point of the sound field shall be a broadband random noise with three different spectra in the frequency range 100 Hz to 10 kHz and a defined $L_{p,C} - L_{p,A}$ value:

— H-oriented noise (Ho) $L_{p,C} - L_{p,A} = -1,2^{+0,1}_{-0,2}$ dB

— M-noise (M) $L_{p,C} - L_{p,A} = 2,0^{+0,2}_{-0,2}$ dB

— L-oriented noise (Lo) $L_{p,C} - L_{p,A} = 6,0^{+0,4}_{-0,2}$ dB

The spectra shall fulfil the spectral shape and tolerances given in Annex B.

NOTE 1 The spectrum of the H-oriented noise has a rising output (+3 dB/octave) between 100 Hz and 10 kHz. The spectrum of the M-noise has a flat output up to 2 kHz and a falling characteristic above. The spectrum of the L-oriented noise has a falling output (–3 dB/octave) from 100 Hz to 10 kHz.

The crest factor shall be 5 ± 1.

NOTE 2 In EN ISO 4869-2:2018, H-noise is defined as having an $L_{p,C} - L_{p,A}$ value of –2 dB and L-noise is defined as having an $L_{p,C} - L_{p,A}$ value of 10 dB. It has been found that the generation of H and L test noises is complicated and for the purposes of this standard, alternative noises of slightly different spectral shape are stated.

6.3 Broadband noise test sound

The test sound at the reference point of the sound field shall be a broadband random noise with the crest factor 5 ± 1.

If pink noise is used as broadband noise the spectrum shall fulfil the spectral shape and tolerances given in Annex B.

6.4 Speech signal

The speech test signal according to ITU-T P50_F:1999 (Female speech test signal) shall be used, starting at time 0,15 s and ending at time 10,75 s. If a longer signal is needed repeat a part of the signal and verify that the rms does not change by more than ± 0,2 dB.

NOTE The ITU-T P50_F signal includes silent parts at the beginning and at the end. The duration of the signal is selected to avoid influence of these silent parts.

6.5 Entertainment audio test signal

The test signal shall be broadband random noise with overall spectral shape of long-term speech and music as referenced in IEC 60268-1:1985. The crest factor shall be 5 ± 1.

7 Test procedures

7.1 General

An overview of the supplementary acoustic test procedures is reported in Annex A.

7.2 Level-dependent hearing protectors

7.2.1 Introduction

The A-weighted equivalent diffuse-field related SPL is measured with the level-dependent function switched on and operating at full volume for three different external noise spectra. The measurements are conducted in a range of sound level settings. The HML test sounds according to 6.2 shall be used. This test procedure does not apply to hearing protectors specific for impulse noise.

7.2.2 Level-dependent earmuff

7.2.2.1 Test method

The SPL effective to the ear comprising the passively attenuated SPL and the sound output of the level-dependent function shall be measured using the MIRE technique described in 5.4. The measured sound levels shall be corrected for the diffuse-field frequency response of the test subject to give the A-weighted equivalent diffuse-field related SPL as a function of the external SPL. If the DUT is fitted with a volume control, it shall be set to maximum audio output.

Four earmuffs and eight test subjects shall be used. Each of the four earmuff samples shall be tested on two subjects. Measurements shall be taken on both ears.

Determine the A-weighted equivalent diffuse-field related SPL as a function of the external SPL for each ear and for each type of test sound specified in 6.2. The measurement shall start at an external SPL of 65 dB(A) and shall increase in steps of 5 dB, ensuring that data points for the A-weighted equivalent diffuse field related SPL lower and higher than 85 dB(A) are encompassed.

The measurement shall start 10 s after the activation of the test sound or a period specified by the manufacturer. The measurement time shall be at least 20 s.

If the DUT is battery powered specified fresh batteries shall be fitted. Systems with external power source (e.g. hearing protector connected to a radio system) shall be operating as specified by the manufacturer.

7.2.2.2 Calculation procedure

Calculate for each type of external noise spectrum (Ho, M, Lo) and for each of the sixteen ears tested the external SPL for which the A-weighted equivalent diffuse-field related SPL equals 85 dB(A). Use linear interpolation between adjacent test values of the external SPL on either side of the 85 dB(A) value.

Calculate for each test sound the mean value and the standard deviation of the interpolated values of the external SPL for the sixteen ears tested.

Subtract one standard deviation from the mean value of external noise level to obtain the criterion level for each type of external noise spectrum.

Obtain the criterion levels for H-noise with $L_{p,C} - L_{p,A} = -2$ dB and L-noise with $L_{p,C} - L_{p,A} = 10$ dB by extrapolation from the M-value to the H-oriented resp. the L-oriented values. Assume a linear relation for the change in external SPL with $(L_{p,C} - L_{p,A})$-value on either side of the M-value of $L_{p,C} - L_{p,A} = 2$ dB.

An example of the calculation is given in C.1.