



SLOVENSKI STANDARD
oSIST prEN 17479:2020

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Varovala sluha - Navodila za izbiro ustreznih individualnih preskusnih metod

Hearing protectors - Guidance on selection of individual fit testing methods

Gehörschützer - Leitfaden zur Auswahl von Prüfverfahren für den individuellen Sitz

Protecteurs individuels contre le bruit - Recommandations relatives au choix des méthodes individuelles de contrôle de l'ajustement

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Hearing protectors - Guidance on selection of individual fit testing methods

Protecteurs individuels contre le bruit -
Recommandations relatives au choix des méthodes
individuelles de contrôle de l'ajustement

Gehörschützer - Leitfaden zur Auswahl von
Prüfverfahren für den individuellen Sitz

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European foreword

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Introduction

The need for the use of hearing protectors is obvious nowadays. Appropriate hearing protection is chosen based on different selection criteria such as required sound attenuation, comfort, workplace environment and a possible need for communication, audibility of important sounds etc. Reference to different selection criteria for hearing protector selection are given in EN 458:2016 “Hearing protectors — Recommendations for selection, use, care and maintenance — Guidance document”.

As appropriate sound attenuation should be key in this selection process, this should be compared to the user’s need in two steps. Firstly, appropriate hearing protection should be selected based on the attenuation data from the REAT test according to EN 352, as provided by the manufacturer. Secondly, using fit testing methods, the individual protective properties of the hearing protector should be assessed. Especially, since no ear is similar, what gives a certain protection to one, might give a non-appropriate protection to another. The attenuation of the hearing protector is roughly maximized by the mean attenuation values from the REAT test, but the real attenuation is determined by how well the hearing protector fits to the ear (acoustical sealing, insertion depth, etc.). Hence it is very important that the acoustic seal be checked. In addition, the real attenuation can be estimated and compared to the required sound attenuation. While allowing a test on site and on the end user, the lack of precision of fit testing methods cannot be a substitute for selection but these methods are the necessary complement to this selection. Therefore, comparison to selection data are expected to be accounted for in this lack of precision. If no acceptable fit can be reached after carefully following the manufacturer’s instructions, i.e. if the comparison is not satisfactory, the user should consider another size of that type of hearing protection or select a suitable alternative.

Fit testing can also be used to increase the awareness of the user on the importance of a proper fit. It will help the user in achieving the right level of protection against the noise hazard and the workplace environment. It could also form part of the training for safety engineers, healthcare specialists and supervisors, to provide a good understanding of the importance of a proper fitting and it can also be a helpful training aid for the user.

This document gives guidance for appropriate selection of fit testing methods and measurement, providing practical guidance on fit testing methods, their uses and limitations. The uncertainty of fit testing methods is one of those limitations, which should be taken into account. There is the uncertainty that is inherent to the way the fit testing system works. Furthermore, there is the repeatability of the measurement due to differences in positioning of the hearing protector that leads to an increase of the uncertainty of the system as a whole.

This document does not specify the technical requirements for manufacturing fit testing equipment as they do not fall within the scope of this document.

prEN 17479:2020 (E)**1 Scope**

This document gives guidance on the appropriate selection of fit testing methods and measurement, and provides practical guidance on fit testing methods, their uses and limitations.

This document does not specify the technical requirements for manufacturing fit testing equipment.

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

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:

— ISO Online browsing platform: available at <http://www.iso.org/obp>

— IEC Electropedia: available at <http://www.electropedia.org/>

3.1 fit testing

<hearing protectors> procedure for checking the individual protective properties of a hearing protection device

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Note 1 to entry: Individual protective properties can be evaluated by using different measurement procedures.

3.2 repeatability

closeness of the agreement between the results of successive measurements of the same test item carried out under the same conditions of measurement

Note 1 to entry: These conditions are called repeatability conditions.

Note 2 to entry: Repeatability conditions include:

- the same measurement procedure;
- the same observer;
- the same measuring instrument, used under the same conditions;
- the same location;
- repetition over a short period of time.

Note 3 to entry: Repeatability may be expressed quantitatively in terms of the dispersion characteristics of the results.

[SOURCE: ISO/IEC Guide 98-3:2008, B.2.15, modified]

3.3 reproducibility

closeness of the agreement between the results of measurements of the same test item carried out under changed conditions of measurement

Note 1 to entry: A valid statement of reproducibility requires specification of the conditions changed.

Note 2 to entry: The changed conditions may include:

- principle of measurement;
- method of measurement;
- observer;
- measuring instrument;
- reference standard;
- location;
- provision of suitable facility (e.g. sound booth);
- conditions of use;
- time.

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Note 3 to entry: Reproducibility may be expressed quantitatively in terms of the dispersion characteristics of the results.

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Note 4 to entry: Results are here usually understood to be corrected results.

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[SOURCE: ISO/IEC Guide 98-3:2008, B.2.16, modified]

3.4 personal attenuation rating PAR

individual attenuation given as a single value in dB that a user obtains for the fit of the hearing protector that was tested

Note 1 to entry: The PAR can be either the combined left-right (binaural) or separate left-right ear value.

Note 2 to entry: The calculation procedure is not standardized and is specified by the manufacturer for a specific fit testing method.

3.5 real-ear attenuation at threshold method REAT method

test procedure for determination of the sound attenuation of a hearing protector

Note 1 to entry: The measurement of sound attenuation is described in EN ISO 4869-1.

prEN 17479:2020 (E)**3.6****threshold of hearing**

lowest sound pressure level at which, under specified conditions, a person gives a predetermined percentage of correct detection responses on repeated trials

Note 1 to entry: For the purpose of this document, the threshold of hearing is measured with (occluded threshold of hearing) and without (open threshold of hearing) the hearing protector.

[SOURCE: EN ISO 4869-1:2018, 3.7, modified: “(occluded threshold of hearing)” and “(open threshold of hearing)” added in Note 1 to entry. Last sentence of Note 1 to entry of EN ISO 4869-1:2018, 3.7 deleted.]

3.7**surrogate hearing protector**

hearing protector modified by the manufacturer of the fit testing system that has been demonstrated when used in the fit testing system to yield attenuation equivalent to the standard hearing protectors that it represents

Note 1 to entry: Surrogate hearing protectors include surrogate samples, surrogate earplugs and surrogate earmuffs.

4 Individual fit testing methods**4.1 General**

The fit testing methods can be categorized in three different ways:

- mechanical or acoustical tests according to the physical principle;
- subjective (sound recognition at the threshold of hearing or loudness balancing) or objective (measuring) tests;
- tests for one specified product only or for a range of different hearing protectors.

Each test method will have a different pass/fail criterion. Refer to the manufacturer for further information.

In this document, the term “timeframe” takes into consideration:

- fitting of the hearing protector on the user;
- fitting of the appropriate test equipment;
- measurement of both ears;
- data analysis.

NOTE The initial setup of the test apparatus is not included.

4.2 Test methods

Currently available tests comprise:

Method 1: Sound-level measurements with microphone in real ear (MIRE)

This is an acoustic test method where a sound field is generated. With two microphones the sound pressure levels outside of the hearing protector and behind or under the hearing protector are

measured, usually simultaneously. With some corrections the sound attenuation can be calculated from these values.

- Method 1a: Sound field generated by a headset
- Method 1b: Sound field generated by a loudspeaker

Method 2: Audiometric method (determination of the threshold of hearing with and without hearing protector)

This is an acoustic test method. The thresholds of hearing with and without hearing protector are determined in a subjective measurement. The difference of the two measured thresholds of hearing is the sound attenuation.

- Method 2a: Sound field generated by a headset
- Method 2b: Sound field generated by a loudspeaker

Method 3: Audiometric based method (determination of a threshold of hearing with and without hearing protector)

This is an acoustic test method. Thresholds of hearing with and without hearing protector are determined in a subjective measurement. The principle is similar to method 2, but instead of an audiometer a custom-built device especially for fit testing is used.

- Method 3a: Sound field generated by a headset
- Method 3b: Sound field generated by a loudspeaker

NOTE The thresholds determined are not the audiometric thresholds of hearing.

Method 4: Loudness balancing method

This is an acoustical test method. The test subject balances the loudness between the two ears with one or two earplugs and without any earplug in a subjective measurement.

Method 5: Acoustic leakage test

This is an acoustic test method. A sound pressure level is generated and measured by both a loudspeaker and a microphone directly inside the earplug in the ear canal. The frequency characteristic of the sound in the ear canal contains objective information on the fitting of the earplug.

Method 6: Air leakage test

This is a non-acoustic test method, based on an air pressure measurement. The leakage of a custom moulded earplug in the ear canal is objectively determined by the decay of a small over-pressure behind the earplug or by measuring the maximum achievable over-pressure for a given maximum pressure of the pump.

4.3 Reference method for sound attenuation measurements of hearing protectors

The reference method for determining the sound attenuation of hearing protectors is the so-called REAT method ("Real Ear Attenuation at Threshold") in accordance with EN ISO 4869-1:2018. It is also used in the type examination test as specified in EN 352-1, EN 352-2 and EN 352-3. Here the threshold of hearing of the subject is measured twice in a diffuse sound field: once with and once without hearing protector. The measurement is performed with one-third octave band noise at the octave band centre frequencies between 125 Hz (optionally 63 Hz) and 8 000 Hz. The threshold of hearing is usually determined via a bracketing method (e.g. by the Békésy method). The REAT method provides

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information on a sample of 16 subjects (mean, standard deviation) and requires according to the specifications of the standard very low ambient noise levels and a diffuse sound field.

NOTE The sound attenuation determined by the methods described in 4.2 generally will differ from the values obtained in the laboratory tests. These numbers are the mean values of subjective, binaural tests at the threshold of hearing. For each product it is necessary to define limits of the sound attenuation from the individual fit testing that are in accordance with the laboratory data.

4.4 Different methods for the individual quality fit of hearing protectors**4.4.1 Sound-level measurements with microphone in real ear (MIRE)****4.4.1.1 General**

The MIRE method involves measurement of sound pressure levels inside and outside of the ear. The sound field is generated either by a headset or a loudspeaker.

The difference between the level in the ear under the hearing protector and outside the ear (called noise reduction) is determined directly with the use of two microphones. The sound attenuation of an earplug can be determined from the difference of the two sound pressure levels. In order to get both values in one measurement two microphones are used: the first one inserted in the earplug from the outside (e.g. a tube microphone) and the second one outside of the ear (if applicable, under the headset that generates the test sounds). The sound pressure level in the open ear canal cannot be measured directly, but will be deduced from the level outside of the occluded ear. Therefore, it is necessary to take into account correction factors that describe the effect of the ear on the sound field. Moreover the influence of the measuring position in the occluded ear canal (typically not at the tympanic membrane but in the earplug or at its end) shall be considered. The whole system (including the sound field) shall be calibrated in relation to validated subjective attenuation data.

In this connection, it should be noted that the noise reduction does not correspond directly to the sound attenuation of a hearing protector ("insertion loss"). To determine the insertion loss, measurements shall be taken twice in the same ear canal, with and without a hearing protector in place. This difference between noise reduction and insertion loss shall be taken into account when the attenuation is reported.

NOTE The basic method of taking measurements in the ear canal is described in the standard EN ISO 11904-1.

4.4.1.2 Sound field generated by a headset (method 1a)

In principle, it is possible to test any earplug that can be worn under a headset, but probably the correction values discussed above need to be adjusted for every product. Moreover, the earplugs shall be modified in order to incorporate the microphone for the measurement under the earplug (e.g. a tube microphone).

Characteristics:

- method: objective;
- test signals: broadband noise;
- $f = 125$ Hz to 8000 Hz;
- maximal background noise: 80 dB(A);
- sound field: headphone;
- timeframe: 5 min;
- principle: sound level difference.

4.4.1.3 Sound field generated by a loudspeaker (method 1b)

The sound attenuation of a hearing protector can be determined in the sound field of a loudspeaker. Corrections for the microphone positions and the sound field are incorporated. This method has the advantage that earmuffs and all kinds of earplugs can be tested, also bulky types that would not fit under a headset. As described in 4.4.1.2 only specially modified hearing protectors with an inserted microphone can be used.

Characteristics:

- method: objective;
- test signals: broadband noise;
- $f = 125$ Hz to 8000 Hz;
- maximal background noise: 80 dB(A);
- sound field: direct field;
- timeframe: 5 min;
- principle: sound level difference for hearing protectors.

4.4.2 Audiometric method (determination of the threshold of hearing with and without hearing protector)

4.4.2.1 General

This method is similar in principle to the REAT method and can be realized with the help of an audiometer. Here as well, the threshold of hearing of the test subject is measured with and without hearing protectors. This method needs a quiet environment since it works at the threshold of hearing.

Two aspects of the measurement procedure that can vary are described below:

- The test sounds can be narrow band noises or pure tones. Since the sound field and (for pure tones) the test noises are different to the laboratory conditions the thresholds of hearing can be expected to have other values. Thus, also the calculated sound attenuation could be different.
- The threshold of hearing can be determined either with ascending levels or by means of an up-and-down (bracketing) method. In the latter, the level is by turns increased and reduced several times, and the threshold of hearing level is narrowed down by the upward and downward excursions.

4.4.2.2 Sound field generated by a headset (method 2a)

It can be used for all types of earplugs that can be worn under a headset.

Characteristics:

- method: subjective;
- test signals: pure tones or narrow band noises;
- $f = 125$ Hz to 8 000 Hz or selected band(s);
- maximal background noise: 40 dB(A) (based on EN ISO 8253-1:2010);