TC 43

International Standard 389

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION•МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ•ORGANISATION INTERNATIONALE DE NORMALISATION

Acoustics — Standard reference zero for the calibration of pure tone air conduction audiometers

Acoustique — Zéro normal de référence pour l'étalonnage des audiomètres à sons purs en conduction aérienne

Second edition — 1985-03-15

UDC 534.771 : 53.089.6 **Ref. No. ISO 389-1985 (E)**

Descriptors : acoustics, audiometry, audiometers, calibration, sound pressure.

Price based on 4 pages

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 389 was prepared by Technical Committee ISO/TC 43, *Acoustics*.

The first edition of ISO 389 was published in 1975. In ISO 389-1975 were combined, without change to the technical content, ISO Recommendation R 389-1964 and Addendum 1 to ISO/R 389, published in 1970. This second edition of ISO 389 cancels and replaces the first edition, of which it constitutes a revision. The reasons for the revision of ISO 389 are fully explained in clause 0, Introduction.

Addendum 1 to ISO 389, originally published in 1983 as an addendum to the first edition of ISO 389 (i.e. ISO 389-1975), remains valid and is applicable to this second edition of ISO 389.

Printed in Switzerland

Acoustics — Standard reference zero for the calibration of pure tone air conduction audiometers

0 Introduction

The first edition of ISO 389 specified a standard reference zero for the scale of hearing threshold level applicable to pure tone air conduction audiometers in terms of the response of certain types of earphone measured on an artificial ear or coupler of stated type. Five of these earphone-coupler combinations corresponded with those used at that same time in standardizing laboratories in France, Germany, F.R., the United Kingdom, the USA and the USSR. In a second set of values the corresponding reference equivalent threshold sound pressure levels for eleven audiometric earphones were given, referred to a single type of coupler, the National Bureau of Standards, Washington, USA, type 9A coupler, which was later specified in IEC Publication 303.

Most of the earphone-coupler combinations mentioned in the first edition of ISO 389 are now no longer in use. On the other hand, reference equivalent threshold sound pressure levels for supra-aural earphone patterns not covered by the first edition have now been specified in Addendum 1 to ISO 389 (refer to "Foreword" for the historical background to this International Standard). Moreover, ISO 7566 specifies a standard reference zero for the calibration of pure tone bone conduction audiometers. It therefore appeared necessary to reissue ISO 389 in order to delete obsolete data and to update the title and some definitions in the light of recent developments while leaving the relevant technical content unchanged. The ISO member bodies of the countries primarily concerned with certain types of standard earphones and artificial ears have agreed to eliminate obsolete data.

1 Scope and field of application

This International Standard specifies a standard reference zero for the scale of hearing threshold level applicable to pure tone air conduction audiometers in order to promote agreement and uniformity in the expression of hearing threshold level measurements throughout the world.

This International Standard states the information in a form suitable for direct application to the calibration of audiometers, that is, in terms of the response of two different standard types of earphone measured on a coupler in accordance with IEC Publication 303.

This International Standard is based on an assessment of the information available from the various standardizing laboratories responsible for audiometric standards and from scientific publications. Some notes on the derivation and application of the recommended reference levels are given in the annex.

2 References

ISO 6189, *Acoustics — Pure tone air conduction threshold audiometry for hearing conservation purposes.*

ISO 7029, *Acoustics — Threshold of hearing by air conduction as a function of age and sex for otologically normal persons.*

ISO 7566, *Acoustics — Standard reference zero for the calibration of pure tone bone conduction audiometers.* [1)]

ISO 8253, *Acoustics — Pure tone audiometric test methods.* [1)]

IEC Publication 303, *IEC provisional reference coupler for the calibration of earphones used in audiometry.*

IEC Publication 318, *An IEC artificial ear, of the wideband type, for the calibration of earphones used in audiometry.*

3 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1 air conduction: Transmission of sound through the external and middle ear to the inner ear.

3.2 acoustic coupler: A cavity of specified shape and volume which is used for the calibration of a supra-aural earphone in conjunction with a calibrated microphone to measure the sound pressure developed within the cavity.

NOTE — An acoustic coupler is specified in IEC Publication 303.

3.3 artificial ear: A device for the calibration of an earphone which presents to the earphone an acoustic impedance

1) At present at the stage of draft.

equivalent to the impedance presented by the average human ear. It is equipped with a calibrated microphone for the measurement of the sound pressure developed by the earphone.

NOTE — An artificial ear is specified in IEC Publication 318.

3.4 threshold of hearing: The level of a sound at which, under specified conditions, a person gives 50 % of correct detection responses on repeated trials.

3.5 otologically normal person: A person in a normal state of health who is free from all signs or symptoms of ear disease and from obstructing wax in the ear canal, and who has no history of undue exposure to noise.

3.6 equivalent threshold sound pressure level (monaural earphone listening): For a given ear, at a specified frequency, for a specified type of earphone and for a stated force of application of the earphone to the human ear, the sound pressure level set up by the earphone in a specified acoustic coupler or artificial ear when the earphone is actuated by that voltage which, with the earphone applied to the ear concerned, would correspond to the threshold of hearing.

3.7 reference equivalent threshold sound pressure level (RETSPL): At a specified frequency, the modal value of the equivalent threshold sound pressure levels of a sufficiently large number of ears of otologically normal persons, of both sexes, aged between 18 and 30 years inclusive, expressing the threshold of hearing in a specified acoustic coupler or artificial ear for a specified type of earphone.

NOTE — The relation between hearing threshold levels for air conduction and age is specified in ISO 7029.

3.8 hearing level (of a pure tone): At a specified frequency, for a specified type of earphone and for a specified manner of application, the sound pressure level of this pure tone produced by the earphone in a specified acoustic coupler or artificial ear minus the appropriate reference equivalent threshold sound pressure level.

3.9 hearing threshold level (of a given ear): At a specified frequency and for a specified type of transducer, the threshold of hearing expressed as hearing level.

NOTE — For appropriate test conditions see, for example, ISO 6189 and ISO 8253.

4 Specifications

The reference equivalent threshold sound pressure levels (RETSPLs) are dependent on the pattern of earphone and on the pattern of acoustic coupler used to calibrate it.

The recommended standard values for two different earphones in a coupler in accordance with IEC Publication 303 are given in the table.

The earphone shall be applied to the coupler without acoustic leakage with a nominal static force of 4,5 ± 0,5 N, not including the weight of the earphone itself.

Table — Recommended reference equivalent threshold sound pressure levels in a coupler in accordance with IEC Publication 303
(measured data values rounded to the nearest half decibel)

Frequency Hz	RETSPL (Reference: 20 μPa) dB	
125	47,5	45,0
250	28,5	25,5
500	14,5	11,5
1 000	8,0	7,0
1 500	7,5	6,5
2 000	8,0	9,0
3 000	6,0	10,0
4 000	5,5	9,5
6 000	8,0	15,5
8 000	14,5	13,0
Pattern of earphone[1]	Beyer DT48 with flat cushion	Telephonics TDH39 with MX41/AR cushion[2]

1) TDH39 earphones, with their ear-cushions, should be placed both on the ear and on the coupler; when calibrating the Beyer DT48 earphone, the cushion should, however, be removed and an adaptor used, as described by H. Mrass and H. G. Diestel, in *Acustica*, **9**, 61-64 (1959).

2) In 1963 the filter cloth in the Telephonics TDH39 earphone was changed, but matched to produce the same earphone response on the 9A coupler. During the change about 1 000 units where produced with an unmatched cloth. The data given in this International Standard are from several earphones manufactured both before and after 1963.

Annex

Notes on the derivation and application of the recommended reference levels

(This annex does not form an integral part of the standard.)

A.1 Derivation

It is very important to note that the RETSPLs given in the table refer, as closely as can be ascertained from existing data, to the same hearing threshold levels. The differences between the values are mainly due to differences between the acoustical properties of the coupler used and those of the average human ear.

The RETSPLs given in the table for the Beyer DT48 correspond to an average of 15 determinations published, or otherwise communicated to the International Organization for Standardization, during the period from 1950 to 1961. The values have been determined by a cooperative investigation carried out by the following five standardizing laboratories:

Centre National d'Études des Télécommunications, Palaiseau, France;

Physikalisch-Technische Bundesanstalt, Braunschweig, Germany, F.R.;

National Physical Laboratory, Teddington, United Kingdom;

National Bureau of Standards, Washington, USA;

V.N.I.I.M. Laboratory, Leningrad, USSR.

The RETSPLs given in the table for the Telephonics TDH39 were derived at a later date by subjective loudness balancing methods.

A.2 Application

A.2.1 As regards the calibration of audiometers which are fitted with earphones of one of the patterns considered in the table, measurements of the acoustical output, using the specified type of coupler, suffice to calibrate the audiometer in terms of the recommended RETSPLs given in the appropriate column in the table. When the earphone is applied to the human ear, the headband used should provide a nominal static force of 4,5 ± 0,5 N.

NOTE — A headband providing a force of 4,5 N for a mean head width of 145 mm will usually comply with this tolerance for adult test populations.

A.2.2 In the case of audiometers fitted with earphones of patterns neither mentioned in the table nor specified in ISO 389/Add.1, it is necessary first to determine the corresponding RETSPLs for this pattern of earphone. This would normally be done by comparing the earphone subjectively with an earphone of one of the patterns considered in the table, using a suitable "equal-loudness balance" or "threshold balance" technique. In certain cases, the results of such comparisons may already be available. For details of the technical procedures and facilities for such work, reference should be made to the manufacturer or direct to the appropriate standardizing laboratory.

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