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 audiometers

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

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FOREWORD

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO Member Bodies). The work of developing International Standards is carried out through ISO Technical Committees. Every Member Body interested in a subject for which a Technical Committee has been set up 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.

Prior to 1972, the results of the work of the Technical Committees were published as ISO Recommendations; these documents are now in the process of being transformed into International Standards. As part of this process, Technical Committee ISO/TC 43 has reviewed ISO Recommendation R 389 and found it technically suitable for transformation. International Standard ISO 389 therefore replaces ISO Recommendation R 389-1964 and Addendum 1 to which it is technically identical.

ISO Recommendation R 389 was approved by the Member Bodies of the following countries :

Australia	Germany	Romania
Austria	Hungary	South Africa, Rep. of
Belgium	India	Sweden
Brazil	Italy	Switzerland
Chile	Japan	United Kingdom
Czechoslovakia	Netherlands	U.S.A.
Denmark	Norway	U.S.S.R.
Finland	Poland	Yugoslavia
France	Portugal	

No Member Body expressed disapproval of the Recommendation.

The Member Bodies of the following countries disapproved the transformation of ISO/R 389 into an International Standard :

Germany
United Kingdom

Printed in Switzerland

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

1 SCOPE AND FIELD OF APPLICATION

The need has frequently been expressed, both by otologists and audiologists and the makers of audiometers, for an internationally accepted basis of calibration for pure-tone audiometers of the types commonly employed for diagnostic or screening purposes.

This International Standard specifies a standard reference zero for the scale of hearing threshold level applicable to pure-tone audiometers, which it is hoped will help 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 certain standard types of earphone measured on an artificial ear or coupler of stated type. The earphone-coupler combinations given in table 1 correspond with those currently used in a number of standardizing laboratories. Table 2 gives the corresponding reference equivalent threshold sound pressure levels for eleven audiometric earphones referred to a single type of coupler, namely, the National Bureau of Standards, Washington, U.S.A., Type 9-A Coupler. Of these eleven earphones, five are those currently used as reference standards in a number of standardizing laboratories, and the remaining six are other types which have been used on commercial equipment and in audiometric laboratories.

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 annex A to this International Standard.

2 DEFINITIONS

For the purpose of this International Standard the following definitions apply :

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

2.2 reference equivalent threshold sound pressure level (monaural earphone listening), at a specified frequency, for a specified type of earphone and for a specified pattern of artificial ear: Modal value, at that frequency, of the equivalent threshold sound pressure levels of an adequately large number of ears of otologically normal subjects within the age limits of 18 to 30 years inclusive.

NOTE — For the purpose of this International Standard, an "otologically normal subject" is understood to be a person in a normal state of health who is free from all signs or symptoms of ear disease and from wax in the ear canal, and has no history of undue exposure to noise.

3 SPECIFICATIONS

3.1 The reference equivalent threshold sound pressure level, for constant auditory threshold, is dependent on the pattern of earphone and on the pattern of artificial ear employed for its calibration. Usage in this respect may vary from one nation, or standardizing laboratory, to another.

The recommended standard values given in table 1 correspond to the arrangements adopted by different standardizing laboratories, in so far as these have been reported to the International Organization for Standardization.

3.2 The recommended standard values for different earphones on the 9-A coupler are given in table 2.

The earphone should be applied to the 9-A coupler without acoustic leakage with a force of between 4 and 5 N, not including the weight of the earphone itself.

TABLE 1 – **Recommended reference equivalent threshold sound pressure levels**

Frequency	Reference equivalent threshold sound pressure levels relative to 2×10^{-5} Pa				
Hz	dB				
125	44,5	47,5	47	45,5	55
250	27,5	28,5	28	24,5	33
500	11,5	14,5	11,5	11	14,5
1 000	5,5	8	5,5	6,5	8,5
1 500	4,5	7,5	6,5	6,5	8,5
2 000	4,5	8	9	8,5	9
3 000	6	6	8	7,5	10,5
4 000	8	5,5	9,5	9	11,5
6 000	17	8	8	8	18,5
8 000	14,5	14,5	10	9,5	9,5
Pattern of earphone	Audio 15	Beyer DT 48	S.T.C. 4026-A	W.E. 705-A	T.D. 6
Type of artificial ear or coupler	C.N.E.T. artificial ear	N.B.S. type 9-A coupler (with P.T.B. adapter)	B.S. 2042 (figures 1a, 2b) artificial ear	N.B.S. type 9-A coupler	IU-3 type artificial ear
Country of origin of data	France	Germany	United Kingdom	U.S.A.	U.S.S.R.

TABLE 2 – **Recommended reference equivalent threshold sound pressure levels in the 9-A coupler**
(The values derived were obtained by rounding off the measured data to the nearest 0,5 dB)

Frequency	Reference equivalent threshold sound pressure levels relative to 2×10^{-5} Pa										
Hz	dB										
125	48,5	47,5	51,0	45,5	54,0	44,0	44,0	46,5	46,5	51,0	45,0
250	28,0	28,5	30,5	24,5	32,0	25,0	25,0	26,0	26,0	28,5	25,5
500	12,0	14,5	13,5	11,0	14,0	11,5	11,0	10,5	11,0	10,0	11,5
1 000	6,5	8,0	6,5	6,5	8,0	6,5	5,0	5,0	7,0	6,0	7,0
1 500	–	7,5	7,0	6,5	8,0	5,5	–	5,0	7,0	6,5	6,5
2 000	6,0	8,0	7,5	8,5	9,5	7,5	8,5	7,5	9,0	6,5	9,0
3 000	8,0	6,0	8,0	7,5	10,0	8,0	–	6,5	10,0	9,0	10,0
4 000	3,5	5,5	10,5	9,0	11,0	9,0	13,0	13,0	13,5	9,0	9,5
6 000	14,5	8,0	13,5	8,0	17,5	17,0	–	11,0	8,5	18,5	15,5
8 000	12,0	14,5	20,5	9,5	12,5	13,0	9,0	13,0	11,0	14,0	13,0
Pattern of earphone[1]	Audio 15	Beyer DT 48 with flat cushion	S.T.C. 4026-A	W.E. 705-A	T.D. 6	Permoflux PDR 8 MX41/AR cushion	Permoflux PDR 1 Maico "Dough-nut" cushion	Permoflux PDR 1 ADC case	Permoflux PDR 1 MX41/AR cushion	Permoflux PDR 10 MX41/AR cushion	Telephonics TDH 39 MX41/AR cushion[2]

1) For these data to be valid the earphone should be placed both on the ear and on the coupler with its earcushion, with one exception; when calibrating the Beyer DT 48 earphone on the 9-A coupler, the cushion should be removed and an adapter 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 TDH-29 earphone was changed, but matched to produce the same earphone response on the 9-A coupler. During the change about 1 000 units were produced with an unmatched cloth. The data given in this International Standard are from several earphones manufactured both before and after 1963.

ANNEX A

NOTES ON THE DERIVATION AND APPLICATION OF THE RECOMMENDED REFERENCE LEVELS

A.1 DERIVATION

A.1.1 It is very important to note that the reference levels shown in the various columns of the tables all refer, as closely as can be ascertained from existing data, to the same auditory threshold levels. The differences between the values are due to the use, in various laboratories, of different earphones as calibration standards, and of different types of artificial ear or coupler for measuring their response.

A.1.2 The reference levels listed in table 1 correspond to an average of 15 determinations published, or otherwise communicated to the International Organization for Standardization during the period 1950 to 1961. The relations between the values cited in the various columns of table 1 have been determined by a co-operative investigation carried out by the following five standardizing laboratories :

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

Physikalisch-Technische Bundesanstalt, Braunschweig, Germany;

National Physical Laboratory, Teddington, United Kingdom;

National Bureau of Standards, Washington, U.S.A.;

V.N.I.I.M. Laboratory, Leningrad, U.S.S.R.

A.1.3 National standard earphones : Audio 15, STC 4026-A and T.D. 6 (table 2).

The transfer of the reference pressure levels for these earphones from their national standard couplers to the type 9-A coupler has been based in each case on the relative responses of the earphones on the two couplers in question.

A.1.4 Earphones that are not national standards (table 2).

Use was made of subjective loudness balancing and probe microphone transfer data in the derivation of the reference pressure levels in the 9-A coupler. Where more than one determination had been performed for the same earphone, the mean of the several determinations was used.

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 tables, measurements of the acoustical output, using the specified type of artificial ear or coupler, suffice to calibrate the audiometer in terms of the recommended reference levels given in the appropriate column in the table.

A.2.2 In the case of audiometers fitted with earphones of other patterns, it is necessary first to determine the corresponding reference levels 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.

ANNEX B

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20) Communications made to the International Organization for Standardization by the standardizing laboratories referred to in annex A, by the "Subcommittee on Noise" of the American Academy of Ophthalmology and Otolaryngology, by Allison Laboratories, Inc., by the Maico Company, and by the Walter Reed Army Medical Center.