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Draft Indian Standard

Audiometric Test Room — Specification

[ICS 13.140]

Ear, Nose, Throat and Head & Neck Surgery (ENT - H&N) Instruments Sectional Committee, MHD 04	Last date for comments: **24 January 2025**

FOREWORD

(Formal clause will be added later)

Hearing measurements in an audiometric test room may be conducted for various diagnostic and screening purposes. These measurements are subject to errors and inaccuracy if the testing is conducted in presence of excessively high noise.

Exclusion of all ambient noise from an audiometric test room is not feasible nor practical from structural and cost considerations. However, to ensure that hearing tests are not influenced by excessive ambient noise masking, there is a need to specify certain limits on ambient noise in audiometric test rooms.

This Indian Standard specifies maximum permissible ambient sound pressure levels which can be allowed in an audiometric test room, and also provides guidance on how to achieve the requirements.

The maximum permissible ambient sound pressure levels are specified for hearing threshold measurements down to 0 dB. The standard also indicates permissible levels for lowest hearing threshold measurements other than 0 dB.

The standard is intended for use by all persons testing hearing and for distributors, installers, designers, and manufacturers of audiometric test rooms.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis shall be rounded off in accordance with IS 2: 2022 ‘Rules for rounding off numerical values (*second revision*)’. The number of significant places retained in the rounded off value should be same as that of the specified value in this standard.

Indian Standard

AUDIOMETRIC TEST ROOM — SPECIFICATION

1 SCOPE

This document establishes limits for permissible ambient noise in audiometric test rooms and specifies the methods of measurement to be used. Within this standard, maximum permissible ambient sound pressure levels and their measurement are specified for performing hearing threshold measurements via:

– Pure-tone air conduction audiometry by means of various earphones;
– pure-tone bone conduction audiometry by means of bone vibrator;
– sound field audiometry by means of one or more loudspeakers; primarily over the test frequency range of 125 Hz to 8 000 Hz.

The document also specifies ambient noise requirements for performing speech audiometry.
The purpose of this document is to ensure that tests of hearing in audiometric test rooms are as accurate and reproducible as possible and are not influenced by the masking effects of ambient noise.

2 REFERENCES

The standards given below contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of these standards.

IS No.	*Title*
ISO 8253-1:2010	Acoustics — Audiometric test methods — Part 1: Pure-tone air and bone conduction audiometry
ISO 8253-2:2009	Acoustics — Audiometric test methods — Part 2: Sound field audiometry with pure-tone and narrow-band test signals
IS 15575 (Part 1):2016 / IEC 61672-1:2013	Electroacoustics — Sound level meters — Part 1: Specifications
IS 6964:2018 / IEC 61260-1:2014	Electroacoustics — Octave-Band and Fractional Octave Band Filters — Part 1: Specifications

3.TERMS AND DEFINITIONS: -

For the purpose of this standard, the following terms and definitions shall apply

3.1 Audiometric test room

Enclosed space used for testing hearing

EXAMPLE >

A prefabricated room known as an audiometric test booth or sound-treated room.

Note to entry: An audiometric test room may also be known as an audiometric test area, hearing test space, or hearing test room.

3.2 Ambient noise

All-encompassing noise normally associated with a given environment, being usually a composite of sounds from many sources near and far
Note 1 to entry: ambient noise includes any type of unwanted noise that would create a nuisance, perceptual confusion or result in unintended masking of test signals for the listener undergoing a hearing test.

3.3 Ambient sound pressure level ambient noise level LS

Level of ambient sound measured in an audiometric test room.
Note 1 to entry: Ambient sound pressure level is expressed in decibels (dB). The reference value is 20 Pa.
Note 2 to entry: This standard specifies requirements for maximum permissible ambient sound pressure levels,
LS, max in the audiometric test room for various audiometric testing modalities and frequency ranges.

3.4 Masking
Process by which the hearing threshold of a given ear for a particular sound is raised by the presence of another (masking) sound [SOURCE: ISO 8253-1:2010]

3.5 Air conduction

Transmission of sound through the external and middle ear to the inner ear [SOURCE: ISO 389-1:2017]

3.6 Supra-aural earphone supra-aural headphone
Earphone applied externally to the outer ear that presses against the pinna so that the electroacoustic transducer is close to the pinna
EXAMPLE TDH 39 with MX 41/AR cushions as mentioned in this document.

3.7 Circumaural earphone circumaural headphone

Earphone which encloses the pinna and rests on the surrounding surface of the head EXAMPLE HDA 200 earphones as mentioned in this document.

3.8 Insert earphone

Earphone consisting of a body worn transducer, sound tube, nipple adaptor, and a foam ear tip, the ear tip of which is inserted into the ear canal.
EXAMPLE ER-3A Earphones as mentioned in this document.

3.9 Bone conduction

Transmission of sound to the inner ear primarily by means of mechanical vibration of the cranial bones [SOURCE: ISO 389-3:2016]

3.10 Bone vibrator

Electromechanical transducer intended to produce the sensation of hearing by vibrating the cranial bones [SOURCE: ISO 8253-1:2010]

3.11 Hearing threshold

Lowest sound pressure level or vibratory force level at which, under specified conditions, a person gives a predetermined percentage of correct detection responses on repeated trials [SOURCE: ISO 8253-1:2010]

3.12 Hearing level of a pure tone HL of a pure tone

For a specified signal and a specified manner of signal presentation, sound pressure level of this signal in a specific ear simulator, acoustic coupler, mechanical coupler or in a sound field, minus the appropriate reference threshold sound pressure level or reference equivalent threshold vibratory force level

Note 1 to entry: Refer to ISO 8253-1 and ISO 8253-2 for further background on reference threshold levels and determination of hearing levels for different transducers.

3.13 Hearing threshold level (of a given ear)

At a specified frequency and for a specific type of transducer, hearing threshold at that frequency, expressed as hearing level

[SOURCE: ISO 8253-1:2010]

3.14 Speech signal

Acoustic signal which carries information in a given language

Note 1 to entry: A speech signal can be a voice signal or an acoustic signal simulating a voice signal [SOURCE: ISO 8253-3:2022]

3.15 Speech level

Sound pressure level of a specified speech material as measured in an appropriate acoustic coupler, ear simulator or in a sound field, with a specified frequency and time weighting [SOURCE: ISO 8253-3:2022]

3.16 Hearing level for speech HL for speech

For a specified speech material and a specified manner of signal presentation, the speech level minus the appropriate reference speech recognition threshold level

[SOURCE: ISO 8253-3:2022]

Note 1 to entry: Refer to ISO 8253 -3 for further background on reference speech recognition threshold levels.

3.17 Octave-band filter

Band-pass filter for which the ratio of upper band-edge frequency to lower band-edge frequency is the octave frequency ratio [SOURCE: IS 6964:2018 / IEC 61260-1:2014]

Note 1 to entry: Refer to IS 6964:2018 / IEC 61260-1:2014 for the specifications and background information of octave band and one-third-octave band filters used in this standard

3.18 Noise floor

Lower limit of measurement of an instrument calculated from the addition of all noise sources and unwanted signals within a measurement system

Note 1 to entry: Signals beneath the noise floor cannot be reliably measured by the instrument.

4 PERMISSIBLE AMBIENT NOISE

4.1 General

Hearing measurements in an audiometric test room may be conducted for different audiometric purposes. However, if the ambient sound pressure levels in the room are high, the results of audiometric tests in that environment may be inaccurate. This occurs because high ambient noise leads to an elevation of hearing threshold levels of the test subject, due to the psychoacoustic phenomenon of masking. To minimize inaccuracy of hearing measurements due to masking, this standard proposes requirements to limit ambient noise in an audiometric test room.

4.2 Permissible ambient noise for hearing threshold determinations.

Ambient sound pressure levels in an audiometric test room shall not exceed certain values to avoid masking of the test signals used to determine hearing thresholds. These values are specified as maximum permissible ambient sound pressure levels, $L_{S,\max}$, in one-third octave bands for:

A lowest hearing threshold level of 0 dB;

A maximum amount of allowable threshold shift (uncertainty) of +2 dB and of +5 dB (as applicable) at the lowest test tone level.

NOTE 1 See clause 4.3 for ambient sound pressure levels for measuring minimum hearing threshold levels other than 0 dB

NOTE 2 A maximum allowable threshold shift of +2 dB means that threshold elevation will be limited to 2 dB when testing is conducted at signal levels corresponding to 0 dB HL in the presence of ambient noise equal to the relevant $L_{S,\max}$ specified by this standard.

4.2.1 *Permissible ambient noise for pure-tone air conduction audiometry by means of earphones.*

Table 1 specifies values for $L_{S,\max}$ for pure-tone air conduction audiometry when typical current supra-aural earphones are used. Three test tone frequency ranges are specified — from 125 Hz to 8 000 Hz, from 250 Hz to 8 000 Hz and from 500 Hz to 8 000 Hz. The average sound attenuation of these earphones is given in Table 2. These values are based on experimental data for two commercially available earphone types.

If other types of earphones are used, the difference in the sound attenuation of those earphones and the values for sound attenuation of typical current supra-aural earphones in Table 2 shall be added to the values for $L_{S,\max}$ specified in Table 1. For sound attenuation values of these other types of earphones, refer to Table 2, or the values specified by the earphone manufacturer, as applicable.

NOTE 1 This standard does not endorse or recommend any earphone product. Audiometric earphones other than those mentioned in this standard may be employed to meet the requirements

of this standard, provided th at sound attenuation information over the relevant frequency range is known or provided by the manufacturer.

NOTE 2 See Annex A for calculating $L_{S,\max}$ when using earphones other than typical current supra-aural earphones. See clause A.3 when using noise-excluding headsets in conjunction with audiometric earphones.

If lowest hearing threshold level measurements other than 0 dB are to be performed in a particular test room, the appropriate $L_{S,\max}$ levels are obtained by adding to the values of Table 1, the value of the lowest hearing threshold level to be measured.

NOTE 3 See clause 4.3 for permissible ambient noise when measuring lowest hearing threshold levels other than 0 dB.

Table 1 – Maximum permissible ambient sound pressure levels in one-third-octave bands, $L_{S,\max}$, for pure-tone air conduction audiometry for hearing threshold level measurements down to 0 dB when typical current supra-aural earphones are used.

Mid-frequency of one-third-octave band Hz	**Maximum permissible ambient sound pressure levels**[a] $L_{S,\max}$ (Reference: 20 µPa) dB		
	Test tone frequency range		
	125 Hz to 8 000 Hz	250 Hz to 8 000 Hz	500 Hz to 8 000 Hz
31.5	56	66	78
40	52	62	73
50	47	57	68
63	42	52	64
80	38	48	59
100	33	43	55
125	28	39	51
160	23	30	47
200	20	20	42
250	19	19	37
315	18	18	33
400	18	18	24
500	18	18	18
630	18	18	18
800	20	20	20
1 000	23	23	23
1 250	25	25	25
1 600	27	27	27
2 000	30	30	30

2 500	32	32	32
3 150	34	34	34
4 000	36	36	36
5 000	35	35	35
6 300	34	34	34
8 000	33	33	33

NOTE 1 Using the values given; the lowest hearing threshold level to be measured is 0 dB, with a maximum uncertainty of +2 dB due to ambient noise. If a maximum uncertainty of +5 dB due to ambient noise is permitted, the values may be increased by 8 dB.

NOTE 2 See clause 4.3 for permissible ambient noise when measuring lowest hearing threshold levels other than 0 dB.

[a] [SOURCE: Table 2 of ISO 8253-1:2010]

Table 2 – Average sound attenuation, in decibels, for different earphones

Frequency Hz	**Typical current supra-aural earphone**[a] dB	**Etymotic ER-3A**[b] dB	**Sennheiser HDA 200**[b] dB
31.5	0	33	□
40	0	33	□
50	0	33	□
63	1	33	17
80	1	33	16
100	2	33	15
125	3	33	15
160	4	34	15
200	5	35	16
250	5	36	16
315	5	37	18
400	6	37	20
500	7	38	23
630	9	37	25
800	11	37	27
1 000	15	37	29
1 250	18	35	30
1 600	21	34	31
2 000	26	33	32
2 500	28	35	37
3 150	31	37	41
4 000	32	40	46
5 000	29	41	45
6 300	26	42	45
8 000	24	43	44

a The values given are based on measurements using pure tones in a free sound field and using Telephonic TDH39[b] with MX 41/AR cushions[b] and Beyer DT48[b] earphones.

b This is a product available commercially. This information is given for the convenience of users of th is standard and does not constitute an endorsement by BIS of this product.

[SOURCE: Table 3 of ISO 8253-1:2010]

Table 3 – Maximum permissible ambient sound pressure levels in one-third-octave bands, *LS,max,* for pure-tone bone conduction audiometry for hearing threshold level measurements down to 0 dB

Mid-frequency of one-third-octave band Hz	**Maximum permissible ambient sound pressure levels[a]** $L_{S,\max}$ (Reference: 20 µPa) dB	
	Test tone frequency range	
	125 Hz to 8 000 Hz	250 Hz to 8 000 Hz
31.5	55	63
40	47	56
50	41	49
63	35	44
80	30	39
100	25	35
125	20	28
160	17	21
200	15	15
250	13	13
315	11	11
400	9	9
500	8	8
630	8	8
800	7	7
1 000	7	7
1 250	7	7
1 600	8	8
2 000	8	8
2 500	6	6
3 150	4	4
4 000	2	2
5 000	4	4
6 300	9	9
8 000	15	15

NOTE 1 Using the values given, the lowest hearing threshold level to be measured is 0 dB, with a maximum uncertainty of +2 dB due to ambient noise. If a maximum uncertainty of +5 dB due to ambient noise is permitted, the values may be increased by 8 dB.

NOTE 2 With most of the current sound level meters, it is difficult to measure sound pressure levels below 5 dB.

NOTE 3 See clause 4.3 for permissible ambient noise when measuring lowest hearing threshold levels other than 0 dB.

[a] [SOURCE: Table 4 of ISO 8253-1:2010]

4.2.2 *Permissible ambient noise for pure-tone bone conduction audiometry.*

Table 3 specifies values for LS,max for pure-tone bone conduction audiometry by means of bone vibrator. Two test tone frequency ranges are specified for bone conduction — from 125 Hz to 8000 Hz and from 250 Hz to 8 000 Hz.

If lowest hearing threshold levels other than 0 dB are to be measured in a particular test room, the appropriate maximum ambient sound levels are obtained by adding to the values of Table 3, the value of the lowest hearing threshold level to be measured.

NOTE 1 See clause 4.3 for permissible ambient noise when measuring lowest hearing threshold levels other than 0 dB.

4.2.3 *Permissible ambient noise for sound field audiometry.*

Table 4 specifies values for LS,max for sound field audiometry using pure tones, frequency-modulated tones or other narrow-band test signals presented by means of one or more loudspeakers as per the specifications of ISO 8253 -2:2009. Two test tone frequency ranges are specified for sound field audiometry—125 Hz and above; and 250 Hz and above.

If lowest hearing threshold levels other than 0 dB are to be measured in a particular test room, the appropriate maximum ambient sound levels are obtained by adding to the values of Table 4, the value of the lowest hearing threshold level to be measured.

NOTE 1 See clause 4.3 for permissible ambient noise when measuring lowest hearing threshold levels other than 0 dB.

4.2.4 *Permissible ambient noise for speech audiometry.*

The ambient sound pressure levels in the test room shall not unduly affect the perception of the speech signals. The requirements for permissible ambient sound pressure levels in the test room depend on the mode of presentation of the speech signal, i.e. through an earphone, bone vibrator or loudspeaker.

For maximum permissible ambient sound pressure levels:

- of speech signals presented through an earphone, refer to requirements of clause 4.2.1
- of speech signals presented through a bone vibrator, refer to requirements of clause 4.2.2
- of speech signals presented through a loudspeaker, refer to requirements of clause 4.2.3

Note 1 to entry: Requirements for ambient noise during speech audiometry can be less stringent than those for pure - tone threshold audiometry. If a test room is appropriate for pure-tone

threshold audiometry down to a certain hearing level value over the whole frequency range, theroom can also serve for speech audiometry for the same mode of presentation of test signals for signal levels down to the same hearing level values.

Table 4 – Maximum permissible ambient sound pressure levels, $L_{S,max}$, in one-third- octave bands for sound field audiometry

Mid-frequency of one-third- octave band[a] Hz	**Maximum permissible ambient sound pressure levels**[b] $L_{S,max}$ (Reference: 20 µPa) dB	
	Lowest test tone frequency	
	125 Hz	250 Hz
31.5	52	60
40	44	53
50	38	46
63	32	41
80	27	36
100	22	32
125	17	25
160	14	18
200	12	12
250	10	10
315	8	8
400	6	6
500	5	5
630	5	5
800	4	4
1 000	4	4
1 250	4	4
1 600	5	5
2 000	5	5
2 500	3	3
3 150	1	1
4 000	□ 1	□ 1
5 000	1	1
6 300	6	6
8 000	12	12
10 000	14	14
12 500	15	15

NOTE 1 Using the values given, the lowest hearing threshold level to be measured is 0 dB, with a maximum uncertainty of +2 dB due to ambient noise. If a maximum uncertainty of +5 dB due to ambient noise is permitted, the values may be increased by 8 dB.

NOTE 2 With most of the current sound level meters, it is difficult to measure sound pressure levels below 5 dB.

NOTE 3 See clause 4.3 for permissible ambient noise when measuring lowest hearing threshold levels other than 0 dB.

[a] When narrow-band noise is used as a test signal, maximum permitted ambient sound pressure levels should be lower than those specified in this table.

[b] [SOURCE: Table 2 of ISO 8253-2:2009]

4.3 Permissible ambient noise when measuring lowest hearing threshold levels other than 0 dB

If the lowest hearing threshold levels to be measured in the audiometry room are other than 0 dB, other values for LS,max are appropriate. These sound pressure levels are calculated by adding to the values given in Table 1, Table 3, and Table 4, as appropriate, the minimum hearing threshold level to be measured.

EXAMPLE 1 If it is desired for an audiometric room to test to a minimum hearing threshold of

+15 dB (15 dB above 0 dB) for pure-tone bone conduction threshold measurements, then the new maximum permissible ambient noise values are calculated by adding 15 dB to each of the values of Table 3 over the frequency range to be employed in the test room.

EXAMPLE 2 If it is desired for an audiometric room to test to able to accurately test a minimum hearing threshold of -10 dB (10 dB below 0 dB) for pure-tone sound field measurements, then the new maximum permissible ambient noise values are calculated by subtracting 10 dB from each of the values of Table 4 over the frequency range to be employed in the test room.

The lowest hearing threshold level for which testing should be carried out is determined by the requirements of the diagnostic or screening test procedure, the intended demographic which is to be tested in the room, structural feasibility and cost considerations. The test requirements for testing young children (e.g. in a paediatric clinic) may vary significantly from those required for older adults or for adults being screened for occupational safety (e.g. in an industrial setting). When testing young children, testing will likely need to be carried out to 0 dB threshold levels whereas this may not be required for an older person, or for occupational hearing screenings.

4.4 Psycho-acoustic check on ambient noise

As an informal subjective check, a psycho-acoustic check of the ambient noise may be carried out by conducting an audiometric test on at least two test subjects who are known to have stable audiograms and, at all frequencies, lower (better) hearing thresholds levels than the lowest hearing levels to be used during regular testing. Hearing threshold levels obtained in this way, which are higher by 5 dB or more, indicate a requirement for reduction of the noise in the room. If bone conduction audiometry is to be performed in the room, the check shall be carried out by means of a bone vibrator. If sound field audiometry is to be performed in the room, the check shall be carried out by means of one or more loudspeakers. The audiometric test shall be carried out during the time in which the audiometry would normally be conducted to closely match real- world conditions.

NOTE: The specified psycho-acoustic check on ambient noise is not a replacement for achieving compliance with this standard. Refer to Clause 6 of this standard for requirements for achieving compliance with this standard.

5 MEASUREMENT OF AMBIENT NOISE

5.1 Measurement instrumentation

The measurements shall meet the requirements for:

- class 1 sound level meters designated as being compliant with IS 15575 (Part 1) / IEC 61672-1
- one-third-octave-band filter set relevant to this standard and complying with IS 6964 / IEC 61260-1
- noise floor to be at least 6 dB below the sound pressure level being measured.

The equipment used should have calibration certification traceable to the relevant standards.

NOTE – The sound level meter and filter combination are typically part of the same instrument.

5.2 Conditions for ambient noise measurements

The measurements of ambient sound pressure levels shall be made at a time when conditions are representative of those existing when audiometric tests are carried out. If a ventilation system is usually operating during testing, noise measurements shall be made with that system operating.

NOTE – This would include in-take and out-take exhaust fans and other ventilation systems, lights, audiometer, amplifiers, and other instrumentation located in the audiometric test room. Those noises which occur only occasionally, and which are readily avoided in the normal testing protocol need not be considered , provided the audiometric test will always be interrupted during these infrequent noise conditions .

5.3 Measurement procedure

The measurements shall be made with the microphone of the sound level meter at the position, or positions, at which the head of the test subject would be in the audiometric test room, but with the subject not present.

The following settings should be used for measurements using the sound level meter and filter combination:

- Frequency weighting: Z (‘flat’ or ‘zero’ frequency weighting)
- Time weighting: S (‘slow’ time weighting)
- Filtering: one-third-octave band (1/3 octave)

The microphone orientation shall be that producing the highest readings for each frequency band. If the person making the measurements is in the audiometric test room, that person shall be positioned so as not to reduce the level of the ambient noise reach ing the microphone. (e.g. by obstructing a potential noise source).

6 Compliance with the standard

The ambient sound pressure levels in an audiometric test room shall be measured as in clause 5.3 using instrumentation as in clause 5.1 and conditions as in clause **5.2** of this standard.

The measured ambient sound pressure levels shall be compared to the maximum permissible ambient sound pressure levels highlighted in this standard, for each of the audiometric testing modalities and test frequency ranges to be employed in the audiometric test room in reference to clause **4.2.**

EXAMPLE 1 If an audiometric test room would only employ air conduction testing with typical current supra-aural earphones, and bone conduction testing with a bone vibrator, then the measured ambient sound pressure levels will be compared with the levels shown in Table 1 and Table 3, over the frequency range to be employed in the test room.

EXAMPLE 2 If an audiometric test room would employ air conduction testing with insert earphones e.g., of type ER- 3A, then the measured ambient sound pressure levels will be compared with the maximum permissible levels calculated by taking account for the extra attenuation provided by the earphones over current typical supra -aural earphones, for the frequency range to employed in the test room (See Annex A for explanation and sample calculations)

For each test modality and test frequency range selected to be employed in the audiometric test room, measurements could result in two outcomes:

- If the measured ambient sound pressure levels do not exceed the relevant LS,max levels, the audiometric test room is considered acceptable for audiometry for hearing threshold level measurements down to 0 dB, for the selected test modality in the selected test frequency range.
- If one or more of the measured ambient sound pressure levels exceeds the relevant *LS,max* levels, the audiometric test room is considered not acceptable for audiometry for hearing threshold level measurements down to 0 dB, for the selected test modality in the selected test frequency range.

Compliance with the standard's maximum permissible ambient sound pressure level limits is to be ideally achieved for hearing threshold level measurements down to 0 dB. However, for certain use-cases, or due to structural feasibility or cost considerations, if lowest hearing threshold measurements other than 0 dB are to be performed in the audiometric test room, then this lowest hearing threshold level which can be reliably measured, as per the requirements of this standard, shall be stated.

NOTE 1: See clause 4.3 for ambient sound pressure levels for measuring lowest hearing threshold levels other than 0 dB.

NOTE 2: Measurements of the ambient noise sound pressure levels are ideally conducted annually or whenever any new noise source is operating within or in the vicinity of the audiometric test room.

Annex A
(informative)

Calculating permissible ambient sound pressure levels for air-conduction audiometry when using earphones other than current typical supra-aural earphones

A.1 General

Table 1 specifies values for maximum permissible ambient sound pressure levels, *LS ,max* for air conduction audiometry when typical current supra-aural earphones are used. The average sound attenuation of these earphones is given in Table 2. These values are based on experimental data for two commercially available earphone types - Telephonic TDH39 with MX 41/AR cushions; and Beyer DT48 earphones.

If other types of earphones are used, the difference in the sound attenuation of those earphones and the values in Table 2 is to be added to the values for *LS,max* specified in Table 1.

A.2 Example for calculating estimated maximum permissible ambient sound pressure levels using earphones other than current typical supra-aural earphones

Considering the use case where an audiometric test room would only perform air conduction testing of hearing thresholds using insert earphones ER-3A instead of current typical supra- aural earphones. Using the attenuation values of the selected insert earphones highlighted in Table 2, the estimated values of *LS,max* for using the earphones in the audiometric test room can be calculated as per Table A.1.

NOTE The estimated maximum permissible ambient sound pressure levels specified in Table A.1 is only applicable for pure-tone audiometric testing using insert earphones ER-3A, over the frequency range specified. If other test modalities or frequency ranges are to be also used, then the ambient sound pressure levels in the audiometric room must also meet the respective requirements of *LS,max* for those cases as applicable.

A.3 Usage of noise-excluding headsets in conjunction with audiometric earphones

For cases when audiometric testing needs to be carried out at a location where the ambient noise is greater than those levels specified in this standard, users might find it desirable to employ with the earphones, an additional noise-excluding headset of known attenuation.

The user should ensure that such noise-excluding headsets are intended for the purpose of audiometric measurements, and that the audiometer in use has been adequately calibrated for their usage in conjunction with the audiometric earphones. Then, by using the attenuation values of the combination of earphones and noise-excluding headset, as specified by the manufacturer, the estimated values for maximum permissible ambient sound pressure levels in the test room can be calculated.

NOTE: Refer to clause A.2. for sample calculation procedure.

It is important to note that for earmuffs or personal sound protectors not intended for use in audiometric measurements, the attenuation data supplied may not be applicable. This is because, in most applications of such additional equipment, the shells of the earmuff are modified to allow for the insertion of the audiometric earphones. This may significantly vary the attenuation performance of the device and also result in the audiometer falling out of calibration and failing to produce correct hearing levels due to the use of the modified equipment.

Table A.1 – Calculation to estimate maximum permissible ambient sound pressure levels in one-

third-octave bands, *LS,max* , for pure-tone air conduction audiometry for hearing threshold level measurements down to 0 dB when ER-3A earphones are used, over test frequency range of 125 Hz to 8 000 Hz.

Mid-frequency of one-third-octave band Hz	$L_{S,max}$ **using current typical supra-aural earphones**[a] dB	**Average sound attenuation of typical current supra-aural earphones**[b] dB	**Average sound attenuation of selected ER- 3A insert earphones**[c] dB	**Difference in attenuation of selected earphones from typical current supra-aural earphones** dB	**Calculated estimate of $L_{S,max}$ when ER-3A insert earphones are used**[d] dB
	A	B	C	(C – B)	A + (C – B)
31.5	56	0	33	33	89
40	52	0	33	33	85
50	47	0	33	33	80
63	42	1	33	32	74
80	38	1	33	32	70
100	33	2	33	31	64
125	28	3	33	30	58
160	23	4	34	30	53
200	20	5	35	30	50
250	19	5	36	31	50
315	18	5	37	32	50
400	18	6	37	31	49
500	18	7	38	31	49
630	18	9	37	28	46
800	20	11	37	26	46
1 000	23	15	37	22	45
1 250	25	18	35	17	42
1 600	27	21	34	13	40
2 000	30	26	33	7	37
2 500	32	28	35	7	39
3 150	34	31	37	6	40
4 000	36	32	40	8	44
5 000	35	29	41	12	47
6 300	34	26	42	16	50
8 000	33	24	43	19	52

[a] Source: Table 1 of this standard for test tone frequency range of 125 Hz to 8 000 Hz

[b] Source: Table 2 of this standard for typical current supra-aural earphone

[c] Source: Table 2 of this standard for Etymotic ER-3A

[d] Calculated estimated $L_{S,\max}$ (Reference: 20 µPa) of ER-3A earphones for pure-tone air conduction audiometry for hearing threshold level measurements down to 0 dB, over test tone frequency range of 125 Hz to 8000 Hz.

NOTE 1 Using the values given, the lowest hearing threshold level to be measured is 0 dB, with a maximum uncertainty of +2 dB due to ambient noise. If a maximum uncertainty of +5 dB due to ambient noise is permitted, the values may be increased by 8 dB.

NOTE 2 See clause 4.3 for permissible ambient noise when measuring lowest hearing threshold levels other than 0 dB.

Annex B

(informative)

Design and selection considerations for audiometric test rooms

B.1 General

The primary requirement of an audiometric test room is to provide an enclosed space which limits the ambient noise to ensure accuracy and reproducibility of hearing tests. If the ambient sound pressure levels in an existing audiometric test room are greater than those specified in this standard, then alternate approaches should be used to reduce the level of the excessive ambient noise and provide a quieter environment for testing hearing. This could be achieved by either designing and building a new test room, modifying an existing room or selecting prefabricated test room. It might also be necessary to select an alternative site for the room with lower environmental noise sources. This Annex only provides general guidance for the initial design and selection of audiometric test rooms. Detailed design and construction plans should be made in consultation with experts.

B.2 Considerations for the design of audiometric test rooms

B.2.1 Use of sound absorbing materials

The use of sound absorptive surfaces and acoustical treatment such as acoustic panels for walls and ceilings is recommended to provide an appropriate atmosphere for audiometric tests, reduce reverberation and to secure maximum absorption and attenuation of sounds arising inside the room and those arriving from outside. The use of sound-absorbing curtains and blankets on walls and over doors can provide noise reduction where acoustical treatment might not be feasible. The floor of each room should be covered with carpet or a cushioning material to reduce impact and scraping noises.

B.2.2 Minimizing acoustical leaks

A major source of the ambient noise in the room may be acoustical leaks around doors, windows, pipes, and ducts. Doors that provide a tight seal and are constructed with dense materials like wood or metal, with a core filled with sound-absorbing materials, can help reduce noise transmission. Using sound-proof windows which typically have multiple layers of glass with air gaps, bonded with noise damping materials can block and absorb sound to reduce noise.

A leading source of ambient noise is the air conditioning and ventilating system, particularly fan and fan motor noise. However, since acoustically treated rooms have a high level of thermal isolation and are generally tightly sealed, excluding ventilation can have a negative impact on the comfort of the client due to lack of availability of fresh air and temperature control.

Therefore, it is recommended to employ an acoustically treated air condition and ventilating system that does not produce noise that exceeds the noise levels specified in the standard. When that is not

feasible, it is advisable to use a system with variable air flow and lower the airflow speed during tests to minimize distracting noise.

B.2.3 Noise reduction by isolation

The location of an audiometric test room should in a quiet surrounding environment, as far away as possible from excessive noise sources, such as busy areas of a building, traffic noise, loud machines etc. A completely enclosed testing space which employs noise isolating elements can also help provide large amounts of noise reduction.

The characteristics of a sound isolator (a wall, ceiling, or floor) differ from those of a sound absorber (e.g., acoustic panel). The isolator must be nonporous, and its effectiveness relies principally in proportion to its weight per square meter of surface. However, this effect increases slowly by weight, and large sound reductions can be obtained economically by the use of double walled structures wherein a complete separation between walls is maintained throughout by an air space or resilient connections.

Thus, designing and constructing test rooms as rooms within rooms, can help structurally isolate the test room space from the host room or building. Single or double walls can be installed depending on the level of acoustic isolation required.

B.2.4 Audiometric Room layout

Audiometric test rooms should be of an adequate size to accommodate the various tests to be performed, keeping in mind the increased size considerations for pediatric assessment and sound field audiometry. The larger the room, the smaller the impact of furniture, equipment and people will have on the sound field environment.

It is desirable to have a minimum amount of distraction for the subject under test. Thus, individual audiometric test rooms, or at least large sections of a room should be acoustically and visually well separated from each other.

The location of furniture and equipment should also be considered and ideally placed in fixed positions to ensure acoustic measurements are not affected, resulting in consistent testing results. Patient-centric considerations include choosing comfortable furniture and adequate lighting.

B.3 Considerations for the selection of audiometric test rooms

B.3.1 Design characteristics of ideal audiometric test rooms

Commercially available test rooms should be designed so that they “float” within a structure and thereby eliminate structure-borne sound. Room walls, which may be single or double-walled, and the roof and floor should all be independent of the surrounding construction. If the noise radiated by the floor is not negligible, a floating floor is to be installed. Ceiling constructions should provide noise reduction equivalent to that of the walls and prevent excessive transmission of impact sounds from above. Double walls are recommended to achieve sound insulation which can help eliminate

external structure and airborne sound. Doors and windows should maintain the effectiveness of the walls and ceiling, and that the ventilation system, if it is to be used during testing, should not introduce ambient noise into the room in excess of the appropriate levels specified in this standard.

B.3.2 Selection of test room based on amount of noise reduction provided

As in the case of designing and modifying test rooms, the primary consideration in the selection of commercially available audiometric test rooms is that the ambient sound pressure levels in the test room do not exceed those specified in this standard.

If new construction or prefabricated rooms are to be installed in an existing space, selection criteria for the test room should ensure that noise reduction provided by the room results in ambient sound pressure levels that fulfil the requirements of this standard, for the intended use- cases.

To determine the noise reduction required in the existing space, one-third octave band sound pressure levels from 125 to 8 000 Hz should be measured in the area where the test room is to be placed using the method described in clause 5. The difference between the measured levels minus the LS,max levels specified in clause 4 for the audiometric condition and test frequency range to be employed, are the minimum noise reduction levels required.

Audiometric test rooms which can comfortably provide these required noise reduction levels should then be selected.

It should be kept in mind that the noise reduction amounts stated by the Audiometric test room manufacturers are approximate values and are based on test conditions which may vastly differ from those in the intended installation location. The noise reduction provided by a given prefabricated test room can depend in a complex manner on the size and the acoustical properties of the larger room in which the test room is to be located and the distance between the existing walls and the room. In addition, construction and assembly factors may introduce a degree of variability in noise reduction. For these reasons, a safety factor of at least 5 to 10 dB should be added to the estimated minimum amount of noise reduction.

Bibliography

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