INTERNATIONAL STANDARD

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Acoustics — Audiometric test methods —
Part 1:
Basic pure tone air and bone conduction threshold audiometry

Acoustique — Méthodes d'essais audiométriques —

Partie 1: Audiométrie liminaire fondamentale à sons purs en conduction aérienne et en conduction osseuse

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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. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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 8253-1 was prepared by Technical Committee ISO/TC 43, *Acoustics*.

ISO 8253 will consist of the following parts, under the general title *Acoustics — Audiometric test methods*:

— *Part 1: Basic pure tone air and bone conduction threshold audiometry*

— *Part 2: Sound field audiometry with pure tone and narrow-band signals*

Annex A of this part of ISO 8253 is for information only.

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Introduction

This International Standard lays down requirements and procedures for carrying out basic audiometric tests in which pure tones are presented to the test subject using earphones or bone vibrators. Electrophysiological test methods are not included. Procedures for air conduction threshold audiometry for hearing conservation purposes are given in ISO 6189. Where appropriate, both International Standards have been brought into line with one another.

In order to obtain a reliable measure of hearing ability, many factors are involved. IEC 645 specifies requirements for audiometers. It is essential that audiometric equipment, when in service, be checked and the calibration maintained. This part of ISO 8253 outlines a calibration scheme. To avoid masking of the test signal by ambient noise in the audiometric test room, the levels of the ambient noise shall not exceed certain values, depending upon the method of signal presentation to the test subject, i.e. by earphone or by bone vibrator. This part of ISO 8253 gives maximum permissible ambient sound pressure levels which shall not be exceeded when hearing threshold levels down to 0 dB have to be measured. It indicates the maximum ambient sound pressure levels which are permissible when other minimum hearing threshold levels have to be measured. It sets out procedures for determining hearing threshold levels by pure tone air conduction and bone conduction audiometry. For screening purposes, only methods for air conduction audiometry are outlined.

Audiometry can be performed by using

a) a manual audiometer;

b) an automatic recording audiometer;

c) computer-controlled audiometric equipment.

Methods for threshold audiometry are given for these three types of signal presentation. For screening purposes, only methods using a manual or a computer controlled audiometer are set out.

The procedures are applicable to the majority of adults and children. Other procedures may yield results equivalent to those derived by the procedures specified in this part of ISO 8253. For very young, aged or sick people, some modification of the recommended procedures is likely to be required. This may result in a less accurate measurement of hearing.

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Acoustics — Audiometric test methods —

Part 1:
Basic pure tone air and bone conduction threshold audiometry

1 Scope

This part of ISO 8253 specifies procedures and requirements for air conduction and bone conduction threshold audiometry. For screening purposes, only air conduction pure tone audiometric test methods are described. The procedures may not be appropriate for special populations, for example very young children.

Some audiometric procedures need to be carried out at levels above the hearing threshold levels of the subjects. These and other tests are not described in this part of ISO 8253.

Procedures and requirements for speech audiometry, electrophysiological audiometry, and where loudspeakers are used as a sound source are not specified. Air conduction threshold audiometry for hearing conservation purposes is described in ISO 6189.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 8253. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 8253 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 389 : 1985, *Acoustics — Standard reference zero for the calibration of pure tone air conduction audiometers.*

ISO 7566 : 1987, *Acoustics — Standard reference zero for the calibration of pure-tone bone conduction audiometers.*

IEC 225 : 1966, *Octave, half-octave and third-octave band filters intended for the analysis of sounds and vibrations.*

IEC 303 : 1970, *IEC provisional reference coupler for the calibration of earphones used in audiometry.*

IEC 318 : 1970, *An IEC artificial ear, of the wideband type, for the calibration of earphones used in audiometry.*

IEC 373 : 1971, *An IEC mechanical coupler for the calibration of bone vibrators having a specified contact area and being applied with a specified static force.*

IEC 645 : 1979, *Audiometers.*

IEC 651 : 1979, *Sound level meters.*

IEC 804 : 1985, *Integrating-averaging sound level meters.*

3 Definitions

For the purposes of this part of ISO 8253, the following definitions apply.

3.1 air conduction: The transmission of sound through the outer 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 an earphone in conjunction with a calibrated microphone to measure the sound pressure developed within the cavity.

NOTE — An acoustic coupler is specified in IEC 303.

3.3 artificial ear: A device for the calibration of an earphone which presents to the earphone an acoustic impedance 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 318.

3.4 bone conduction: The transmission of sound to the inner ear primarily by means of mechanical vibration of the cranial bones.

3.5 bone vibrator: An electromechanical transducer intended to produce the sensation of hearing by vibrating the cranial bones.

3.6 mechanical coupler: A device designed to present a specified mechanical impedance to a vibrator applied with a specified static force and equipped with a mechano-electrical transducer to measure the vibratory force level at the surface of contact between vibrator and mechanical coupler.

NOTE — A mechanical coupler is specified in IEC 373.

3.7 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.

3.8 hearing threshold: The 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.

3.9 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 hearing threshold.

3.10 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 years and 30 years inclusive, expressing the hearing threshold in a specified acoustic coupler or artificial ear for a specified type of earphone.

3.11 equivalent threshold force level (monaural listening)**:** For a given ear, at a specified frequency, for a specified configuration of bone vibrator and for a stated force of application of the bone vibrator to the human mastoid bone, the vibratory force level set up by the bone vibrator on a specified mechanical coupler when the bone vibrator is actuated by that voltage which, with the bone vibrator applied to the mastoid bone concerned, would correspond to the hearing threshold.

3.12 reference equivalent threshold force level (RETFL): At a specified frequency, the mean value of the equivalent threshold force levels of a sufficiently large number of ears of otologically normal persons of both sexes aged between 18 years and 30 years inclusive, expressing the hearing threshold in a specified mechanical coupler for a specified type of bone vibrator.

3.13 hearing level of a pure tone (at a specified frequency, for a specific type of transducer and for a specified manner of application)**:** The sound pressure level (or the vibratory force level) of a pure tone, produced by the transducer in a specified artificial ear or acoustic coupler (or mechanical coupler) minus the appropriate reference equivalent threshold sound pressure level (or reference equivalent threshold force level).

3.14 hearing threshold level of a given ear (at a specified frequency and for a specified type of transducer)**:** The hearing threshold at that frequency, expressed as hearing level.

3.15 occlusion effect: The change (usually an increase) in level of a bone-conducted signal reaching the inner ear when an earphone or an earplug is placed over or at the entrance of the ear canal, thereby forming an enclosed air volume in the external ear. The effect is greatest at low frequencies.

3.16 masking:

(1) The process by which the hearing threshold of a given ear to a particular sound is raised by the presence of another (masking) sound.

(2) The amount by which the hearing threshold level of a given ear is so raised, expressed in decibels.

3.17 effective masking level of a noise band: A level equal to that hearing level of a pure tone — the frequency of which coincides with the geometric centre frequency of the noise band — to which the threshold of hearing of the pure tone is raised by the presence of the masking noise band.

NOTE — IEC 645 specifies that masking levels for narrow band noise be calibrated in terms of effective masking level.

3.18 vibrotactile threshold level: The level of the vibratory force or sound pressure at which a person gives a predetermined percentage of correct detection responses on repeated trials due to the sensation of vibration on the skin.

3.19 pure-tone audiometer: An electroacoustic instrument, equipped with earphones, that provides pure tones of specified frequencies at known sound pressure levels. In addition, it may be equipped with bone vibrator(s) and/or masking facilities.

3.20 manual audiometer: An audiometer in which the signal presentations, frequency and hearing level selection and recording of the results are performed manually.

3.21 computer-controlled audiometer: An audiometer in which the test procedure is controlled by computer. For the purposes of this part of ISO 8253, a computer is considered as any electronic device that has a program controlling the test procedure.

3.22 automatic recording audiometer: An audiometer in which hearing level variations are under the subject's control and are recorded automatically.

3.23 sweep-frequency audiometer: An automatic recording audiometer where the frequency is varied continuously or in steps much smaller than one-third octave.

3.24 screening audiometry: Screening audiometry is a pass-fail procedure where pure tones of a fixed level, the screening level, are presented.

3.25 pure-tone audiogram of a subject: Presentation, in graphical or tabular form, of the hearing threshold levels of the subject's ears, determined under specified conditions and by a specified method, as a function of frequency.

4 General aspects of audiometric measurements

4.1 General

Hearing threshold levels can be determined by air conduction and bone conduction audiometry. In air conduction audiometry, the test signal is presented to the test subject by earphones. In bone conduction audiometry, the test signal is presented by a bone vibrator placed on the mastoid or forehead of the test subject. It is recommended that threshold level determinations be started with air conduction measurements followed by bone conduction measurements. Hearing threshold levels can be determined using test tones with fixed frequencies (fixed-frequency audiometry) or a test signal with frequency varying with time according to a predetermined rate of change (sweep-frequency audiometry). Methods for fixed-frequency audiometry are given in clause 6 and sweep-frequency audiometry is described in clause 7. In air and bone conduction measurements, the hearing threshold levels of both ears shall be determined separately. Under specified conditions, masking noise shall be applied to the ear not under test (contra-lateral ear). The masking noise is presented to that ear through a supra-aural, circum-aural or insert-type earphone. No calibration standards for insert or circum-aural earphones currently exist.

4.2 Standard reference zero for the calibration of audiometric equipment

The standard reference zero for air conduction audiometers is given in ISO 389 and ISO 389/Add. 1 and Add. 2 and for bone conduction audiometers in ISO 7566 in terms of reference equivalent threshold sound pressure levels or force levels (RETSPL or RETFL respectively) at specified frequencies. Different RETFL-values are valid for different locations of the vibrator, i.e. at the mastoid or forehead. ISO 7566 : 1987 presents values for mastoid location and gives corresponding difference values for forehead location of the vibrator in annex C.

4.3 Requirements on audiometric equipment

Audiometers shall be constructed in accordance with IEC 645 and calibrated in accordance with the requirements of ISO 389 and ISO 7566.

4.4 Qualified tester

A qualified tester is understood to be someone who has followed an appropriate course of instruction in the theory and practice of audiometric testing. This qualification may be specified by national authorities or other suitable organizations. Throughout this part of ISO 8253, it is assumed that tests will only be carried out by, or be under the supervision of, a qualified tester.

NOTE — The tester should make decisions on the following aspects of the audiometric test which are not specified in detail in this part of ISO 8253:

a) which ear is tested first (usually the ear considered to be more sensitive);

b) whether or not masking is required;

c) whether the responses of the test subject correspond with the test signals;

d) whether there is any external noise event or any behaviour or response of the test subject that might invalidate the test;

e) whether to interrupt, terminate or repeat all or part of the test.

4.5 Test time

Care shall be taken not to fatigue the test subject unduly since reliable results may be progressively difficult to obtain if the test subject is not given a rest from testing after about 20 min.

4.6 Conditions for audiometric test environments

Ambient sound presure levels in an audiometric test room shall not exceed the values specified in clause 11.

The test subject and the tester shall be comfortably seated during audiometric testing and shall be neither disturbed nor distracted by non-related events nor by people in the vicinity.

Air temperature in the audiometric test room should be in the range permitted for offices by local authorities. The audiometric test room should allow for sufficient exchange of air.

If the audiometer is operated manually, the test subject shall be clearly visible to the tester but shall not be able to see the audiometer settings change nor the test tone switched on or interrupted. When using an automatic recording audiometer, the recording mechanism shall not be visible to the test subject.

When the test is carried out from outside the audiometric test room, the test subject shall be visually monitored through a window or by a closed circuit TV-system. Acoustic monitoring of the subject should be undertaken.

5 Preparation and instruction of test subjects before audiometric testing and positioning of transducers

5.1 Preparation of test subjects

Recent exposure to noise may cause a temporary elevation of the hearing threshold levels. Therefore, significant noise exposure should be avoided before audiometric testing or it shall be noted. In order to avoid errors due to excessive physical exertion, test subjects should be present at least 5 min prior to testing.

Normally, the audiometric test is preceded by an otoscopic examination carried out by a qualified person. If obstructing wax is found in the canal(s) of the outer ear it shall be removed

and audiometry may be delayed for a suitable period. The ear should also be checked for the possibility of collapsing ear canals and appropriate action taken, if necessary.

NOTES

1 Preliminary information about the type of hearing loss and masking requirements can be obtained by performing tuning fork tests.

2 The qualifications for a qualified person may be specified by national authorities or other suitable organizations.

5.2 Instruction of test subjects

In order to achieve reliable test results, it is essential that relevant instruction in the test procedure be given unambiguously and that it is fully understood by the test subject.

The instructions shall be phrased in language appropriate to the listener and shall normally indicate

a) the response task;

b) that the test subject shall respond whenever the tone is heard in either ear, no matter how faint it may be;

c) the need to respond as soon as the tone is heard and to stop responding immediately once the tone is no longer heard;

d) the general pitch sequence of the sound;

e) which ear shall be tested first.

The response task from the test subject shall be clearly observable to indicate when the tone is heard and is no longer heard. Examples of commonly used responses are

a) pressing and releasing a signal switch;

b) raising and lowering the finger or hand.

Test subjects shall also be instructed to avoid unnecessary movements so as to obviate extraneous noise. After the instructions have been given, the test subject shall be asked if he/she has understood. The test subject shall be informed that he/she may interrupt the test in case of any discomfort. If there is any doubt, the instructions should be repeated.

5.3 Placement of transducers

In advance of testing, the following actions should be undertaken: spectacles and head ornaments, when necessary, and hearing aids shall be removed. Hair shall be moved from between the head and the sound transducers, i.e. earphones and bone vibrators, if possible. The transducers shall be fitted by the tester to ensure that they are properly positioned and subjects shall be instructed not to touch the transducers thereafter. Testing shall not commence immediately after the transducers have been positioned/adjusted. The sound opening of an earphone shall face the ear canal entrance. The bone vibrator shall be positioned so that the largest possible area of the tip is in contact with the skull. If placed on the mastoid, the vibrator shall be positioned behind and as near as possible to the pinna, without touching it.

6 Air conduction hearing threshold level determinations using fixed-frequency audiometry

6.1 General

The audiometric test may be carried out using a manual audiometer, an automatic recording audiometer or a computer-controlled audiometer. The procedures are described in 6.2, 6.3 and 6.4.

The order of presentation of test tones when the audiometer settings are performed manually shall be from 1 000 Hz upwards, followed by the lower frequency range, in descending order. A repeat test shall be carried out at 1 000 Hz on the ear tested first.

Vibrotactile sensations may occur at low frequencies and high hearing levels; care, therefore, shall be taken that such sensations are not misinterpreted as hearing sensations.

Preferably, automatic recording and computer controlled audiometers should present test tones in the same sequence as in manual audiometry.

6.2 Manually controlled threshold determination

6.2.1 Presentation and interruption of test tones

The test tone shall be continuous and presented for a duration of 1 s to 2 s. When a response occurs, the interval between tone presentations shall be varied but shall not be shorter than the test tone duration. Unless otherwise stated, reference to tone presentation throughout this part of ISO 8253 refers to this method.

NOTE — Automatically pulsed tones are sometimes used as an alternative stimulus. However, correlative data are not currently available. The use of such stimulus should be noted on the audiogram.

6.2.2 Initial familiarization

The test subject shall be familiarized with the task prior to threshold determination by presenting a signal of sufficient intensity to evoke a definite response. By using the familiarization step, the tester can be sure that the test subject understands and can perform the response task.

NOTE — The following method of familiarization can be used:

a) present a tone of 1 000 Hz at a hearing level which is clearly audible, for example 40 dB for a normal hearing test subject;

b) reduce the level of the tone in steps of 20 dB until no response occurs;

c) increase the level of the tone in steps of 10 dB until a response occurs;

d) present the tone again at the same level.

If the responses are consistent with the tone presentation, the familiarization is completed. If not, it should be repeated. After a second failure, the instructions should be repeated.

In cases of profound deafness, these procedures may not be applicable.

6.2.3 Hearing threshold level measurements with and without masking

In 6.2.3.1, test procedures are outlined for those tests in which masking noise is not applied to the non-test ear. In 6.2.3.2, procedures are outlined for tests with masking. The method for calculating hearing threshold level is given in 6.2.4.

6.2.3.1 Procedures for testing without masking

Two audiometric test procedures with a manual audiometer are specified: a bracketing and an ascending method. These methods differ only in the sequence of the levels of the test tones presented to the test subject.

In the ascending method, present consecutive test tones having ascending levels until a response occurs.

In the bracketing method, present consecutive test tones having ascending levels until a response occurs, after which present test tones having levels in a descending sequence.

When properly carried out, both methods will result in substantially the same hearing threshold levels.

Measurements using the ascending method differ from those of the bracketing method only in step 2 of the measurements presented below.

Step 1

Present the first test tone at a level which is 10 dB below the lowest level of the test subject's response during the familiarization session. After each failure to respond to a test tone, increase the level of the test tone in steps of 5 dB until a response occurs.

Step 2

Ascending method

After the response, decrease the level in steps of 10 dB until no response occurs and then begin another ascent. Continue until three responses occur at the same level out of a maximum of five ascents.

If, using the ascending method, less than three responses out of five ascents (or less than two responses out of three ascents in the shortened method) have been obtained at the same level, present a test tone at a level 10 dB higher than the level of the last response. Then repeat the test procedure.

A shortened version of the ascending method has been shown to yield nearly equivalent results and may be appropriate in some cases. In this shortened version, continue the testing until at least two responses occur at the same level out of three ascents.

Bracketing method

After the response, increase the level of the test tone by 5 dB and begin a descent in which the level of the tone is decreased in steps of 5 dB until no response occurs. Then decrease the level of the test tone another 5 dB and begin the next ascent at this level. This should be continued until three ascents and three descents have been completed.

Shortened versions of the bracketing method may be appropriate in some cases. This consists of omitting the further descent of 5 dB after no response occurred or requiring only two ascents and two descents in series provided that the four minimal response levels differ by no more than 5 dB.

Step 3

Proceed to the next test frequency at an estimated audible level, as indicated by the previous responses, and repeat step 2. Finish all test frequencies on one ear.

NOTE — For any frequency, the familiarization, or an abbreviated form of it, may be repeated.

Finally, repeat the measurement at 1 000 Hz. If the results at 1 000 Hz of the repeat measurement for that ear agree to 5 dB or less with those of the first measurements for the same ear, proceed to the other ear. If 10 dB or more improvement in hearing threshold level is discernible, retest at further frequencies in the same order until agreement to 5 dB or less has been obtained.

Step 4

Proceed until both ears have been tested.

6.2.3.2 Procedures for testing with masking

To avoid the test tone being heard in the ear not under test, it may be necessary to apply masking noise to that ear. For the procedure described below, the masking noise signal is delivered by means of the supra-aural earphone.

Although experience will, to a large extent, dictate the procedures used and the choice of the masking noise level, the following procedure is recommended to determine the hearing threshold level with masking.

Step 1

Present a test tone to the ear being tested at a level equal to the hearing threshold level without masking. Present masking noise to the ear not under test with an effective masking level equal to the hearing threshold level of the ear not under test. Increase the level until the test tone is inaudible or until it exceeds the test tone level.

Step 2

If the tone is still audible when the noise level equals the test tone level, assume this to be the hearing threshold level. If the tone is masked, increase its level until it becomes audible again.

Step 3

Increase the noise level by 5 dB. If the test tone is inaudible, increase the test tone level until the tone becomes audible again. Repeat this procedure until the test tone remains audible although the level of the masking noise has been increased by more than 10 dB. This masking level — that is the level above which no further increase in the tone level was required for its audibility — is the correct masking level and this procedure should have produced the correct hearing threshold level for that test frequency. Note the correct masking level.

NOTES

1 This is the plateau-seeking method. In some cases where the plateau is short, the above procedure may give false results.

2 The masking noise may also mask the test tone in the ear being tested. This phenomenon, called overmasking, may be reduced by presenting the masking noise using an appropriate insert earphone. At present, no calibration standard exists for insert earphones.

6.2.4 Calculation of hearing threshold level

The hearing threshold levels for each frequency and ear shall be determined in accordance with the following procedures, depending upon the measurement method used.

6.2.4.1 Determination when the ascending method has been used

For each frequency and ear, determine the lowest level at which responses occur in more than half of the ascents. This level is defined as the hearing threshold level.

NOTE — If the lowest response levels span more than 10 dB at a given frequency, the test should be considered of doubtful reliability and should be repeated. This should be noted on the audiogram.

6.2.4.2 Determination when the bracketing method has been used

For each frequency and ear, average the lowest levels at which responses occur in the ascents. Again, for each frequency and ear, average the lowest levels at which responses occur in the descents. Determine the mean value of the two averages obtained in this way for each frequency and ear. This mean value, rounded up to the nearest whole number in decibels, is taken as the hearing threshold level for that frequency and ear.

NOTE — If the lowest response levels in the ascents deviate by more than 10 dB among themselves and/or if the lowest response levels in the descents deviate by more than 10 dB among themselves, the test should be repeated.

6.3 Hearing threshold determination with an automatic recording audiometer

Automatic recording audiometers often have no masking facilities and this procedure is therefore limited to recommendations for air conduction audiometry and for cases where no masking is required.

6.3.1 Presentation of test tone

The test tone may be presented either pulsed or continuous. Pulsed tones are preferably used for threshold determination. When both pulsed and continuous tones are used, pulsed tones shall be presented first.

NOTES

1 Temporal characteristics of the pulsed tone are specified in IEC 645.

2 Continuous tones are used only for some specialized audiological purposes.

6.3.2 Familiarization

Prior to the hearing threshold level measurements, the following familiarization of the test subject with the test tones and response tasks shall be carried out:

a) start the attenuation system, but not necessarily the recording mechanism, at the first test frequency (1 000 Hz);

b) observe the test subject's performance — practice for 20 s to 30 s will indicate whether the test subject has understood the instructions; if so, start the recorder mechanism; if not, repeat the instructions.

6.3.3 Hearing threshold level measurements

After the recorder mechanism has been started, the test shall be continued until both ears have been tested once.

6.3.4 Calculation of hearing threshold level

The following procedure shall be applied to the results of the test:

a) ignore the first reversal following a change of frequency and any reversals associated with a trace excursion of 3 dB or less;

b) average the peaks and average the valleys of the tracing for a given frequency and ear;

c) determine the mean of the two averages obtained in b); this mean value, rounded up to the nearest whole number in decibels, is the hearing threshold level for that frequency and ear.

NOTES

1 An audiometric recording should be considered of doubtful reliability and should be repeated if either of the following conditions apply;

— less than six reversals remain after a);

— the peaks deviate by more than 10 dB among themselves and/or the valleys deviate by more than 10 dB among themselves.

2 When the trace excursions are regular, results very close to those obtained by the procedure given above may be obtained more simply by "visual averaging".

3 On average, a difference exists between hearing threshold levels determined by manual audiometry and those recorded by automatic audiometers. This difference is assumed in this part of ISO 8253 to be 3 dB, the hearing threshold level values determined by automatic audiometers being lower than those determined by manual audiometry using 5 dB steps.

6.4 Computer-controlled threshold determination

The programming and operation of computer-controlled audiometric equipment shall be in such a way that results are equivalent to those obtained by the methods described in this part of ISO 8253.

7 Air conduction hearing threshold level determinations using sweep-frequency audiometry

7.1 General

In sweep-frequency audiometry, the frequency range is swept automatically at a given rate of change which is normally logarithmic. The normal sweep direction is from low to high but also the reverse direction may be applicable.

Sweep-frequency audiometers often have no masking facilities and this procedure is therefore limited to recommendations for air conduction audiometry and for cases where no masking is required.

7.2 Presentation of test tone

The test tone may be presented either pulsed or continuous. Pulsed tones are preferably used for threshold determination. When both pulsed and continuous tones are used, pulsed tones shall be presented first.

7.3 Familiarization

Prior to hearing threshold level measurements, the following familiarization of the subject with the test tones and response tasks shall be carried out:

a) start the attenuation system, but not the recording mechanism, at the lowest frequency required;

b) observe the subject's performance — practice for 20 s to 30 s will indicate whether the subject has understood the instructions; if so, start the recorder mechanism; if not, repeat the instructions.

7.4 Hearing threshold level measurement

After the recording mechanism has been started, the test shall be continued until both ears have been tested.

7.5 Calculation of hearing threshold level at a specified frequency

For a specified frequency, the hearing threshold level is determined by averaging from the tracing the three peaks and averaging the three valleys closest to the frequency in question. The mean of these two averages, rounded to the nearest whole number in decibels, is the hearing threshold level for that frequency and ear.

The hearing threshold level may be determined as a semi-continuous function of frequency by forming a running average of three consecutive pairs of peaks and valleys. The arithmetic mean of these six level values is the hearing threshold level for a frequency equal to the geometric mean value for the six frequencies at which these peaks and valleys occur.

NOTES

1 If the three peaks and/or the valleys used to obtain an average deviate by more than 10 dB among themselves, the threshold determination is less reliable.

2 When trace excursions are regular, results very close to those produced by the method above may be obtained by forming the simple average of each peak-valley pair and each valley-peak pair, or simply by "visual averaging".

8 Bone conduction hearing threshold audiometry

8.1 Method of audiometry

Hearing threshold levels for air conduction depend to a certain extent on the audiometric test method. This aspect has not been systematically investigated for bone conduction audiometry. Therefore no quantitative adjustments for different techniques (manual or automatic recording) are recommended at this time for bone conduction audiometry. The same procedures for air and bone conduction audiometry shall be used.

For precise monaural hearing threshold level determination, bone conduction audiometry requires masking of the ear not under test at all levels.

NOTE — Where a precise monaural bone conduction hearing threshold is not required, bone conduction audiometry may be undertaken without masking.

8.2 Occlusion

The ear being tested by bone conduction should be unoccluded. If the ear is occluded (see note 1 in 8.3), it shall be noted on the audiogram.

8.3 Airborne sound radiation from the bone vibrator

Any airborne sound which the bone vibrator radiates when in contact with the head of a test person having unimpaired outer and middle ear function should be low enough in level to provide a sufficient margin between the true bone conduction hearing threshold level and a false air conduction hearing threshold level evoked by the bone vibrator.