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Acoustics — Audiometric test methods —

Part 3:
Speech audiometry

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Acoustique — Méthodes d'essais audiométriques —

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International Organization for Standardization
 Case postale 56 • CH-1211 Genève 20 • Switzerland
 Internet central@isocs.iso.ch
 X.400 c=ch; a=400net; p=iso; o=isocs; s=central

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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 voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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International Standard ISO 8253-3 was prepared by Technical Committee ISO/TC 43, *Acoustics*.

ISO 8253 consists 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 test signals*
- *Part 3: Speech audiometry*

Annexes A and B of this part of ISO 8253 are for information only.

Introduction

Speech audiometry is used in connection with diagnostic evaluation, audiological rehabilitation and the evaluation of hearing disability. The purpose of a particular test is to assist in the choice of speech test material and mode of presentation.

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Acoustics — Audiometric test methods —

Part 3: Speech audiometry

1 Scope

This part of ISO 8253 specifies procedures and requirements for speech audiometry with the recorded test material being presented by air conduction through an earphone, by bone conduction through a bone vibrator, or from a loudspeaker for sound field audiometry. Methods for using noise either for masking the non-test ear or as a competing sound are described. All test procedures are based on the use of open-set test material.

This part of ISO 8253 also contains requirements on recorded speech material and recommended procedures for the maintenance and calibration of speech audiometric equipment.

Some test subjects, for example children, may require amended test procedures not specified in this part of ISO 8253.

It is recognized that standards for speech audiometry cannot be met using live voice speech tests, however, guidance is given in an informative annex so as to make such tests as reliable as possible.

This part of ISO 8253 does not specify the contents of the speech material because of the variety of languages. The type of test material may significantly influence the result of speech audiometry.

Specialized tests such as those used for evaluating directional hearing and dichotic hearing are not included in this part of ISO 8253.

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 266:—¹⁾, *Acoustics — Preferred frequencies*.

ISO 8253-1:1989, *Acoustics — Audiometric test methods — Part 1: Basic pure tone air and bone conduction threshold audiometry*.

ISO 8253-2:1992, *Acoustics — Audiometric test methods — Part 2: Sound field audiometry with pure tone and narrow band test signals*.

IEC 645-1:1992, *Audiometers — Part 1: Pure-tone audiometers*.

IEC 645-2:1993, *Audiometers — Part 2: Equipment for speech audiometry*.

1) To be published. (Revision of ISO 266:1975)

3 Definitions

For the purposes of this part of ISO 8253, the definitions given in ISO 8253-1 and ISO 8253-2 and the following definitions apply.

- 3.1 air-conduction:** Transmission of sound through the external and middle ear to the inner ear.
- 3.2 bone-conduction:** Transmission of sound to the inner ear primarily by means of mechanical vibration of the cranial bones.
- 3.3 otologically normal person:** 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, who has no history of undue exposure to noise, to potentially ototoxic drugs, or of familial hearing loss.
- 3.4 free sound field:** Sound field where the boundaries of the room exert a negligible effect on the sound waves.
- 3.5 quasi-free sound field:** Sound field where the boundaries of the room exert only a moderate effect on the sound waves, and which fulfills the requirements specified in subclause 5.3 of ISO 8253-2:1992.
- 3.6 diffuse sound field:** Sound field which in a given region has statistically uniform energy density, for which the directions of propagation at any point are randomly distributed.
- 3.7 reference point:** For sound field audiometry, the midpoint of a straight line connecting the listener's ear canal openings in the listening position in the sound field.
- 3.8 speech signal:** Test signal generated by a natural human or synthetic voice.
- 3.9 speech level:** Sound pressure level or vibratory force level of the speech signal as measured in an appropriate coupler, artificial ear or in a sound field with specified frequency weighting and specified time weighting.

NOTES

1 For example, the speech level may be expressed as the equivalent continuous sound pressure level or vibratory force level determined by integration over the duration of the speech signal with frequency weighting C. For speech test lists based on single test items separated by silent intervals, the integration should not include these intervals. For test lists based on single test items with carrier phrase, the integration should include the test items only.

2 For lists of single test items, the equivalent continuous sound pressure level may be estimated by subtracting 5 dB from the average of the maximum measured sound pressure levels using frequency weighting C and time weighting I.

3.10 speech detection threshold level: For a given test subject, a specified speech signal and a specified manner of signal presentation, the speech level of the test material at which it is detected (not understood) in a specified percentage of the trials, usually 50 %.

NOTE — Speech detection threshold has been called "speech awareness threshold".

3.11 speech recognition score: For a given test subject, a specified speech signal, a specified manner of signal presentation and at a specified speech level, the percentage of correctly recognized test items or scorable items if the scoring method is not based on whole test items.

NOTE — Speech recognition score has been called "speech discrimination score".

NOTE — Speech recognition score has been called “speech discrimination score”.

3.12 maximum speech recognition score: For a given test subject, a specified speech signal and a specified manner of signal presentation, the maximum speech recognition score obtained regardless of speech level.

NOTE — The difference between 100 % and the maximum speech recognition score is the speech recognition loss, which has been called “speech discrimination loss”.

3.13 speech recognition threshold level: For a given test subject, a specified speech signal and a specified manner of signal presentation, the lowest speech level at which the speech recognition score is equal to 50 %.

NOTE — Speech recognition threshold has been called “speech reception threshold”.

3.14 reference speech recognition threshold level: For a specified speech signal and a specified manner of signal presentation, the median value of the speech recognition threshold level of a sufficiently large number of otologically normal persons, of both sexes, between 18 and 25 years inclusive and for whom the test material is appropriate.

3.15 optimum speech level: For a given test subject, a specified speech signal and a specified manner of signal presentation, the speech level(s) at which maximum speech recognition score is obtained.

3.16 half-optimum speech level: For a given test subject, for a specified speech signal and a specified manner of signal presentation, the speech level at which half of the maximum speech recognition score is obtained and which is lower than the optimum speech level(s).

NOTE — Half-optimum speech level has been called “half-peak level”.

3.17 speech recognition curve: For a specified speech signal and a specified manner of presentation, a curve that describes for an individual test subject the speech recognition score as a function of speech level.

NOTE — The speech recognition curve has been called the “articulation function”.

3.18 reference speech recognition curve: For a specified speech signal and a specified manner of presentation, a curve that describes the median speech recognition score as a function of speech level for a sufficiently large number of otologically normal persons of both sexes, aged between 18 and 25 years inclusive and for whom the test material is appropriate.

NOTE — The choice of method of calculating the reference speech recognition curve from individual sets of data may affect the curve.

3.19 hearing level for speech: For a specified speech signal and a specified manner of signal presentation, the speech level minus the appropriate reference speech recognition threshold level.

3.20 competing sound level: Sound pressure level or vibratory force level of a competing sound as measured with specified frequency weighting and specified time weighting in an appropriate coupler, artificial ear or in a sound field.

3.21 speech-to-noise level difference: Difference in level between speech and competing sound as measured using identical weightings according to 3.9 and 3.20, respectively.

NOTE — This is often called “speech-to-noise ratio”. This term is used in this part of ISO 8253.

3.22 masking: Process by which the hearing threshold of a given ear for a particular sound is raised by the presence of another (masking) sound.

NOTE — Quantitatively, the effect of masking on speech is the amount, expressed in decibels, by which the speech recognition threshold level of a given ear is raised.

3.23 effective masking level for speech: Level of a specified masking sound which is numerically equal to that hearing level for speech to which the speech recognition threshold level for a specified speech signal for a notional normal person would be raised by the presence of that masking sound.

NOTE — The so-called notional normal person is one whose hearing conforms to the standards for threshold and for masking efficiency (ISO 389 and ISO 389-4).

3.24 most comfortable level for speech: For a given test subject and a specified manner of presentation, the speech level at which the loudness of the speech signal is judged by the test subject to be the most comfortable.

3.25 connected speech: Continuous speech with natural intonation, consisting of consecutive sentences with logical connections.

NOTE — Connected speech has been called “running speech”.

3.26 spondee: Two-syllable word with equal stress on each syllable.

3.27 logatom: Monosyllabic or polysyllabic unit that has no verbal meaning to the listener.

NOTE — A logatom is sometimes called a “nonsense syllable”.

3.28 test item: A particular monosyllabic or polysyllabic word or logatom, or time-limited segment of connected speech, used in accordance with defined rules of presentation and scoring in a speech audiometric procedure.

NOTE — Scoring may be based on a complete test item or parts thereof being correctly recognized.

3.29 test list: A number of selected test items, presented and scored as a single unit.

3.30 set of test items: A selected number, at least 10, of test items from a test list.

3.31 phonemically balanced test list: Test list which contains approximately the same proportions of the various phonemes as are present in typical speech communication within a given language.

NOTE — The adjective “phonetically balanced” has also been used.

3.32 carrier phrase: Sentence or phrase in which a test item is embedded such that the correct recognition of the test item is not dependent upon the context or meaning of the sentence or phrase.

3.33 open-set test material: Set of test items in which the number of alternative responses to each test item is unlimited.

4 Requirements for recorded speech material

4.1 Scope of the recording

Each copy of the recording shall contain the following signals:

- a) the speech test material;
- b) a signal for the calibration of the speech audiometer, of a duration not less than 60 s; the calibration signal shall be a weighted random noise, e.g. as specified in IEC 645-2:1993, subclause 13.1, a band of noise centred at 1 kHz and having a bandwidth of one-third octave or a frequency-modulated tone at 1 kHz having a bandwidth of at least one-third octave; the modulating signal shall be either sinusoidal or triangular with a repetition rate in the range from 4 Hz to 20 Hz;
- c) signals for testing the frequency response of the speech audiometer including the playback equipment and the recording; such signals shall have a duration of not less than 15 s and consist of one-third-octave bands of white noise centred at the preferred one-third octave frequencies in accordance with ISO 266 in the frequency range 125 Hz to 8 000 Hz;
- d) signals for testing the harmonic distortion of the speech audiometer; pure tones of frequencies 250 Hz, 500 Hz and 1 000 Hz shall be available with a duration of not less than 60 s each and a peak level corresponding to the highest peak level of the recorded speech test material.

NOTE — A signal according to subclause 15.1 may be included in the recording to be used as a competing sound.

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4.2 Levels

4.2.1 Speech test material

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The level of the speech test material shall meet one of the following two requirements.

a) Equal speech level method

The average speech level of the smallest set of test items to be used at a predetermined sound pressure level shall not deviate by more than ± 1 dB from the average of all test items within the list. The speech level of any single test item shall not deviate by more than ± 3 dB from the average level of all test items of a list. The average speech level of test lists shall not differ from the average level of all test items recorded by more than ± 1 dB.

b) Equal reference speech recognition threshold level method

The average reference speech recognition threshold level of the smallest set of test items to be used at a predetermined sound pressure level shall not deviate by more than ± 1 dB from the average of all test items within the list. The reference speech recognition threshold level of any single test item shall not deviate by more than ± 3 dB from the average of all test items of the list. The average speech recognition threshold level of test lists shall not differ from the average level of all test items recorded by more than ± 1 dB.

4.2.2 Calibration signal

The level of the calibration signal shall meet one of the following two requirements.

a) Equal speech level method.

The level of the calibration signal shall not deviate by more than $\pm 0,5$ dB from the average level of all test items as measured in accordance with 4.2.1 a). The level of the calibration signal shall be measured using the same frequency and time weightings as when measuring the speech level.

b) Equal reference speech recognition threshold level method

The level of the calibration signal in relation to the reference speech recognition threshold level shall be as specified by the manufacturer with a tolerance of $-0,5$ dB.

4.3 Signal-to-noise ratio

The level of any inherent background noise on the recording shall be at least 40 dB below the level of the calibration signal in accordance with 4.2.2 as measured using the same frequency and time weighting as when measuring the speech level.

4.4 Test room

The room in which the speech is recorded shall be sufficiently quiet to provide a speech-to-noise ratio of at least 40 dB and shall have a reverberation time of less than 0,5 s at any frequency in the range from 125 Hz to 8 000 Hz.

4.5 Frequency response of recording equipment

The frequency response of the recording equipment including the microphone used shall be flat within -2 dB in the frequency range from 125 Hz to 8 000 Hz.

NOTE — The quality of the recording and negligible loss of quality after repeated use make digital recordings superior.

4.6 Interval between successive test items

The intervals between the successive test items shall be constant within -10 %.

NOTE — For single test words, an interval of not less than 4 s is suggested.

4.7 Documentation

Each copy of the recording shall be supplied with documentation containing the following information:

- a) a printed version of the recorded speech material;
- b) the method(s) of scoring;
- c) the reference speech recognition curves for monaural and binaural listening conditions for each kind of test material recorded and for each method of scoring, including measures of variation; the origin of the reference curves and details of measuring conditions (e.g. number, range of age and range of hearing threshold levels of test subjects and type of equipment for speech audiometry used);
- d) the durations, frequency spectra and relative levels of the calibration signal and other recorded signals for the purpose of testing performance specifications in accordance with 4.1 b), c) and d);
- e) the speech level of each test item relative to a common reference level when the level of the speech test material is adjusted according to the equal speech recognition threshold level method;

- f) the level of the calibration signal and its relationship to the reference speech recognition threshold level when the level of the speech test material is adjusted according to the equal speech recognition threshold level method;
- g) the intervals between successive test items;
- h) the frequency and time weightings used to measure the speech level.

5 Speech signal level

The level of a speech signal shall be expressed in terms of either speech level or hearing level for speech for the particular test material being used. See IEC 645-2:1993, clause 9.

6 Masking noise level

IEC 645-2:1993, clause 13, specifies the reference conditions for the masking noise. The effective masking level for speech by a masking sound having a certain frequency spectrum and sound pressure level depends on the characteristics of the speech signal. Therefore, generally valid effective masking levels cannot be specified.

7 Ambient sound pressure levels in test room

The ambient sound pressure levels in the test room shall not mask the speech signals. The requirements for the 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.

NOTE — Requirements for ambient noise during speech audiometry are 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, the room 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. Maximum permissible ambient sound pressure levels for pure tone audiometry in the frequency range from 125 Hz to 8 000 Hz, are specified in ISO 8253-1 using earphones and bone vibrator's and in ISO 8253-2 for sound field audiometry.

8 Sound field speech audiometry

Sound field speech audiometry can be performed with and without competing sound reproduced especially for the purpose of the test.

The recommended position of the speech loudspeaker is frontal to the listener at an angle of incidence of 0°. If the speech audiometric results from an individual test subject are to be compared with the reference speech recognition threshold level or the reference speech recognition curve, respectively, the position of the speech loudspeaker shall be identical to that used for the determination of the reference values.

If noise is to be presented as a competing sound to the speech signal, the recommended positions of the noise loudspeakers are given in 15.2.

The type of sound field (free, quasi-free or diffuse), as specified in ISO 8253-2:1992, clause 5, and the position of the reference point shall be specified.