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Ergonomics — Accessible design — Sound pressure levels of spoken announcements for products and public address systems

Ergonomie — Conception accessible — Niveaux de pression acoustique des annonces vocales pour les produits et systèmes de sonorisation

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 159, *Ergonomics*, Subcommittee SC 5, *Ergonomics of the physical environment.*

Introduction

Today, people conduct their daily lives along with spoken announcements from various products such as home electrical appliances, information and telecommunication products, office-automation equipment, heating equipment, toys, sanitary equipment, and health care products. Some products use spoken announcements to provide instructions in indoor and outdoor public areas such as ticket vending machines, elevators, and escalators. Public address systems are often installed to provide spoken announcements. Such announcements can be indistinct to listeners because of hearing loss that can occur with ageing or because of ambient noise in the surroundings.

This International Standard specifies methods for determining an appropriate sound level range of spoken announcements so that all listeners, including people with age-related hearing loss, can hear them properly against ambient noises. This sound level range specification was determined based on results of experiments in which people of different ages participated. Spoken announcements for which sound pressure levels are within the range specified in this International Standard are expected to be audible and comfortably loud for most users in the presence of ambient noise.

This International Standard is intended to be applied as necessary to products depending on the product type and its conditions of use. It does not apply to spoken announcements used for evacuation or emergency purposes.

ISO 9921 specifies recommended levels of speech-communication quality necessary for conveying comprehensive messages in different applications. Therefore, ISO 9921 differs from this International Standard.

This International Standard adopts the principles of accessible design from ISO/IEC Guide 71, which are amplified in ISO/TR 22411.

Ergonomics — Accessible design — Sound pressure levels of spoken announcements for products and public address systems

1 Scope

This International Standard specifies methods to determine an appropriate sound pressure level range for spoken announcements in environments where ambient noise is less than 80 dB. The specified methods follow the concepts of ISO/IEC Guide 71 and includes consideration of older persons with decreased hearing ability to determine sound pressure levels of spoken announcements. The spoken speech levels that are specified in this International Standard are for products and public-address systems. To improve the accessibility and usability of products, spoken announcements must not only be audible but also presented at comfortable speech levels.

The target products that present spoken announcements are consumer products such as electronic home appliances, information and communication technology services, and products providing services for general users in public facilities indoors and outdoors such as train stations, airports, meeting rooms, amusement parks, and fairs.

This International Standard is not applicable to products providing private information such as automated teller machines in public spaces.

This International Standard is applicable when a loudspeaker producing a spoken announcement is located a short distance from the user in an environment where the sound pressure level with a standard frequency weighting A of ambient noise does not exceed 80 dB. This International Standard is applicable to spoken announcements that are audible to persons with normal hearing for their age when presented by a target product under quiet and anechoic conditions. This International Standard is applicable for both recorded voice and synthetic speech announcements.

This International Standard does not specify sound pressure levels of spoken announcements for systems with automatic sound pressure level control to compensate for fluctuating ambient noise levels. This International Standard is not applicable to spoken announcements heard through headphones or earphones, or to spoken announcements heard with the ear close to the speech sound source, such as in ear speakers specified in IEC 60268-7. This International Standard considers only the audibility of speech and not the process of speech understanding.

This International Standard does not specify the sound pressure levels of spoken announcements presented in emergency situations such as signals for fire alarms, gas leakage, and crime prevention; those are covered in ISO 7240-16 and ISO 7240-19. This International Standard does not specify the sound pressure levels of spoken announcements in automobiles; those are covered in ISO 15006.

NOTE 1 A spoken announcement presented in a repetitive manner from a product such as electronic home appliance is presumed to be heard as an auditory sign but not as a message and is therefore usable with a lower sound pressure level of the spoken announcement than this International Standard specifies.

NOTE 2 It is known that the word recognition performance of native speakers of the language of the announcement is better than that of non-native speakers.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 389-1, *Acoustics — Reference zero for the calibration of audiometric equipment — Part 1: Reference equivalent threshold sound pressure levels for pure tones and supra-aural earphones*

ISO 1996-1, *Acoustics — Description, measurement and assessment of environmental noise — Part 1: Basic quantities and assessment procedures*

ISO 3382-2:2008, *Acoustics — Measurement of room acoustic parameters — Part 2: Reverberation time in ordinary rooms*

ISO 8253-1, *Acoustics — Audiometric test methods — Part 1: Pure-tone air and bone conduction audiometry*

IEC 60050-801, *International Electrotechnical Vocabulary — Chapter 801: Acoustics and electroacoustics*

IEC 60268-16, *Sound system equipment — Part 16: Objective rating of speech intelligibility by speech transmission index*

IEC 61260, *Electroacoustics — Octave-band and fractional-octave-band filters*

IEC 61672-1, *Electroacoustics — Sound level meters — Part 1: Specifications*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-801, IEC 60268-16, and the following apply.

3.1
spoken announcement
message presented by a live human voice, a synthesized voice, or a recorded/digitized human voice

3.2
ambient noise
sound other than the sound to be measured as a signal

Note 1 to entry: For this International Standard, spoken announcements are regarded as signals.

3.3
speech transmission channel
acoustic and/or electro-acoustic signal path between a source of a signal and a user

3.4
speech transmission index
STI
metric with values 0 through 1 representing the transmission quality of speech with respect to speech intelligibility by a speech transmission channel

[SOURCE: IEC 60268-16]

3.5
simplified STI
metric with values 0 through 1 representing the transmission quality of speech with respect to speech intelligibility by a speech transmission channel calculated only with octave-band sound pressure level difference between the sound pressure level of spoken announcements and sound pressure level of ambient noise based on STI specified in IEC 60286-16

Note 1 to entry: Simplified STI does not account for effects of reverberation.

3.6
speech level
sound pressure level with a standard frequency weighting A or octave-band equivalent sound pressure level of a spoken announcement

3.7
signal-to-noise ratio
S/N
sound pressure level of a signal measured relative to ambient noise

3.8
minimum speech level
speech level with a standard frequency weighting A at which a listener can achieve audibility

3.9
maximum speech level
speech level with a standard frequency weighting A at which half of the listeners feel that the spoken announcement is too loud

3.10
audibility
extent to which the words of spoken announcements are recognizable by listeners

3.11
hearing threshold level
HTL
sound pressure level of a sound at which a person gives a predetermined percentage of correct detection responses on repeated trials minus the reference equivalent threshold sound pressure level

Note 1 to entry: It applies to a specified signal and specified manner of signal presentation under specified conditions according to ISO 8253-1. The reference equivalent threshold sound pressure level shall be in accordance with ISO 389-1.

3.12
pure tone average
PTA
average in decibels of hearing threshold levels of specified frequencies

3.13
reverberation time
T
duration required for the space-averaged sound energy density in an enclosure to decrease by 60 dB after the source emission has stopped

Note 1 to entry: The reverberation time is expressed in seconds.

4 Symbols

Symbols used in this International Standard are presented below.

$L_{N,A}$ sound pressure level of ambient noise with a standard frequency weighting A, in decibels, as measured using the method specified in Annex A

$L_{N,i}$ an octave-band sound pressure level of ambient noise in band *i*, in decibels, as measured using the method specified in Annex A

$L_{S,A}$ speech level with a standard frequency weighting A, in decibels, as measured using the method specified in Annex A

$L_{S,i}$ an octave-band sound pressure level of spoken announcements in band *i,* in decibels, as measured using the method specified in Annex A

T_i a transmission index of octave band *i*, presented as a metric rating between 0 and 1

I STI or simplified STI calculated as a weighted average of T_i from 125 Hz to 8 kHz octave bands

5 Range of sound pressure level of spoken announcements

5.1 General

This International Standard specifies the sound pressure level range of spoken announcements without consideration of reverberation and distance between a signal source and a listener.

The range of the sound pressure level of spoken announcements shall be determined with a minimum speech level and a maximum speech level. The minimum speech level for older users is higher than that for young users, as presented in Annex B. The minimum speech level shall be set to maintain the audibility of spoken announcements considering older listeners with otologically normal hearing for their age. The maximum speech level shall be set to avoid annoyance of listeners with the spoken announcement. Because of their greater hearing sensitivity in general, the speech level for younger adults is used to set the limit used in this International Standard because they are expected to perceive discomfort at lower levels than older adults.

Usually, a mean speech level is 55 dB to 75 dB at 1 m distance from a talker.[8]

When a spoken announcement with a fixed sound pressure level is used, the level shall be adjusted to fall between the minimum and the maximum speech levels, as calculated according to this International Standard.

When the sound level is controllable by users, the level shall be variable to cover a part of the specified range in this International Standard. Audible distortion of spoken announcement from a loudspeaker should be avoided to choose the speech level range for a product.

NOTE It is useful to indicate a speech level range determined by this International Standard at or around the volume control function using a device such as a volume knob, button, or slider.

The A-weighted sound pressure level method is the simplest method, but it has limitations. It shall not be applied in the case of noises that are predominantly low-frequency noises or when ambient noise has a dominant tonal component. In such cases, the effect of ambient noise will not be estimated correctly. The simplified STI method, which is based on STI specified in IEC 60286-16, is applicable for broadband noise both with and without dominant narrow band components. This method is more accurate than the A-weighted sound pressure level method.

NOTE 1 Under circumstances in which the required conditions for both methods listed above cannot be followed, the STI method described in Annex D according to IEC 60268–16 is useful.

NOTE 2 To ascertain the appropriate sound pressure level range of spoken announcements for a product, the level of noise that is typical in the operating environment of the product can be used.

5.2 Criteria to determine the speech level

The required speech level for comfortable listening to spoken announcement is 55 dB which minimizes listening difficulty for younger adults in quiet conditions.[9]

The required signal-to-noise ratio used to determine the minimum speech level for older adults can be estimated using information provided in Annex B. Typical older listeners require a 5 dB signal-to-noise ratio, which corresponds to an STI of 0,65, or better for the best understanding of a clearly spoken single word in an anechoic condition under ambient noise. The difference of required S/N improvement for older listeners from younger listeners is varied from 2 dB to 6 dB among languages. It depends on the PTA difference between younger and older listeners.

The maximum speech level shall be determined by following 5.4. Younger adults have better hearing sensitivity than older adults in general. Because they are expected to perceive discomfort at lower levels than older adults, the level for younger adults is used to set the limit used in this International Standard.

5.3 Relevant factors related to speech perception

Sound reflections are expected to have a detrimental effect on speech perception. A method of STI in IEC 60268-16, Annex L is the standardized method, by which one can predict the detrimental effect of sound reflections. This method uses reverberation time, room volume of the space and distance between a signal source, and a listener to predict STI. To adapt the criteria of STI 0,65 in a closed or a semi-closed space, relevant factors shall be considered when the space is reverberant and/or the quality of a spoken announcement is inferior.

Another factor is the effect of phonetic characteristics of speech for different languages. Annex B presents results of variation of a word recognition test conducted in six countries. The difference of mean scores between different languages for young listeners is approximately 5 dB.

For consumer products that present messages or instructions to users, users are assumed to be physically near the product at the time the messages or instructions are presented. For the simulation method of STI standardized in IEC 60268-16, Annex L, 2 m of distance between a signal source to the users will meet the criteria 0,65 of STI under a typical reverberant environment when the signal-to-noise ratio is 5 dB to 10 dB.

Figure 1 presents the typical relation between the signal-to-noise ratio and STI with distance of 2,0 m. At distances greater than 2 m, sound reflections might detrimentally affect speech transmission under reverberant conditions.

This International Standard shall be used for distances equal to or less than 2 m between a signal source and a listener. The record of measurement conditions and results shall be noted. Examples of the record of measurement conditions and results are presented in Annex C.

NOTE 1 In a free field, where reverberation does not exist, the source-receiver distance is highly variable. Reverberation need not be considered.

NOTE 2 The typical reverberation time of an elementary school classroom (dimensions: 8 m × 8 m × 3 m) is 0,45 s.