



JAPANESE
INDUSTRIAL
STANDARD

Translated and Published by
Japanese Standards Association

JIS T 8161-1 : 2020

(JSAA/JSA)

**Acoustics — Hearing protectors —
Part 1: Subjective method for the
measurement of sound attenuation**

ICS 13.340.20

Reference number : JIS T 8161-1 : 2020 (E)

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T 8161-1 : 2020

Date of Establishment: 2020-04-25

Date of Public Notice in Official Gazette: 2020-04-27

Investigated by: Japanese Industrial Standards Committee
Standards Board for ISO area
Technical Committee on Safety

JIS T 8161-1 : 2020, First English edition published in 2021-06

Translated and published by: Japanese Standards Association
Mita MT Building, 3-13-12, Mita, Minato-ku, Tokyo, 108-0073 JAPAN

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Contents

	Page
Introduction	1
1 Scope	1
2 Normative references	2
3 Terms and definitions	2
4 Measurement of the sound attenuation of hearing protectors	4
4.1 Test signals	4
4.2 Test site	4
4.3 Test equipment	6
4.4 Test subjects	7
4.5 General test procedure and instruction of the test subject	8
4.6 Determination of hearing protector attenuation	9
5 Application force	9
5.1 Earmuffs	9
5.2 Semi-aural earplugs	9
6 Test report	10
Annex A (normative) Uncertainty of hearing protector attenuation measurements	12
Annex B (informative) Evaluation of two hearing protector attenuation measurements	16
Annex C (informative) Minimum and maximum sound pressure levels for test signals	19
Bibliography	20
Annex JA (informative) Comparison table between JIS and corresponding International Standard	22

Foreword

This Japanese Industrial Standard has been established by the Minister of Health, Labour and Welfare and the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee according to the proposal for establishment of Japanese Industrial Standard submitted by Japan Safety Appliance Association (JSAA)/Japanese Standards Association (JSA) with a draft being attached, based on the provision of Article 12, paragraph (1) of the Industrial Standardization Act. This Standard partially replaces **JIS T 8161:1983**, which has been withdrawn.

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JIS T 8161 series consists of the following 2 parts under the general title *Acoustics — Hearing protectors —*:

Part 1: Subjective method for the measurement of sound attenuation

Part 2: Estimation of effective A-weighted sound pressure levels when hearing protectors are worn

Acoustics — Hearing protectors — Part 1 : Subjective method for the measurement of sound attenuation

Introduction

This Japanese Industrial Standard has been prepared based on **ISO 4869-1** : 2018, Edition 2, with some changes in the technical contents to increase convenience of use.

The dotted underlines indicate changes from the corresponding International Standard. A list of modifications with the explanations is given in Annex JA.

1 Scope

This Standard specifies a subjective method for measuring sound attenuation of hearing protectors at the threshold of hearing. This Standard is applicable to hearing protectors, including earplugs and earmuffs, that are commonly used to reduce the noise to which ear is exposed.

The method is a laboratory method designed to yield reproducible values under controlled measurement conditions. The values reflect the attenuating characteristics of the hearing protector only to the extent that users wear the device in the same manner as did the test subjects.

For a more representative indication of field performance the methods of **ISO/TS 4869-5** can be used.

This test method yields data which are collected at low sound pressure levels (close to the threshold of hearing) but which are also representative of the attenuation values of hearing protectors at higher sound pressure levels. An exception occurs in the case of amplitude-sensitive hearing protectors for sound pressure levels above the point at which their level-dependent characteristics become effective. At those sound pressure levels the method specified in this Standard is inapplicable.

NOTE 1 Due to masking from physiological noise in the occluded ear tests, sound attenuations below 500 Hz can be overestimated by a few decibels.

NOTE The International Standard corresponding to this Standard and the symbol of degree of correspondence are as follows.

ISO 4869-1 : 2018 *Acoustics — Hearing protectors — Part 1 : Subjective method for the measurement of sound attenuation* (MOD)

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standard and **JIS** are IDT (identical), MOD (modified), and NEQ (not equivalent) according to **ISO/IEC Guide 21-1**.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS C 1514 *Electroacoustics — Octave-band and fractional-octave-band filters*

NOTE Corresponding International Standard : IEC 61260-1 : 2014 *Electroacoustics — Octave-band and fractional-octave-band filters — Part 1 : Specifications*

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

IEC 60263 *Scales and sizes for plotting frequency characteristics and polar diagrams*

3 Terms and definitions

For the purpose of this Standard, the following terms and definitions apply.

3.1

hearing protector

device worn within the external earcanal or pinna, or covering a substantial part of the ear or head to protect the auditory organ from noise

NOTE In the previous edition, the term “ear protector” was used. Hearing protectors can include electronic devices for communication, and/or devices designed to play an active role in the reduction of the noise level between the hearing protector and the eardrum.

3.2

earmuff

hearing protector consisting of an ear-cup to be pressed against each pinna (supra-aural) or of an earcup to be pressed against the head, around the pinna (circumaural)

The ear-cups can be pressed against the head with a special headband or neck band or by means of a device attached to a safety helmet or other equipment.

3.3

earplug

hearing protector worn within the external earcanal (aural) or in the concha against the entrance to the external earcanal (semi-aural)

3.4

helmet

device which covers a substantial part of the head to absorb the impact energy in the event of an impact and protect the head from suffering severe head injury

3.5

hearing level

difference between the sound pressure level of this pure tone produced by the earphone in a specified acoustic coupler or ear simulator and the appropriate reference equivalent threshold sound pressure level at a specified frequency, for a specified type of earphone and for a specified manner of application

3.6

hearing threshold level

difference, expressed in decibels, between a person's threshold of hearing for a presented sound heard in one of or both ears and the corresponding reference threshold of hearing

3.7

threshold of hearing

lowest sound pressure level at which, under specified conditions, a person gives a correct detection responses

This ignores detection of sound from other sound source reaching either of the ears.

3.8

sound attenuation

difference in decibels between the threshold of hearing with and without the hearing protector in place for a test subject for a given test signal

3.9

pink noise

noise whose power spectral density is inversely proportional to frequency

3.10

reference point

fixed spatial position within the test chamber to which all objective measurements of the sound field characteristics are referenced and which coincides with the midpoint of a line connecting the test subject's earcanal openings when the test subject is seated for measurements

3.11

reverberation time

time required for the sound pressure level to decrease by 60 dB after the sound source has stopped

NOTE See **ISO 354** [1].

3.12

white noise

noise whose power spectral density is not essentially dependent on frequency

NOTE See **ANSI S12.6**.

4 Measurement of the sound attenuation of hearing protectors**4.1 Test signals**

The test signals shall consist of pink noise or white noise filtered through one-third-octave bands with centre frequencies in accordance with **JIS C 1514**. Tests shall be performed at the following centre frequencies :

125 Hz, 250 Hz, 500 Hz, 1 000 Hz, 2 000 Hz, 4 000 Hz and 8 000 Hz

4.2 Test site**4.2.1 General**

The sound field at the test site shall have sound incidence from many directions. Such a sound field is adequately approximated when the requirements of **4.2.2**, **4.2.3** and **4.2.4** are met. The measurements of the sound field shall be conducted with the test subject and the subject's chair absent.

4.2.2 Sound pressure level and sound pressure level variation

The sound pressure level and sound pressure level variation shall be as follows.

- a) The sound pressure level at all test frequencies measured with an omnidirectional microphone at positions 15 cm from the reference point on the front-back, right-left and up-down axes shall deviate by no more than ± 2.5 dB from the sound pressure level at the reference point. In addition, the difference between the right-left positions shall not exceed 3 dB. The orientation of the microphone shall be kept the same at each position.
- b) The directionality of the sound field shall be evaluated at the reference point for test signals with centre frequencies greater than or equal to 500 Hz. The measurements shall be conducted with a directional microphone with a typical free-field polar response at the one-third-octave test signals of at least 10 dB front-to-side rejection for a cosine microphone, or at least 10 dB front-to-back rejection for a cardioid microphone. The microphone shall be rotated at the reference point through 360° in the horizontal plane. The variation of the observed sound pressure levels in each test signal shall remain within the variation allowed in Table 1. The sound pressure levels can also be obtained by measuring at fixed 15 degree increments as the microphone is rotated.

**Table 1 Allowable variation of sound-field sound pressure levels for
cosine microphone or cardioid microphone**

Unit: dB

Front-to-side rejection or front-to-back rejection	Allowable field variation
25 or over	20
20 or over to and excl. 25	15
15 or over to and excl. 20	10
10 or over to and excl. 15	5
Under 10	Microphone not suitable
NOTE The variation in microphone response as the microphone is rotated in a random incidence field is related to the directional characteristics of the microphone and the degree of randomness of the field being measured. Therefore, the allowable sound field response variations are related to the free-field directional response characteristics of the microphone. The microphone characteristics can be obtained from the microphone manufacturer or by measurement in a free field.	

4.2.3 Reverberation time

The reverberation time in the test space, with the test subject and the test subject's chair absent, shall not exceed 1.6 s for each of the test signals.

4.2.4 Ambient noise level

The ambient noise level at the test site in the test room shall not exceed the values given in Table 2. The ambient noise level shall be determined by measuring the sound pressure level with the test subject absent.

NOTE The ambient noise level includes the noise present in the room and the possible noise from the test equipment while it is on and running, but in the absence of the test signals.

Table 2 Maximum permissible ambient noise level

Centre frequency Hz	One-third-octave band sound pressure level dB	Centre frequency Hz	One-third-octave band sound pressure level dB
63	25	1 000	1
80	21	1 250	1
100	18	1 600	2
125	14	2 000	2
160	11	2 500	1
200	9	3 150	−1
250	6	4 000	−4
315	4	5 000	−2
400	3	6 300	3
500	2	8 000	10
630	1	10 000	20
800	1		
NOTE The levels are set in relation to ISO 8253-1 for the purpose of testing down to −10 dB hearing threshold level.			

4.3 Test equipment

4.3.1 Test signal reproduction

The test equipment shall be capable of producing a test signal at the test site from 112 Hz to 9 000 Hz.

NOTE 112 Hz is the lower limiting frequency of the 125 Hz one-third-octave band and 9 000 Hz is the upper limiting frequency of the 8 000 Hz one-third-octave band.

The test equipment shall be able to generate test signal sound pressure levels at the reference point, for any test signal, that vary from at least 10 dB above the subject's occluded threshold of hearing to 10 dB below the subject's open threshold of hearing. An example is given in Annex C. The band levels shall be measured using filters complying with **JIS C 1514**. During the test, the sounds shall be reproduced without audible distortion, buzzing, crackle, or rattle. When the test equipment generates one-third-octave-band test signals at the maximum sound pressure levels (Annex C) the levels of the other one-third-octave bands shall be at least 40 dB down from the maximum level – at octave steps – from one octave below the test signal down to 63 Hz and from one octave above the test signal up to 16 kHz.

NOTE Due to internal noise restrictions in the sound pressure level measurement equipment, low sound pressure levels can be calculated on the basis of electrical measurements.

4.3.2 Attenuators

Attenuators shall have a range of at least 90 dB for each test signal. Attenuator steps shall be 2.5 dB or smaller.

4.3.3 Linearity of test signals