Australian Standard®

Acoustics—Expression of the subjective magnitude of sound or noise

Part 1: Pure tones, equal-loudness contours

This Australian Standard was prepared by Committee AV/1, Acoustics/ Vibration–Terms, Units and Symbols. It was approved on behalf of the Council of Standards Australia on 11 November 1988 and published on 12 May 1989.

The following interests are represented on Committee AV/1:

Audiological Society of Australia

Australian Acoustical Society

Australian Environment Council

Australian Institute of Physics

Confederation of Australian Industry

CSIRO, Division of Applied Physics

Department of Industrial Relations and Employment, N.S.W.

Monash University

Royal Australian Institute of Architects

Royal Melbourne Institute of Technology

University of Sydney

This Standard was issued in draft form for comment as DR 88057.

Australian Standard®

Acoustics—Expression of the subjective magnitude of sound or noise

Part 1: Pure tones, equal-loudness contours

First published as part of AS 1047—1971.
Revised and redesignated AS 3657.1—1989.

PUBLISHED BY STANDARDS AUSTRALIA
(STANDARDS ASSOCIATION OF AUSTRALIA)
1 THE CRESCENT, HOMEBUSH, NSW 2140
ISBN 0 7262 5475 4

PREFACE

This Standard was prepared by the Standards Australia Committee on Acoustics/ Vibration–Terms, Units and Symbols, to supersede (in part) AS 1047–1971, *Method for the expression of the physical and subjective magnitudes of sound or noise.* This Standard is based on ISO 226–1987, *Method for the expression of the physical and subjective magnitudes of sound or noise*.

Curves defining relations between frequencies of pure tones or narrow bands of noise and their sound pressure levels for the condition of constant loudness level (equal-loudness level contours) express a fundamental property of the human auditory system, and are of basic importance in the field of psychological acoustics.

In common with other subjective phenomena, loudness relations vary in detail from person to person, but, for a group of persons within a restricted age band and free from hearing impairments, a value for the central tendency can be determined to characterize the group. This Standard gives curves applicable to otologically normal persons in the age group of 18 years to 30 years inclusive.

The data specified in this Standard primarily relate to continuous pure tones heard under conditions of binaural listening in free progressive plane waves with the subject directly facing the source of sound (frontal incidence), and with the sound pressure level measured in the free progressive wave at the centre position of the listener's head, but with the listener absent. For other conditions of listening or other configurations of sound field, different relations exist between loudness level and sound pressure level. One example of another sound field configuration is a diffuse field. The relation between frontal incidence and diffuse field together with the resulting equal-loudness level function for narrow bands of noise in a diffuse sound field are specified in Appendix A of this Standard.

The hearing threshold may be considered as a special case of equal-loudness level, and the corresponding threshold sound pressure levels (minimum audible field (MAF)) are included in this Standard. It should be emphasized that the minimum audible field differs from the audiometric zero specified in AS 1591.2–1987, *Acoustics–Instrumentation for audiometry, Part 2: Reference zero for the calibration of pure-tone audiometers*, since that Standard is applicable to monaural listening through earphones with sound pressure levels referred to specified couplers and artificial ears. Direct comparison between the data in AS 1591.2 and in this Standard is therefore not appropriate.

CONTENTS

STANDARDS AUSTRALIA

Australian Standard
Acoustics—Expression of the subjective magnitude of sound or noise

Part 1: Pure tones, equal-loudness contours

1 SCOPE. This Standard specifies the relations existing, for the condition of equal-loudness level, between the sound pressure levels and frequencies of pure (sinusoidal) continuous tones in the following conditions:

(a) The source of sound is directly in front of the listener (frontal incidence).

(b) The sound field in the absence of the listener consists of a free progressive plane wave.

(c) The sound pressure level is measured in the free progressive plane wave in the absence of the listener.

(d) The listening is binaural.

(e) The conditions of equal-loudness level are determined by the modal value of the judgements of an adequately large group of listeners.

(f) The listeners are otologically normal persons in the age group from 18 years to 30 years inclusive.

The relations are expressed by means of an equation in bilinear form, with the sound pressure level as the independent variable and the loudness level as the dependent variable, for the preferred frequencies in the one-third octave series from 20 Hz to 12 500 Hz inclusive.

NOTES:

1. In accordance with convention, the reference dependent variable is taken to be the sound pressure level of a 1000 Hz tone, i.e. the loudness level, expressed in phons. However, the form of the equation remains unchanged (but with transformed coefficients) if the variables are interchanged or if a tone of another frequency in the preferred one-third octave series is taken as the reference.
2. The data in this Standard are approximately equal to equal-loudness level relations between narrow bands of random noise, not exceeding the auditory critical bandwidth.
3. Without extrapolation of the experimental data, the upper limit of the frequency range could not be extended to the next preferred frequency in the one-third octave series. For further information regarding the range 12 500 Hz to 15 000 Hz, see Ref. (1).

Graphical and short tabular presentations of the relations are given in Figure 1 and Tables 2 and 3.

Appendix A specifies the correction to be applied to obtain the equal-loudness level relations for narrow bands of random noise in a diffuse field and the resulting equal-loudness level function.

2 APPLICATION. This Standard is intended as a reference by persons concerned with the study of the human auditory system with respect to the relations between frequencies of pure tones or narrow bands of noise and their sound pressure levels for the condition of constant loudness level.

3 REFERENCED DOCUMENT. The following document is referred to in this Standard:

AS
1633 Acoustics—Glossary of terms and related symbols

4 DEFINITIONS. For the purpose of this Standard, the definitions given in AS 1633 and those below apply.

4.1 Loudness –that attribute of auditory sensation in terms of which sounds may be ordered on a scale extending from soft to loud.

4.2 Loudness level—of a given sound, the sound pressure level of a reference sound, consisting of a sinusoidal plane progressive wave of frequency 1000 Hz coming from directly in front of the listener, which is judged by otologically normal persons to be equally loud to the given sound.

NOTE: Loudness level is expressed in phons.

4.3 Equal-loudness level function—for a pure tone of given frequency or for a narrow band of noise of a given frequency band, the relation between loudness level, expressed in phons, and sound pressure level, expressed in decibels.

4.4 Equal-loudness level contour—a curve in the sound pressure level/frequency plane, connecting points the coordinates of which represent pure tones or narrow bands of noise judged equally loud.

4.5 Normal equal-loudness level function—the equal-loudness level function corresponding to the modal judgement of otologically normal persons within the age group of 18 years to 30 years inclusive.

4.6 Normal equal-loudness level contour—the equal-loudness level contour corresponding to the modal judgement of otologically normal persons within the age group from 18 years to 30 years inclusive.

4.7 Hearing threshold—the level of a sound at which, under specified conditions, a person gives 50% of correct detection responses on repeated trials.

4.8 Otologically normal person—a person in a normal state of health who is free from all signs or symptoms of ear disease and from excess wax in the ear canals, and who has no history of undue exposure to noise.

4.9 Minimum audible field (*MAF*)—at a specified frequency, the sound pressure level of a pure tone or a narrow band of noise corresponding to the modal value of the binaural hearing threshold of otologically normal persons within the age group of 18 years to 30 years inclusive.