INTERNATIONAL STANDARD

ISO 1996-1

Second edition
2003-08-01

Acoustics — Description, measurement and assessment of environmental noise —

Part 1: Basic quantities and assessment procedures

Acoustique — Description, mesurage et évaluation du bruit de l'environnement —

Partie 1: Grandeurs fondamentales et méthodes d'évaluation

Reference number
ISO 1996-1:2003(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 1996-1 was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 1, *Noise*.

This second edition of ISO 1996-1, together with the second edition of ISO 1996-2, cancels and replaces the first edition (ISO 1996-1:1982), and ISO 1996-2:1987, ISO 1996-2:1987/Amd.1:1998 and ISO 1996-3:1987.

ISO 1996 consists of the following parts, under the general title *Acoustics — Description, measurement and assessment of environmental noise*:

— *Part 1: Basic quantities and assessment procedures*

— *Part 2: Determination of sound pressure levels*

Introduction

To be of practical use, any method of description, measurement and assessment of environmental noise must be related in some way to what is known about human response to noise. Many adverse consequences of environmental noise increase with increasing noise, but the precise dose-response relationships involved continue to be the subject of scientific debate. In addition, it is important that all methods used should be practicable within the social, economic and political climate in which they are used. For these reasons, there is a very large range of different methods currently in use around the world for different types of noise, and this creates considerable difficulties for international comparison and understanding.

The broad aim of the ISO 1996 series is to contribute to the international harmonization of methods of description, measurement and assessment of environmental noise from all sources.

The methods and procedures described in this part of ISO 1996 are intended to be applicable to noise from various sources, individually or in combination, which contribute to the total exposure at a site. At the present stage of technology, the evaluation of long-term noise annoyance seems to be best met by adopting the adjusted A-weighted equivalent continuous sound pressure level which is termed a “rating level”.

The aim of the ISO 1996 series is to provide authorities with material for the description and assessment of noise in community environments. Based on the principles described in this part of ISO 1996, national standards, regulations and corresponding acceptable limits for noise can be developed.

Acoustics — Description, measurement and assessment of environmental noise —

Part 1: Basic quantities and assessment procedures

1 Scope

This part of ISO 1996 defines the basic quantities to be used for the description of noise in community environments and describes basic assessment procedures. It also specifies methods to assess environmental noise and gives guidance on predicting the potential annoyance response of a community to long-term exposure from various types of environmental noises. The sound sources can be separate or in various combinations. Application of the method to predict annoyance response is limited to areas where people reside and to related long-term land uses.

Community response to noise can vary differently among sound sources that are observed to have the same acoustic levels. This part of ISO 1996 describes adjustments for sounds that have different characteristics. The term “rating level” is used to describe physical sound predictions or measurements to which one or more adjustments have been added. On the basis of these rating levels, the long-term community response can be estimated.

The sounds are assessed either singly or in combination, allowing for consideration, when deemed necessary by responsible authorities, of the special characteristics of their impulsiveness, tonality and low-frequency content, and for the different characteristics of road traffic noise, other forms of transportation noise (such as aircraft noise) and industrial noise.

This part of ISO 1996 does not specify limits for environmental noise.

NOTE 1 In acoustics, several different physical measures describing sound can have their level expressed in decibels (e.g. sound pressure, maximum sound pressure, equivalent continuous sound pressure). The levels corresponding to these physical measures normally will differ for the same sound. This often leads to confusion. Therefore, it is necessary to specify the underlying physical quantity (e.g. sound pressure level, maximum sound pressure level, equivalent continuous sound pressure level).

NOTE 2 In this part of ISO 1996, quantities are expressed as levels in decibels. However, some countries validly express the underlying physical quantity, such as maximum sound pressure in pascals, or sound exposure in pascal-squared seconds.

NOTE 3 ISO 1996-2 deals with the determination of sound pressure levels.

2 Normative references

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

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

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1 Expression of levels

NOTE For levels defined in 3.1.1 to 3.1.6, frequency weighting or frequency bandwidth, as applicable, should be specified, and time-weighting, if applicable, should be specified.

3.1.1
time-weighted and frequency-weighted sound pressure level
ten times the logarithm to the base 10 of the square of the ratio of a given root-mean-square sound pressure to the reference sound pressure, being obtained with a standard frequency weighting and standard time weighting

NOTE 1 The reference sound pressure is 20 μPa.

NOTE 2 Sound pressure is expressed in pascals (Pa).

NOTE 3 The standard frequency weightings are A-weighting and C-weighting as specified in IEC 61672-1, and the standard time weightings are F-weighting and S-weighting as specified in IEC 61672-1.

NOTE 4 Time-weighted and frequency-weighted sound pressure level is expressed in decibels (dB).

3.1.2
maximum time-weighted and frequency-weighted sound pressure level
greatest time-weighted and frequency-weighted sound pressure level within a stated time interval

NOTE Maximum time-weighted and frequency-weighted sound pressure level is expressed in decibels (dB).

3.1.3
***N* percent exceedance level**
time-weighted and frequency-weighted sound pressure level that is exceeded for N % of the time interval considered

EXAMPLE $L_{AF95,1h}$ is the A-frequency-weighted, F-time-weighted sound pressure level exceeded for 95 % of 1 h.

NOTE The N percent exceedance level is expressed in decibels (dB).

1) Amalgamated revision of IEC 60651 and IEC 60804.

3.1.4
peak sound pressure level
ten times the logarithm to the base 10 of the ratio of the square of the peak sound pressure to the square of the reference sound pressure, where the peak sound pressure is the maximum absolute value of the instantaneous sound pressure during a stated time interval with a standard frequency weighting or measurement bandwidth

NOTE 1 Peak sound pressure level is expressed in decibels (dB).

NOTE 2 Peak sound pressure should be determined with a detector as defined in IEC 61672. IEC 61672 only specifies the accuracy of a detector using C-weighting.

3.1.5
sound exposure level
ten times the logarithm to the base 10 of the ratio of the sound exposure, E, to the reference sound exposure, E_0, the sound exposure being the time integral of the time-varying square of the frequency-weighted instantaneous sound pressure over a stated time interval, T, or an event

NOTE 1 E_0 is equal to the square of the reference sound pressure of 20 μPa multiplied by the time interval of 1 s [400 $(\mu Pa)^2 s$].

$$L_E = 10 \lg \left(\frac{E}{E_0} \right) \text{dB}$$

where

$$E = \int_T p^2(t)\,\mathrm{d}t \text{ dB}$$

NOTE 2 The sound exposure level is expressed in decibels (dB).

NOTE 3 The sound exposure is expressed in pascal-squared seconds ($Pa^2 s$).

NOTE 4 The duration, T, of the integration is included implicitly in the time integral and need not be reported explicitly. For measurements of sound exposure over a specified time interval, the duration of integration should be reported and the notation should be L_{ET}.

NOTE 5 For sound exposure levels of an event, the nature of the event should be stated.

3.1.6
equivalent continuous sound pressure level
ten times the logarithm to the base 10 of the ratio of the square of the root-mean-square sound pressure over a stated time interval to the square of the reference sound pressure, the sound pressure being obtained with a standard frequency weighting

NOTE 1 The A-weighted equivalent continuous sound pressure level is

$$L_{\mathrm{Aeq}\,T} = 10 \lg \left[\frac{1}{T} \int_T {p_\mathrm{A}}^2(t) / {p_0}^2 \mathrm{d}t \right] \text{dB}$$

where

$p_\mathrm{A}(t)$ is the A-weighted instantaneous sound pressure at running time t;

p_0 is the reference sound pressure (= 20 μPa).

NOTE 2 The equivalent continuous sound pressure level is expressed in decibels (dB).

NOTE 3 The equivalent continuous sound pressure level is also termed the “time-averaged sound pressure level”.

3.2 Time intervals

3.2.1
reference time interval
time interval to which the rating of the sound is referred

NOTE 1 The reference time interval may be specified in national or international standards or by local authorities to cover typical human activities and variations in the operation of sound sources. Reference time intervals may be, for example, part of a day, the full day, or a full week. Some countries may define even longer reference time intervals.

NOTE 2 Different levels or sets of levels may be specified for different reference time intervals.

3.2.2
long-term time interval
specified time interval over which the sound of a series of reference time intervals is averaged or assessed

NOTE 1 The long-term time interval is determined for the purpose of describing environmental noise as it is generally designated by responsible authorities.

NOTE 2 For long-term assessments and land use planning, long-term time intervals that represent some significant fraction of a year should be used (e.g. 3 months, 6 months, 1 year).

3.3 Ratings

3.3.1
adjustment
any quantity, positive or negative, constant or variable, that is added to a predicted or measured acoustical level to account for some sound character, the time of day, or the source type

3.3.2
rating level
any predicted or measured acoustic level to which an adjustment has been added

NOTE 1 Measurements like day/night sound pressure level or day/evening/night sound pressure level are examples of rating levels because they are calculated from sound measured or predicted over different reference time periods, and adjustments are added to the reference time interval equivalent continuous sound pressure levels based on the time of day.

NOTE 2 A rating level may be created by adding adjustments to a measured or predicted level(s) to account for some character of the sound such as tonality or impulsiveness.

NOTE 3 A rating level may be created by adding adjustments to a measured or predicted level(s) to account for differences between source types. For example, using road traffic as the base sound source, adjustments may be applied to the levels for aircraft or railway sources.

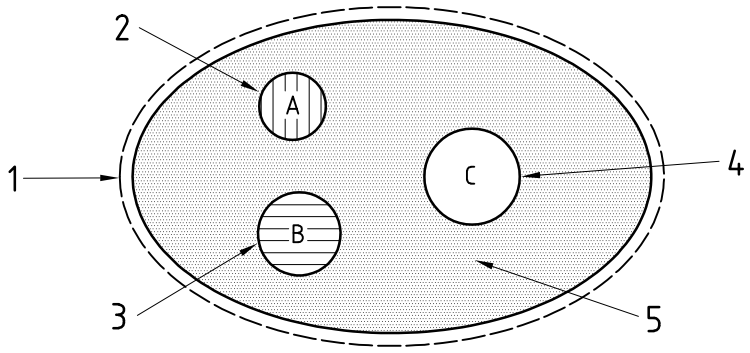
3.4 Sound designations

See Figure 1.

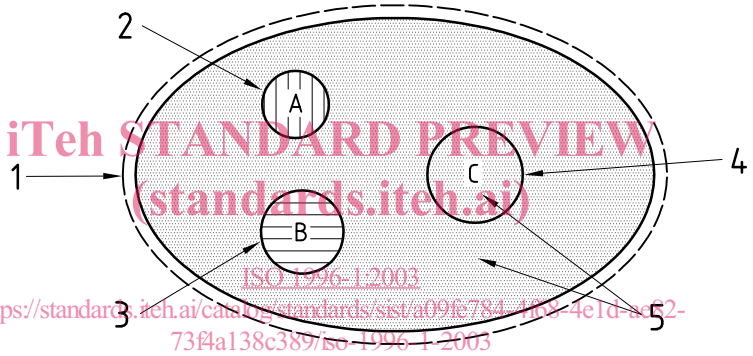
3.4.1
total sound
totally encompassing sound in a given situation at a given time, usually composed of sound from many sources near and far

3.4.2
specific sound
component of the total sound that can be specifically identified and which is associated with a specific source

3.4.3
residual sound
total sound remaining at a given position in a given situation when the specific sounds under consideration are suppressed



a) Three specific sounds under consideration, the residual sound and the total sound



b) Two specific sounds A and B under consideration, the residual sound and the total sound

Key

1 total sound
2 specific sound A
3 specific sound B
4 specific sound C
5 residual sound

NOTE 1 The lowest residual sound level is obtained when all specific sounds are suppressed.

NOTE 2 The dotted area indicates the residual sound when sounds A, B and C are suppressed.

NOTE 3 In b) the residual sound includes the specific sound C since it is not under consideration.

Figure 1 — Total, specific and residual sound designations

3.4.4
initial sound
total sound present in an initial situation before any change to the existing situation occurs

3.4.5
fluctuating sound
continuous sound whose sound pressure level varies significantly, but not in an impulsive manner, during the observation period

3.4.6
intermittent sound
sounds that are present at the observer only during certain time periods that occur at regular or irregular time intervals and are such that the duration of each such occurrence is more than about 5 s

EXAMPLES Motor vehicle noise under conditions of small traffic volume, train noise, aircraft noise and air-compressor noise.

3.4.7
sound emergence
increase in the total sound in a given situation that results from the introduction of some specific sound

3.4.8
impulsive sound
sound characterized by brief bursts of sound pressure

NOTE The duration of a single impulsive sound is usually less than 1 s.

3.4.9
tonal sound
sound characterized by a single frequency component or narrow-band components that emerge audibly from the total sound

3.5 Impulsive sound sources

NOTE Currently, no mathematical descriptor exists which can define unequivocally the presence of impulsive sound or can separate impulsive sounds into the categories given in 3.5.1 to 3.5.3. These three categories, however, have been found to correlate best with community response. Thus the sources of sound listed in 3.5.1 to 3.5.3 are used to define impulsive sound sources.

3.5.1
high-energy impulsive sound source
any explosive source where the equivalent mass of TNT exceeds 50 g, or sources with comparable characteristics and degree of intrusiveness

EXAMPLES Quarry and mining explosions, sonic booms, demolition or industrial processes that use high explosives, explosive industrial circuit breakers, military ordnance (e.g. armour, artillery, mortar fire, bombs, explosive ignition of rockets and missiles).

NOTE Sources of sonic booms include such items as aircraft, rockets, artillery projectiles, armour projectiles and other similar sources. This category does not include the short duration sonic booms generated by small arms fire and other similar sources.

3.5.2
highly impulsive sound source
any source with highly impulsive characteristics and a high degree of intrusiveness

EXAMPLES Small arms fire, hammering on metal or wood, nail guns, drop-hammer, pile driver, drop forging, punch presses, pneumatic hammering, pavement breaking, or metal impacts in rail-yard shunting operations.