INTERNATIONAL STANDARD

ISO 1996-2

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AMENDMENT 1
1998-09-15

Acoustics — Description and measurement of environmental noise —

Part 2:
Acquisition of data pertinent to land use

AMENDMENT 1

Acoustique — Caractérisation et mesurage du bruit de l'environnement

Partie 2: Saisie des données pertinentes pour l'utilisation des sols

AMENDEMENT 1

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.

Amendment 1 to International Standard ISO 1996-2:1987 was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 1, *Noise*.

Subclause 4.1.4 of ISO 1996-2:1987 contains provision for adjustments to be added for impulsive character to sound. However, no numerical guidance is currently contained in this subclause. This clause was left vague because there was a lack of concrete data on this topic in 1987. Since the original adoption of ISO 1996-2 in 1987, a large research programme has been undertaken by the Commission of the European Communities (CEC) and joint research has been undertaken by the USA and Germany. All research results are in fairly good agreement with one another and have been used to develop this amendment.

At the TC 43/SC 1 plenary meeting in South Africa, a general revision to the entire ISO 1996 series was recommended. Therefore, it is expected that the adjustment for impulsive sound will be further examined as a part of a total revision to the entire ISO 1996 series.

Annexes A to C of this part of ISO 1996 are for information only.

International Organization for Standardization
Case postale 56 • CH-1211 Genève 20 • Switzerland
Internet iso@iso.ch

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Acoustics — Description and measurement of environmental noise —

Part 2:
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AMENDMENT 1

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2 References

Add the following reference after ISO 1996-1.

"ISO 10843:1997, *Acoustics — Metrics and techniques for the physical measurement of single impulses or series of impulses*."

3 Definitions

Add the following note and definitions after the introductory phrase.

"NOTE Currently, no mathematical descriptor exists which unequivocally can define the presence of impulsive sound or can separate impulsive sounds into the categories given below. Thus the sources of sound listed in 3.1 and 3.2 are used to define the category.

3.1
highly impulsive sound
a sound from one of the following enumerated categories of sound sources: small arms fire, metal hammering, wood hammering, drop-hammer pile driver, drop forging, pneumatic hammering, pavement breaking, metal impacts of rail-yard shunting operations, or a sound with a comparable characteristic and degree of intrusiveness

NOTE 1 Sources of highly impulsive sound usually involve impacts or some kind of small explosive action (e.g. gunfire).

NOTE 2 Small arms fire includes the supersonic shock wave of a bullet.

3.2
high-energy impulsive sound
a sound from one of the following enumerated categories of sound sources: quarry and mining explosions, sonic booms, demolition and 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, any other explosive

source where the equivalent mass of dynamite exceeds 25 g), or a sound with a comparable characteristic and degree of intrusiveness

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."

Renumber current definitions 3.1, 3.2 and 3.3 as 3.3, 3.4 and 3.5. Add the following definition.

"3.6
ordinary impulsive sound
an impulsive sound that is neither a highly impulsive sound nor a high-energy impulsive sound

NOTE This category includes sounds that are sometimes described as impulsive, but are not normally judged to be as intrusive as highly impulsive sounds. Typical sound sources for this category are car door slams, outdoor ball games such as football (soccer) or basketball, church bells and even bird song (depending on the context in which they are heard). Very fast passbys of vehicles, trains or low-flying military aircraft also may fall into this category."

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Replace subclauses 4.1.2, 4.1.3 and 4.1.4 with the following.

"4.1.2 Rating level

The rating level shall be determined over reference time intervals related to the characteristics of the sources(s) and receiver(s).

NOTE 1 The reference time interval should be divided into several smaller time intervals for which the sound character can be clearly determined during each time interval (e.g. impulsive or tonal or neither).

For impulsive sounds, there are two cases to consider:

Case 1: the impulsive sounds can be identified and separately measured as single events from a distinct source or sources during the reference time interval.

Case 2: the impulsive sounds cannot be separately measured as single events from a distinct source or sources during the reference time interval.

NOTE 2 Annex A provides an explanation for the general methods incorporated herein and annex C provides a bibliography of pertinent references.

NOTE 3 Case 1 allows for greater flexibility; the sound exposure levels from different impulsive sound sources can be combined and corrected, if desired, for the background sound environment.

4.1.2.1 Case 1

This is the case when the impulsive sounds can be identified and separately measured as single events from a distinct source or sources during the reference time interval.

The rating level, $(L_{\mathrm{Ar},T})_i$, for each reference time interval, is given, in decibels, by the equation:

$$\left(L_{\mathrm{Ar},T}\right)_i = 10 \lg \left[10^{0{,}1\left[\left(L_{\mathrm{Aeq},T}\right)_i + \left(K_{\mathrm{T}}\right)_i\right]} + 10^{0{,}1\left[\left(L_{\mathrm{ArKl},T}\right)_i\right]} \right] \text{ dB} \qquad (1)$$

where

$(L_{\mathrm{Aeq},T})_i$ is the equivalent *continuous* A-weighted sound pressure level during the i th reference time interval;

$(K_{\mathrm{T}})_i$ is a tone adjustment applicable to the i th reference time interval defined in 4.1.4;

$(L_{\mathrm{Ar}K\mathrm{I},T})_i$ is the impulse-adjusted A-weighted level of the impulsive sound during the i th reference time interval defined in equation (3).

If impulsiveness is a predominant characteristic of the sound within a specified time interval, an adjustment shall be applied, for this time interval, to the measured A-weighted sound exposure level of each impulsive sound. This adjustment is a function of the sound pressure level(s) and character of the impulsive sounds during the specified time interval.

For each impulsive sound, j, during the i th reference time interval, the rating sound exposure level, $(L_{\mathrm{AEr}j})_i$, is given, in decibels, by the equation:

$$(L_{\mathrm{AEr}j})_i = (L_{\mathrm{AE}j})_i + (K_{\mathrm{I}j})_i \qquad (2)$$

where

$(L_{\mathrm{AE}j})_i$ is the sound exposure level of the j th impulse during the i th reference time interval;

$(K_{\mathrm{I}j})_i$ is an impulse adjustment applicable to the j th impulse during the i th reference time interval.

For each highly impulsive sound the value of adjustment $(K_{\mathrm{I}j})_i$ shall be 12 dB.

For each ordinary impulsive sound the value of adjustment $(K_{\mathrm{I}j})_i$ shall be 5 dB.

NOTE 1 Because general quantitative methods do not exist to predict the *subjective* presence and characterization of impulsive sounds, this part of ISO 1996 uses categorical definitions for different types of impulsive sounds. For information purposes, annex B offers quantitative methods to describe impulsive sounds.

NOTE 2 For high-energy impulsive sounds, some countries use C-weighted sound exposure level, or peak level, etc., to determine a rating level. Other countries use A-weighted sound exposure levels. When the A-weighting is used, the value of the adjustment should be significantly more than 12 dB.

NOTE 3 If impulses occur at a fast rate (greater than about 20 per second) then the sounds are no longer perceived as distinct impulses and no adjustment should be applied. If the rate is regular, then a tone will be perceived and the methods of 4.1.4 should be used. If the rate is irregular, then the individual sounds will merge into a noise-like sound and the methods of 4.1.1 and 4.3 should be used.

4.1.2.2 Case 2

This is the case when the impulsive sounds cannot be separately measured as single events from a distinct source or sources during the reference time interval.

The rating level, $(L_{Ar,T})_i$, for each reference time interval, is given, in decibels, by the equation:

$$(L_{Ar,T})_i = (L_{Aeq,T})_i + K_{Ti} + K_{Ii} \quad (4)$$

where

$(L_{Aeq,T})_i$ is the equivalent continuous A-weighted sound pressure level during the i th reference time interval;

K_{Ti} is a tone adjustment applicable to the i th reference time interval specified in 4.1.4;

K_{Ii} is an impulse adjustment applicable to the i th reference time interval specified.

NOTE 1 Only one adjustment, if any, should be included during any reference time interval.

If impulsiveness is a predominant characteristic of the sound within a specified time interval, an adjustment shall be applied, for this time interval, to the measured equivalent continuous A-weighted sound pressure level. The value of this adjustment shall be 5 dB.

NOTE 2 At present, general quantitative methods do not exist to predict the *subjective* presence and characterization of impulsive sounds. For this reason, this part of ISO 1996 uses categorical definitions for different types of impulsive sounds. For informative purposes, annex B offers quantitative methods to describe impulsive sounds.

4.1.3 Impulsive sound measurement

All measurements of impulsive sounds shall be made in accordance with the procedures contained in ISO 10843. For Case 1, the sound exposure level shall be measured; for Case 2, the equivalent continuous sound pressure level shall be measured.

4.1.4 Adjustment for tones, $(K_T)_i$

If tonal components are predominant characteristics of the sound within a specified time interval, an adjustment, $(K_T)_i$, may be applied, for that time interval, to the measured equivalent continuous A-weighted sound pressure level, $(L_{Aeq,T})_i$. The value of this adjustment shall be stated.

NOTE 1 In some practical cases, a prominent tonal component may be detected in one-third octave spectra if the level of a one-third-octave band exceeds the level of the adjacent bands by 5 dB or more, but a narrow-band frequency analysis may be required in order to detect precisely the occurrence of one or more tonal components in a noise signal. If tonal components are clearly audible and their presence can be detected by a one-third-octave analysis, the adjustment may be 5 dB to 6 dB. If the components are only just detectable by the observer and demonstrated by narrow-band analysis, an adjustment of 2 dB to 3 dB may be appropriate.

NOTE 2 If the tonal characteristics are present for only a part of the reference time interval, the value of K_T should be adjusted to take account of the duration."

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Add annexes A to C.

Annex A

(informative)

Background to impulsive sound assessment methodology

NOTE A large body of research (see annex C for examples) has revealed that exposure to impulsive sounds is more annoying than exposure to noise from other sources when each produces the same equivalent sound level. ISO 1996-2:1987 does not provide numerical guidance for adjustments to rate impulsive sound properly. This lack of numerical guidance is not adequate in view of the present knowledge from numerous research results. Therefore, this amendment to ISO 1996-2 introduces impulsive sound adjustments into the noise rating procedures.

A.1 Research results show that the impulsive sound adjustments are not constant. With the exception of high-energy impulsive sounds (e.g. blasts, sonic booms) where the adjustment may be significantly greater, adjustments for impulsive sound typically range from 2 dB to 15 dB. These adjustments change with the type and character of the sound.

CEC research (e.g. references [2], [3], [14] and [15]) developed the concept of "highly impulsive" sounds. Research data obtained in various field surveys and laboratory studies show that for highly impulsive sounds, the adjustment ranges from 8 dB to 15 dB. In this part of ISO 1996, highly impulsive sounds are defined by specific enumeration of sources. An adjustment of 12 dB is applied to the sound exposure level of highly impulsive sounds.

For each ordinary impulsive sound, research data show that typical adjustments range from 2 dB to 7 dB. In this part of ISO 1996, an adjustment of 5 dB is applied to the sound exposure level of ordinary impulsive sounds.

NOTE This is the value that was used in ISO 1996:1971.

The two values, 5 dB and 12 dB, provide adjustments that normally will be within 3 dB of research-measured values.

A.2 When the impulsive sound can be identified and separately measured, the adjustments are added directly to the sound exposure level of the single events yielding the rating sound exposure level. Within the reference time interval, the rating sound levels of all events are energetically added to the overall equivalent continuous A-weighted sound pressure level. If the overall equivalent continuous A-weighted sound pressure level already includes the impulsive sound energy, precautions should be taken to avoid counting the impulsive energy twice by re-adjusting the impulsive sound adjustments. The re-adjusted values, K_{adj}, can be calculated from the original values, K, by the equation:

$$K_{adj} = 10 \lg (10^{0,1K} - 1) \text{ dB} \qquad \text{(A.1)}$$

For K = 12 dB, K_{adj} = 11,7 dB, and for K = 5 dB, K_{adj} = 3 dB.

A.3 When the impulsive sounds cannot be identified and separately measured, an impulsive sound adjustment of 5 dB is added to the equivalent continuous A-weighted sound level during the corresponding reference time interval.

NOTE This is the same procedure that was used in ISO 1996:1971.

Annex B

(informative)

Impulse characteristics

B.1 One method of describing the impulse characteristic of the sound within the specified time interval is to measure the difference between the A-weighted equivalent-continuous sound pressure level, determined with time-weighting characteristic I, $L_{\mathrm{Aleq},T}$, and $L_{\mathrm{Aeq},T}$ obtained over the same time interval. These sound pressure levels should be determined simultaneously.

B.2 A second method of describing the impulse characteristic of a sound is to measure the ordinary or highly impulsive sound with just time weighting characteristic I.

B.3 The linear peak setting of selected type 1 sound level meters is used in some countries to assess high-energy impulsive sounds with respect to both annoyance analysis and structural damage.

B.4 During the course of the CEC research programme (e.g. references [2], [3], [14] and [15]), a number of descriptors based on short-term (10 ms) equivalent level time-series were investigated. Optimum correlation with subjective rating of impulsiveness was obtained with the "increment" descriptor, defined as the maximum positive difference between successive 10-ms A-weighted equivalent levels. This result is confirmed in reference [6].

Annex C

(informative)

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