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Acoustics — Declared noise emission values of information technology and telecommunications equipment

Acoustique — Valeurs déclarées d'émission acoustique des équipements liés aux technologies de l'information et aux télécommunications

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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).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html

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

This second edition cancels and replaces the first edition (ISO 9296:1988), which has been technically revised, and in addition contains the following changes:

— the Normative references clause has been updated and certain references moved to the Bibliography;

— a new Annex A has been added;

— a Bibliography has been added.

Introduction

Information on acoustical noise emission of information technology and telecommunications equipment (ITT equipment) is needed by users, planners, manufacturers and authorities. This information is required for comparison of the noise emissions from different products and for installation acoustics planning and may be used for workplace noise immission requirements.

In order for equipment noise emission data to be useful, uniform methods are necessary for the following purposes:

— Measurement of noise emission values

ISO 7779 specifies procedures for determining sound power level based on ISO 3741[1] ISO 3744[2] and ISO 3745[3] (reverberation test room or hemi-anechoic room) and emission sound pressure level based on ISO 11201.[7]

— Determination of the noise emission values to be declared

ISO 4871[4] gives guidelines for the preparation of standards for deriving noise emission values for declaration purposes, and the ISO 7574 series[5,6] gives statistical methods for such determination. This document is based on the above-mentioned International Standards.

— Presentation of declared noise emission values

For the presentation of declared noise emission values, it is of prime importance to declare A-weighted sound power levels, L_{WA}. It is recognized, however, that users still desire information on A-weighted emission sound pressure levels, L_{pA}. Therefore, this document provides methods for declaration of both quantities. In the preparation of this document, divergent opinions have been found between various national and international organisations as to the most useful way of presenting noise emission values. In order to avoid any misunderstanding between presentation of sound power levels (re 1 pW) in decibels and emission sound pressure levels (re 20 µPa) in decibels, this document expresses sound power level values to be declared in bels and emission sound pressure level values in decibels, to alleviate the divergent opinions mentioned.

As an option, methods for determination and presentation of subjective characteristics of noise emission are presented in Annex C.

— Verification of declared noise emission values

ISO 7574-4[6] gives methods for the verification of a declared noise emission value. In this document, the procedure is restricted to verifying the statistical upper limit A-weighted sound power level, $L_{WA,c}$, only.

For continuity with ISO 9296:1988 and current practice, this document specifies bels as the unit for declaring sound power levels. It should be noted, however, that the decision has been made to change the unit to decibels in the next edition, and users of this document should begin to prepare for this transition.

Acoustics — Declared noise emission values of information technology and telecommunications equipment

1 Scope

This document is applicable to information technology and telecommunications equipment.

It specifies:

a) for a batch of equipment, the method for determining the following values:

— the declared mean A-weighted sound power level, $L_{WA,m}$;

— the declared mean A-weighted emission sound pressure level, $L_{pA,m}$;

— the statistical adder for verification, K_v;

— the statistical upper limit A-weighted sound power level, $L_{WA,c}$;

b) how acoustical and product information is to be published electronically or in hard-copy format in technical documents or other product literature supplied to users by the manufacturer or declarer;

c) the method for verifying the noise emission values that are declared by the manufacturer or declarer.

NOTE The terms “manufacturer” and “declarer” are used in this document to represent any entity that provides product noise emission information. For instance, a product supplier or importer who does not manufacture the hardware, but offers noise emissions information, is also referred to a manufacturer or a declarer as applicable, in this document.

The uniform methods in this document use the noise emission data obtained in accordance with ISO 7779, and the declaration and verification procedures detailed in ISO 4871[4] and ISO 7574-4.[6]

The basic noise emission values to be declared are the declared mean A-weighted sound power levels, $L_{WA,m}$. Optionally, the declared mean A-weighted emission sound pressure levels at the operator or bystander positions, $L_{pA,m}$, can be declared. These are arithmetic mean values based upon measurements on a random sample of equipment of the batch, in accordance with ISO 7779.

For verification purposes, an additional quantity is required to be declared: the statistical adder for verification, K_v. This is a quantity that is added to the declared mean A-weighted sound power level, $L_{WA,m}$, and used in the verification section of this document to provide a consistent and predictable probability of acceptance for the batch of equipment.

The declared mean A-weighted sound power level for the batch of equipment permits comparison of noise emissions between different products and permits predictions of installation or work-place noise immission levels, as described in ECMA TR/27.[9]

Although the most useful quantity for calculating immission levels due to one or more noise sources is the A-weighted sound power level of the individual source(s), the A-weighted emission sound pressure level may also be useful in estimating the immission level in the immediate vicinity of an isolated piece of equipment.

To avoid confusion between sound power levels and emission sound pressure levels, the declared mean A-weighted sound power level, $L_{WA,m}$, is expressed in bels (B) and the declared mean A-weighted emission sound pressure level, $L_{pA,m}$, is expressed in decibels (dB).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

ISO 7779, *Acoustics — Measurement of airborne noise emitted by information technology and telecommunications equipment*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

3.1 General definitions

3.1.1
information technology and telecommunications equipment
ITT equipment
equipment for information processing, and components thereof, used in homes, offices, server installations, telecommunications installations or similar environments

[SOURCE: ISO 7779:2010, 3.1.3]

3.1.2
batch of equipment
lot of equipment
number of units of information technology or telecommunications equipment intended to perform the same function produced in quantity, manufactured to the same technical specifications and characterized by the same declared noise emission value

Note 1 to entry: The batch may be either an entire production series or a portion thereof.

3.1.3
functional unit
unit of *ITT equipment* (3.1.1), either with or without its own end-use enclosure, that is tested or intended to be tested in accordance with the procedures of ISO 7779

Note 1 to entry: A functional unit can comprise more than one unit of ITT equipment when such units are to be tested together in accordance with the methods of ISO 7779. A functional unit can also comprise one or more units of ITT equipment coupled to one or more units of non-ITT equipment, such as power modules, water pumps, or refrigeration units, when such equipment is necessary for the normal operation of the ITT equipment.

Note 2 to entry: Functional units of ITT equipment can take on a wide range of forms, including commercially available products, prototype units under development, or sub-assemblies and components thereof.

Note 3 to entry: In this document, for simplicity, a functional unit may be expressed as a unit (see 3.2.1 and 3.2.2).

3.1.4
operating mode
condition specified in ISO 7779 in which the equipment being tested is performing its intended function(s)

Note 1 to entry: When possible to implement for acoustic testing, the conditions specified in the relevant annex of ISO 7779 are considered to be typical of average end use.

3.1.5
idle mode
steady-state condition (one or more) specified in ISO 7779, in which the equipment being tested is energized, but is not performing any intended function(s)

3.2 Definitions relating to acoustics

3.2.1
A-weighted sound power level
L_{WA}
sound power level, determined for a particular unit of *ITT equipment* (3.1.1) in accordance with ISO 7779, with A-weighting applied

Note 1 to entry: The A-weighted sound power level, L_{WA} (re 1 pW) is expressed in decibels.

3.2.2
A-weighted emission sound pressure level
L_{pA}
emission sound pressure level, determined for a particular unit of *ITT equipment* (3.1.1) in accordance with ISO 7779, with A-weighting applied, at the operator position(s), or at the bystander positions if no operator position is specified

Note 1 to entry: The A-weighted emission sound pressure level, L_{pA} (re 20 µPa) is expressed in decibels.

3.2.3
sample mean A-weighted sound power level
$\overline{L_{WA}}$
arithmetic average of the *A-weighted sound power levels* (3.2.1) determined for a random sample taken from the *batch of equipment* (3.1.2)

Note 1 to entry: The sample mean A-weighted sound power level, $\overline{L_{WA}}$ (re 1 pW) is expressed in decibels.

Note 2 to entry: This is not a declared noise emission value, but is an interim value to be used for the purpose of computing sample standard deviation of production, s_p for the batch under consideration (see 3.3.3).

3.2.4
declared mean A-weighted sound power level
$L_{WA,m}$
arithmetic average of the *A-weighted sound power levels* (3.2.1) for the *batch of equipment* (3.1.2), used for noise emission declaration

Note 1 to entry: The declared mean A-weighted sound power level, $L_{WA,m}$ (re 1 pW) is expressed in bels.

3.2.5
sample mean A-weighted emission sound pressure level
$\overline{L_{pA}}$
arithmetic average of the A-weighted emission sound pressure levels determined for a random sample taken from the *batch of equipment* (3.1.2)

Note 1 to entry: The sample mean A-weighted emission sound pressure level, $\overline{L_{pA}}$ (re 20 µPa) is expressed in decibels.

Note 2 to entry: This is not a declared value, but is an interim value to be used for the purpose of computing the declared mean A-weighted emission sound pressure level.

3.2.6
declared mean A-weighted emission sound pressure level
$L_{pA,m}$
arithmetic average of the A-weighted emission sound pressure levels for the *batch of equipment* (3.1.2), used for noise emission declaration

Note 1 to entry: The declared mean A-weighted emission sound pressure level, $L_{pA,m}$ (re 20 µPa) is expressed in decibels.

3.2.7
declared noise emission values
value of the declared *mean A-weighted sound power level* (3.2.1), $L_{WA,m}$, or the declared mean *A-weighted emission sound pressure level* (3.2.2), $L_{pA,m}$, or both, and *statistical adder for verification* (3.3.6), K_v, declared for the batch of new equipment

Note 1 to entry: Based on $L_{WA,m}$ and K_v, the statistical upper limit A-weighted sound power level, $L_{WA,c}$, can be computed in accordance with Clause 7.

3.2.8
statistical upper limit A-weighted sound power level
$L_{WA,c}$
limit below which 93,5 % of the *A-weighted sound power levels* (3.2.1) of the batch of new equipment are expected to lie

Note 1 to entry: The statistical upper limit A-weighted sound power level, $L_{WA,c}$ (re 1 pW) is expressed in bels.

Note 2 to entry: According to ISO 7574–4:1985[6] Clause 7, a 95 % probability of acceptance can be assumed if no more than 6,5 % of the equipment in a batch has A-weighted sound power levels greater than $L_{WA,c}$, and the verification procedures therein are used.

Note 3 to entry: The statistical upper limit A-weighted sound power level, $L_{WA,c}$, was called the declared A-weighted sound power level, L_{WAd} in ISO 9296:1988.

3.3 Definitions relating to statistics

NOTE In this document, the symbol σ is used for a standard deviation of a population and the symbol s for a standard deviation of a sample.

3.3.1
standard deviation of repeatability
σ_r
standard deviation of sound power level values obtained under repeatability conditions, that is, the repeated application of the same measurement method on the same equipment within a short interval of time under the same conditions (same laboratory, same operator, and same apparatus)

3.3.2
standard deviation of reproducibility
σ_R
standard deviation of sound power level values obtained under reproducibility conditions, that is, the repeated application of the same measurement method on the same unit of *ITT equipment* (3.1.1) at different times and under different conditions (different laboratory, different operator, different apparatus)

Note 1 to entry: The standard deviation of reproducibility, σ_R, therefore, includes the standard deviation of repeatability, σ_r.

3.3.3
standard deviation of production
σ_p
standard deviation of sound power level values obtained on different units from a batch of *ITT equipment* (3.1.1) of the same family, using the same measurement method under repeatability conditions (same laboratory, same operator, and same apparatus)

3.3.4
total standard deviation
σ_t
square root of the sum of the squares of the standard deviation of reproducibility, σ_R, and the standard deviation of production, σ_p for the equipment in the batch

$$\sigma_t = \sqrt{\sigma_R^2 + \sigma_p^2}$$

3.3.5
reference standard deviation
σ_M
total standard deviation (3.3.4) in sound power level values, specified for the family of *ITT equipment* (3.1.1) under consideration which is considered typical for batches from this family

Note 1 to entry: For the purposes of this document, the reference standard deviation for any family of ITT equipment is fixed to 2,0 dB. See 7.1.

Note 2 to entry: The use of a fixed value of σ_M enables the application of a statistical method to deal with small verification sample sizes. If the total standard deviation, σ_t is different from the reference standard deviation, σ_M, the manufacturer can estimate his risk of rejection on the basis of both standard deviations, σ_t and σ_M (see ISO 7574–4[6]).

3.3.6
statistical adder for verification
K_v
quantity to be added to the declared *mean A-weighted sound power level* (3.2.1), $L_{WA,m}$, such that there will be a 95 % probability of acceptance, when using the verification procedures of this document, if no more than 6,5 % of the batch of new equipment has A-weighted sound power levels greater than ($L_{WA,m}$ + K_v)

Note 1 to entry: The statistical adder for verification, K_v, is expressed in bels.

Note 2 to entry: K_v is determined by the procedures in Annex A.

Note 3 to entry: The statistical adder for verification, K_v, should not be confused with a type of uncertainty[8]. Uncertainty is usually well-documented in the underlying measurement standards and generally represents a plus-or-minus variation around the measured value. Here, K_v is a positive adder only and is used to arrive at a consistent and predictable probability of acceptance when using the statistical verification procedure in Clause 7.

4 Conformity requirements

4.1 For declaration

Declarations are in conformity with this document if they meet the following requirements:

a) for the acoustical noise measurements, the measurement procedures and the installation and operating conditions are in full conformance with ISO 7779;

b) for the determination and presentation of declared noise emission values, the procedures of Clauses 5 and 6 are followed and the requirements therein are met.

4.2 For verification

Verifications are in conformity with this document if they meet the following requirements:

a) for the acoustical noise measurements, the measurement procedures and the installation and operating conditions are in full conformance with ISO 7779;

b) for the verification of the statistical upper limit A-weighted sound power level, $L_{WA,c}$, the procedures of Clause 7 are followed and the requirements therein are met.

5 Determination of the noise emission values to declare

5.1 General

The determination of the declared noise emission values is the sole responsibility of the manufacturer of the equipment.

For declaring noise emission values for a batch of ITT equipment, a random sample shall be drawn from the batch of new equipment under consideration. The A-weighted sound power level, L_{WA}, shall be determined for one or more idle modes and one or more operating modes as defined in ISO 7779. Optionally, the A-weighted emission sound pressure level, L_{pA}, if needed, may also be determined for the same modes as for sound power level. Based on these measured values, the declared mean A-weighted sound power level, $L_{WA,m}$, along with the statistical adder for verification, K_v, shall be determined in accordance with the procedures of 5.2 and 5.4. And, if needed, the declared mean A-weighted emission sound pressure level, $L_{pA,m}$, shall be determined in accordance with the procedures of 5.3.

There are essentially two broad applications of product noise declarations.

First, prospective customers may want to know the basic noise emission levels of the ITT equipment they are considering in order to make informed purchasing decisions and to compare one product to another. The A-weighted sound power level and the A-weighted emission sound pressure level, determined in accordance with accepted standards such as ISO 7779, are the appropriate quantities for this application. This document requires that the mean values of these two quantities, $L_{WA,m}$ and $L_{pA,m}$, for a batch of equipment be declared.

Second, some prospective customers, especially those considering the purchase of large quantities of equipment, may want assurance that a large percentage of the equipment in the batch will have noise levels below a certain limit or specification value; and they would like to verify this fact before purchasing the products. The statistical upper limit A-weighted sound power level, $L_{WA,c}$, is the appropriate quantity for this application, and this document includes procedures for its determination and for its use in the verification procedure.

5.2 Determination of the declared mean A-weighted sound power level, $L_{WA,m}$

The true mean, μ, of a batch of equipment is approximated by the sample mean.

The sample mean A-weighted sound power level, $\overline{L_{WA}}$, is computed by taking a random sample from the batch of new equipment under consideration, and determining the A-weighted sound power level, $L_{WA,i}$, in decibels, for each unit in the sample in accordance with ISO 7779. The value of $\overline{L_{WA}}$, in decibels, is then computed using Formula (1):

$$\overline{L_{WA}} = \frac{1}{M}\sum_{i=1}^{M} L_{WA,i} \qquad (1)$$

where M is the sample size (number of units in the sample).

The values of $L_{WA,i}$ in the summation are not rounded.

NOTE The sample mean A-weighted sound power level, $\overline{L_{WA}}$, becomes a better estimate of the true mean, μ, as the number of units, M, in the sample increases.

The declared mean A-weighted sound power level, $L_{WA,m}$, is the value of the sample mean A-weighted sound power level, $\overline{L_{WA}}$, determined according to Formula (1), but given in bels, rather than decibels, and rounded to the nearest 0,1 B using Formula (2):

$$L_{WA,m} = \frac{1}{10}\overline{L_{WA}} \tag{2}$$

See Annex B for examples of declarations meeting the requirements of this document.

5.3 Determination of the declared mean A-weighted emission sound pressure level, $L_{pA,m}$

The sample mean A-weighted emission sound pressure level, $\overline{L_{pA}}$, at either the operator position(s) or bystander positions, as applicable, shall be determined by computing the arithmetic mean of the A-weighted emission sound pressure levels for the units in the random sample of new equipment using Formula (3) [by analogy with Formula (1)]:

$$\overline{L_{pA}} = \frac{1}{M}\sum_{i=1}^{M} L_{pA,i} \tag{3}$$

The value to be declared for $L_{pA,m}$ is the value of $\overline{L_{pA}}$ rounded to the nearest 1 dB.

5.4 Determination of the statistical adder for verification, K_v

The value of the statistical adder for verification, K_v, (see 3.3.6) shall be determined in accordance with Annex A.

6 Presentation of declared noise emission values

6.1 Required information

The declared noise emission values, $L_{WA,m}$ and K_v, and optionally $L_{pA,m}$, determined in accordance with Clause 5, shall each be declared for at least one configuration or variation of the product deemed to be typical of that marketed to, or purchased by, customers. It is recommended that other representative configurations or variations also be declared, especially for those products available in multiple configurations or with various options that result in different noise emission levels. For example, in addition to the typical configuration of an ITT equipment rack, it may be helpful to declare the noise emission levels for the minimum and maximum configurations of the rack, in order to indicate the expected range of noise levels for the particular product.

NOTE The statistical upper limit A-weighted sound power level, $L_{WA,c}$, is easily computed from the sum of the declared noise emission values $L_{WA,m}$ and K_v, see Formula (5). The value of $L_{WA,c}$, may be required by a purchase specification, regulation, or other document, but it is not a requirement of this document to declare this value explicitly.

The presentation of the declared noise emission values, $L_{WA,m}$, $L_{pA,m}$ and K_v, shall include the following information:

— identification of the product and description of the product configuration or variation with sufficient detail to determine the applicability of the declared noise emission values. If such information is not given, the declared noise emission values shall be taken as applying to all configurations or variations of the listed product;

— the words “Declared noise emission values in accordance with ISO 9296” followed by the values of $L_{WA,m}$ and K_v, and optionally $L_{pA,m}$;

— identification of whether $L_{pA,m}$, if declared, refers to the operator position(s) or to the bystander positions as defined in ISO 7779;

— if more than one operating mode in accordance with ISO 7779 is possible, sufficient information to determine unambiguously the mode(s) used for declaration;

— a note stating “The quantity, $L_{WA,c}$ (formerly called L_{WAd}) can be computed from the sum of $L_{WA,m}$ and K_v.”.

Declared noise emission values should be given in sales, marketing, technical, or other literature supplied to the users, either published online or in hard-copy print format (see Annex B).

6.2 Additional information

Annex C provides optional information on describing the character of the noise emissions.

7 Verification of the statistical upper limit A-weighted sound power level, $L_{WA,c}$

7.1 General

The procedures for verifying the declared noise emission values for ITT equipment are applicable only to the statistical upper limit A-weighted sound power level, $L_{WA,c}$, (i.e. these procedures are not applicable to the declared mean A-weighted sound power level, $L_{WA,m}$, or to the declared mean A-weighted emission sound pressure level, $L_{pA,m}$).

Verification shall be made from acoustical noise measurements using the procedures and the installation and operating conditions in accordance with ISO 7779.

Furthermore, the installation and operating conditions for verification shall be as specified in Clause 5 and stated by the manufacturer as specified in Clause 6.

The procedure for verifying the statistical upper limit A-weighted sound power level, $L_{WA,c}$, for the batch uses the single sampling inspection procedure in accordance with ISO 7574-4. The verification sample size shall be n = 3. The reference standard deviation σ_M shall be 2,0 dB for the family of ITT equipment.

7.2 Verification of $L_{WA,c}$ for a batch of equipment

The following procedure is designed for inspection under reproducibility conditions (see 3.3.2). It may be applied for inspection under repeatability conditions (see 3.3.1) if there is confidence that there is no outstanding systematic error of measurement connected with the relevant test laboratory.

Take a random sample of three units from the batch of new equipment under consideration. Measure the A-weighted sound power levels for each unit in accordance with ISO 7779. The measured values are denoted $L_{WA,1}$, $L_{WA,2}$, and $L_{WA,3}$ in decibels, and their arithmetic mean value, $\bar{L}$, in decibels, is given in Formula (4):

$$\bar{L} = \frac{1}{3}\left(L_{WA,1} + L_{WA,2} + L_{WA,3}\right) \tag{4}$$

This arithmetic mean value $\bar{L}$ is then used in the criteria formulae below to determine whether or not the statistical upper limit value for the batch is verified.

The value of the statistical upper limit A-weighted sound power level, $L_{WA,c}$, in bels, is computed using Formula (5) from the declared mean A-weighted sound power level, $L_{WA,m}$, in bels, and the statistical adder for verification, K_v, in bels, that have been published or otherwise provided by the manufacturer or declarer according to Clause 6 as the declared noise emission values for the batch under consideration:

$$L_{WA,c} = L_{WA,m} + K_v \tag{5}$$

The manufacturer or declarer may have already performed the above computation and provided the value of $L_{WA,c}$ directly. In this case, it should be confirmed that the value is in bels, rather than decibels, and that it has been rounded to the nearest 0,1 B.

The decision on the acceptability of $L_{WA,c}$ for the batch is governed by the following rules:

— if $\overline{L}/10 \leq \left(L_{WA,c} - 0{,}11\,\mathrm{B}\right)$, the value of $L_{WA,c}$ is confirmed as verified for the batch,

— if $\overline{L}/10 > \left(L_{WA,c} - 0{,}11\,\mathrm{B}\right)$, the value of $L_{WA,c}$ is not confirmed as verified for the batch.

NOTE The above criterion formulae, which can be put in the form $\overline{L}/10 \leq A/10$ and $\overline{L}/10 > A/10$, are derived from ISO 7574-4:1985, Formula 6[6] which can be written in the form:

$$A = (10 \times L_{WA,c} - 1{,}514\sigma_M) + 1{,}645\frac{\sigma_M}{\sqrt{n}}$$

The first term in parentheses is the "assumed mean" and the second term is the "critical region" for 95 % confidence (the constant 1,645 is the quantile value of the normal curve corresponding to 95 % probability). Using the values n = 3 and $\sigma_M = 2{,}0$ dB defined in this document, the above expressed in bels, reduces to the following:

$$A/10 = L_{WA,c} - 0{,}0564\sigma_M = L_{WA,c} - 0{,}11\,\mathrm{B}$$

Annex A
(normative)

Procedure for determining the statistical adder for verification, K_v

A.1 General

This procedure is based on the declaration and verification procedures of ISO 7574-4. The statistical adder for verification, K_v is needed in order to provide uniform noise declarations for the ITT equipment and also to provide a predictable probability of acceptance for the declarer.

A.2 Determination of the statistical adder for verification, K_v

A.2.1 Initial considerations

The statistical adder for verification, K_v, is added to the declared mean value during the verification process to compute the statistical upper limit A-weighted sound power level, $L_{WA,c}$ (see Clause 7). The statistical upper limit A-weighted sound power level, $L_{WA,c}$, is not required to be declared by this document, but it is easily computed from the declared mean A-weighted sound power level, $L_{WA,m}$, and the statistical adder for verification, K_v (see 7.2). To obtain the statistical adder for verification, K_v, for a batch of equipment, the declarer shall take into account the following.

a) The standard deviation of reproducibility, σ_R (see 3.3.2) for A-weighted sound power level, L_{WA}, is estimated to be 1,5 dB in ISO 7779 for most ITT equipment, and this value is used for the purposes of this document.

b) The standard deviation of production, σ_p, (see 3.3.3) for the A-weighted sound power level is determined from different units in the sample of the batch carried out in accordance with ISO 7779 under repeatability conditions (same laboratory, same operator, same apparatus).

c) The total standard deviation, σ_t, for the batch for A-weighted sound power level is a combination of the standard deviation of reproducibility, σ_R for the test method and the standard deviation of production, σ_p, for the batch of equipment (see 3.3.4).

   NOTE 1 The total standard deviation, σ_t, for the batch of equipment differs from the total standard deviation, σ_{tot}, in ISO 3744 and ISO 11201 since the latter applies to the test methods themselves, and does not include product-to-product variation.

d) The procedure for verifying the statistical upper limit A-weighted sound power level, $L_{WA,c}$, (see Clause 7) is in accordance with ISO 7574-4, the single sampling inspection procedure with a verification sample size $n = 3$ and a reference standard deviation $\sigma_M = 2{,}0$ dB for the family of ITT equipment is used.

NOTE 2 When the verification procedure of Clause 7 is used in conjunction with the determination procedure given in this annex, the declarer will have a known and predictable probability of acceptance; that is, the batch will be accepted (the stated value for the statistical upper limit A-weighted sound power level will be verified) with a probability of 95 %, and the declared mean A-weighted sound power level for the batch, $L_{WA,m}$, is expected to lie approximately $1{,}5\sigma_M$ below $L_{WA,c}$.

A.2.2 Determination of the sample total standard deviation for the batch

The declaration and verification procedures of ISO 7574-4 upon which the procedures in this document are based assume that the measured values of A-weighted sound power levels of the units in the batch are normally distributed, and that the true mean, μ, and true total standard deviation, σ_t, are known or closely approximated. These true values are approximated by the sample mean A-weighted sound power level, $\overline{L_{WA}}$, and the sample total standard deviation, s_t, defined in Formula (A.2).

The sample mean A-weighted sound power level, $\overline{L_{WA}}$, is determined as in 5.2.

The sample total standard deviation, s_t is determined by the following two-step procedure.

First, the sample standard deviation of production, s_p, for the measured values, $L_{WA,i}$, of the units in the sample is computed according to Formula (A.1):

$$s_p = \sqrt{\frac{1}{M-1}\sum_{i=1}^{M}\left(L_{WA,i} - \overline{L_{WA}}\right)^2} \tag{A.1}$$

where M is the sample size (number of units in the sample).

Second, the sample total standard deviation, s_t, is computed from the sample standard deviation of production, s_p, and the standard deviation of reproducibility, σ_R, which is assigned here the value of 1,5 dB based on ISO 7779:

$$s_t = \sqrt{s_p^2 + \sigma_R^2} = \sqrt{s_p^2 + 1,5^2} \tag{A.2}$$

The values of $\overline{L_{WA}}$ and s_t are estimates of the true mean value, μ, and the true total standard deviation, σ_t, of the batch, respectively. The differences between these estimates and the true values are expected to be small when the sample size, M, is relatively large.

When the sample size is small, the statistical assumptions may no longer result in a known and predictable probability of acceptance. For declarers who want to maintain or approximate the 95 % probability of acceptance even for small sample sizes, an additional "guard band", G (described in A.2.3) can be included in K_v.

Alternatively, the sample standard deviation of production, s_p, can be estimated by the manufacturer from prior experience with similar equipment, particularly when only a limited number of units are available for the sample. If fewer than three units are available, and there is no prior knowledge of s_p, then the manufacturer or declarer shall set a minimum value of s_p = 1,32 dB (such that the sample total standard deviation, s_t, will equal the reference standard deviation, σ_M, of 2,0 dB). Higher values may be warranted, for example, if the product emits prominent discrete tones, if there is significant structure-borne noise, or if there is fan speed control that is sensitive to the test temperature.

Because one of the purposes of this test code is to define a reference standard deviation that is intended to represent the total standard deviation for most ITT equipment, the declarer may simply use this reference standard deviation (σ_M = 2,0 dB) as the value for s_t.

A.2.3 Determination of the statistical adder for verification, K_v

Once the sample mean A-weighted sound power level, $\overline{L_{WA}}$, and the total standard deviation, s_t, have been determined or estimated for the batch, the statistical adder for verification, K_v, shall be computed from Formula (A.3). The computed value shall be given in bels, rounded to the nearest 0,1 B. The reference standard deviation for ITT equipment is σ_M = 2,0 dB (see 3.3.5).

For all sample sizes:

$$K_V = \frac{1}{10}\left[1,514 s_t + 0,564\left(\sigma_M - s_t\right)\right] \tag{A.3}$$

NOTE 1 This formula is based on ISO 7574-4 and for large sample sizes (M > 5), and it will result in a probability of acceptance of 95 %. The constant, 1,514, is the quantile value of the normal distribution curve corresponding to 93,5 % probability.

For $M \leq 5$, the probability of making a declaration that will be verified may be different than 95 %, but generally still above 90 %, and even for a sample of one, generally not lower than 85 %. However, the probability of acceptance for any specific declaration based on a small sample size can be much lower in some extreme cases, as when all the units in the sample happen to be drawn from the low end of the production variation range. Optionally for $M \leq 5$ to maintain or approximate a probability of making a declaration with a probability of acceptance of 95 %, Formula (A.4) and Table A.1 can be used by analogy with Formula (A.3):

$$K_{\mathrm{v}} = \frac{1}{10}\left[1{,}514 s_{\mathrm{t}} + 0{,}564\left(\sigma_{\mathrm{M}} - s_{\mathrm{t}}\right) + G\right] \quad \text{(A.4)}$$

Table A.1 — Guard band value, *G*

Sample size, *M*	**Guard band value**, *G* dB
1	1,00
2	0,75
3	0,50
4	0,40
5	0,35

NOTE 2 The symbol, *G*, is a guard band value as given in Table A.1 as a function of the sample size, *M*. Reference [10] provides the basis for derivation of the guard band values. The guard band is intended to restore a 95 % probability of making a declaration that will be verified across a large population of declarers and verifiers when the sample size is small, but the probability of acceptance for any specific declaration based on a small sample size can be much lower in some extreme cases, as when all the units in the sample happen to be drawn from the low end of the production variation range, even when the guard band is included.

A much larger guard band would be required to guarantee a probability of acceptance of at least 95 % for even the worst case declaration made using a small sample size.

See Annex B for examples of declarations meeting the requirements of this document.

Annex B
(informative)

Examples of noise emission declarations

EXAMPLE 1 Presentation of single product or single configuration in one table

Declared noise emission values in accordance with ISO 9296		
Product name	**Server model XYZ**	
Product description:	Single-frame system configured with one processor subsystem, one I/O drawer with 4 disk drives, bulk power subsystem, and acoustical door set	
Quantities declared	**Operating mode**	**Idle mode**
Declared mean A-weighted sound power level[a], $L_{WA,m}$, B:	7,4	7,2
Declared mean A-weighted emission sound pressure level[b], $L_{pA,m}$, dB:	59	57
Statistical adder for verification[c], K_v, B:	0,4	0,4

[a] The declared mean A-weighted sound power level, $L_{WA,m}$, is computed as the arithmetic average of the measured A-weighted sound power levels for a randomly selected sample, rounded to the nearest 0,1 B.

[b] The declared mean A-weighted emission sound pressure level, $L_{pA,m}$, is computed as the arithmetic average of the measured A-weighted emission sound pressure levels at the bystander positions for a randomly selected sample, rounded to the nearest 1 dB.

[c] The statistical adder for verification, K_v, is a quantity to be added to the declared mean A-weighted sound power level, $L_{WA,m}$, such that there will be a 95 % probability of acceptance, when using the verification procedures of ISO 9296, if no more than 6,5 % of the batch of new equipment, has A-weighted sound power levels greater than ($L_{WA,m}$ + K_v).

NOTE 1 The quantity, $L_{WA,c}$ (formerly called L_{WAd}) can be computed from the sum of $L_{WA,m}$ and K_v.

NOTE 2 All measurements made in conformance with ISO 7779 and declared in conformance with ISO 9296.

NOTE 3 B, dB, abbreviations for bels and decibels, respectively, where 1 B = 10 dB.