Standard ECMA-109

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Declared Noise Emission Values of Information Technology and Telecommunications Equipment

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Introduction

Information on acoustic noise emission of information technology and telecommunications 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 relating to 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

  ECMA-74 specifies procedures for measuring 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[5].

- Determination of the noise emission values to be declared

  ISO 4871 gives guidelines for the preparation of standards for deriving noise emission values for declaration purposes, and the ISO 7574 series gives statistical methods for such determination. ECMA-109 is based upon these basic 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 Ecma Standard specifies that both quantities shall be declared. In the preparation of this Ecma Standard divergences of opinion 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 in decibels re 1 pW and emission sound pressure levels in decibels re 20 μPa, this Ecma Standard expresses sound power level values to be declared in bels and emission sound pressure level values in decibels, to alleviate the divergences of opinion 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 gives methods for the verification of a declared noise emission value. In this Ecma Standard the procedure is restricted to verifying the statistical upper limit A-weighted sound power level, $L_{WA,c}$ only.

The reasons for using bels for declared A-weighted sound power levels are:

i) To avoid user confusion

   In this Ecma Standard the A-weighted sound power level is the primary descriptor and will be reported in accordance with ISO 4871. Many manufacturers and users of information technology and telecommunications equipment have historically used A-weighted emission sound pressure levels in decibels. Since customers want both sound power and emission sound pressure levels, this Ecma Standard utilises both quantities. Without including reference values (*i.e.* 1 pW and 20 μPa), expressing both declared sound power levels and declared emission sound pressure levels in decibels tends to cause confusion. To distinguish the two, this Ecma Standard expresses declared sound power level values in bels, where a bel is 10 decibels re 1pW, and expresses emission sound pressure level values in decibels re 20 μPa.

ii) To avoid misapplication of data

If declared A-weighted sound power levels were expressed in decibels, users may mistakenly compare the sound power levels with workplace regulations of immission sound pressure levels. In many information technology and telecommunications equipment applications, the sound power level (in decibels) value of the equipment is significantly larger than the immission sound pressure level (in decibels) value measurable in the workplace. The later, immission value is the level at human ear location in a given environment which changes with the acoustic environment, such as room size, acoustical attenuation property of floor, wall, ceiling, doors, windows and room partitions, etc. while the sound power level value is an intrinsic property of equipment that does not change with the environment it is placed in.

iii) To promote the use of ECMA-109

The purpose of ECMA-109 is to provide uniform methods of presenting declared noise emission values to users. Without using bels, this objective would be lost since there would be an incentive for some manufacturers to report emission sound pressure levels instead of sound power levels. The primary descriptor of information technology and telecommunications equipment noise is the declared mean A-weighted sound power level, $L_{WA,m}$. If ECMA-109 were to use decibels for declared A-weighted sound power levels, manufacturers who do not implement this Ecma Standard would be at a competitive advantage by reporting emission sound pressure levels in decibels which would be lower than the declared sound power levels also in decibels. Not only would the user be confused, and unable to tell the difference, but the manufacturer who followed ECMA-109 would be at an unfair competitive disadvantage. To eliminate this confusion and disadvantage and to promote the uniform reporting of declared noise emission values, the declared A-weighted sound power levels must be reported in bels.

iv) To use a method based on successful experience

For several years, many international companies, members of Ecma, have reported A-weighted sound power levels in bels and A-weighted emission sound pressure levels in decibels without confusion of their customers. Indeed, their customers have been able to distinguish easily between the important difference of sound power level and emission sound pressure level, and the users have not lost the significance of the digit after the decimal mark. Actually they have been less confused: without using bels, they would wonder: "which decibel do I compare to our specification?".

v) To be consistent with other Ecma and ISO standards

The use of bels for declared A-weighted sound power levels is consistent with ISO 4871 "Acoustics — Declaration and verification of noise emission values of machinery and equipment" and with ISO 7574-1 "Acoustics — Statistical methods for determining and verifying stated noise emission values of machinery and equipment — Part 1: General considerations and definitions". The statistical upper limit A-weighted sound power level, $L_{WA,c}$, is a statistical upper limit value and corresponds to the "declared single-number noise emission value" in ISO 4871 and "labelled value" in ISO 7574-1. The definition of "declared single-number noise emission value " in ISO 4871 and "labelled value" in ISO 7574-1 has a note which states that in some cases, the labelled value may be expressed as the numerical value of sound power level in decibels divided by 10, given with one digit after the decimal mark, *i.e.* in bels. ECMA-109 recognizes that the sound power is determined in decibels, in accordance with either ECMA-74 which is based upon ISO 3741, ISO 3744 or ISO 3745, and is then reported to the customers as a declared value in bels.

The first edition of Standard ECMA-109 was processed by ISO under the fast-track procedure and led to International Standard ISO 9296[4]. The second edition has been adapted to the final wording of ISO 9296.

The third edition was adapted to allow for the determination of declared sound power level based on measurements made in accordance with ECMA-160[6] (using sound intensity) as an alternative to ECMA-74 (reverberation test room or hemi-anechoic room).

The fourth edition corrected minor errors in the third edition, including re-arrangements of the text, and clarified the procedure when only a single machine from a batch has been measured and there is no prior knowledge of the standard deviation of production.

The fifth edition changed Annex A to be normative rather than informative, and added an additional quantity to the declared value when the mean value is based on five or fewer units[8]. It also removed the single equipment sound power level declaration clause due to statistical concerns. In addition, descriptions related to ECMA-160 were removed to align with sound power determination in accordance with ECMA-74.

This sixth edition changes the focus of the declaration to be the mean sound power level rather than the statistical upper limit. In order to maintain compatibility with existing purchasing specifications, eco labels, and other standards which reference the statistical upper limit, all information needed to calculate the upper limit is required in the declaration. The additional guard band for declarations based on small sample sizes added in the fifth edition is changed to being informative rather than normative.

This Ecma Standard has been adopted by the General Assembly of December 2012.

Declared Noise Emission Values of Information Technology and Telecommunications Equipment

1 Scope

This Ecma Standard applies to information technology and telecommunications equipment.

This Ecma Standard specifies:

- the method for determining the mean A-weighted sound power level, $L_{W\mathrm{A,m}}$ for a batch of machines,
- the method for determining the mean A-weighted emission sound pressure level, $L_{p\mathrm{A,m}}$ for a batch of machines,
- the method for determining the statistical adder for verification, K_{v} for a batch of machines,
- the method for determining the statistical upper limit A-weighted sound power level, $L_{W\mathrm{A,c}}$ for a batch of machines to be used for verification,
- acoustical and product information to be published electronically or in hard-copy format in technical documents or other product literature supplied to users by the manufacturer, and
- the method for verifying the noise emission values that are published or stated by the manufacturers and other product suppliers.

The uniform methods in this Ecma Standard use the noise emission data obtained in accordance with ECMA-74, and the procedures specified in ISO 4871 and ISO 7574-4.

The basic noise emission values to be declared or stated are the mean A-weighted sound power level, $L_{W\mathrm{A,m}}$ and the mean A-weighted emission sound pressure level at the operator or bystander positions, $L_{p\mathrm{A,m}}$. These are arithmetic mean values based upon measurements on a sample of machines in accordance with ECMA-74.

For verification purposes, an additional quantity is required to be stated or declared: the so-called statistical adder for verification. This is a factor that is added to the mean A-weighted sound power level and used in the verification section of this Standard to provide a consistent and predictable probability of acceptance for the batch of equipment.

The mean A-weighted sound power level for the batch of machines 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[7].

Although the most useful quantity for calculating immission levels due to one or more sound 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 mean A-weighted sound power level, $L_{W\mathrm{A,m}}$ is stated in bels (B) and the A-weighted emission sound pressure level, $L_{p\mathrm{A,m}}$ is stated in decibels (dB).

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.

ECMA-74, *Measurement of airborne noise emitted by information technology and telecommunications equipment*

ISO 4871, *Acoustics — Declaration and verification of noise emission values of machinery and equipment*

ISO 7574-1, *Acoustics — Statistical methods for determining and verifying stated noise emission values of machinery and equipment, Part 1: General considerations and definitions*

ISO 7574-4, *Acoustics — Statistical methods for determining and verifying stated noise emission values of machinery and equipment, Part 4: Methods for stated values for batches of machines*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply. They are grouped in three categories, general definitions, acoustical definitions and statistical definitions.

General definitions

3.1
information technology and telecommunications equipment
equipment for information processing, and components thereof, used in homes, offices, sever installations, telecommunications installations or similar environments

3.2
batch (lot) of equipment
a 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 The batch may be either an entire production series or a portion thereof.

3.3
operating mode
condition specified in ECMA-74 in which the equipment being tested is performing its intended function(s)

NOTE When possible to implement for acoustic testing, the conditions specified in the relevant annex of ECMA-74 are considered to be typical of average end use.

3.4
idle mode
one or more steady-state condition specified in ECMA-74, in which the equipment being tested is energized, but is not performing any intended function(s)

Acoustical definitions

3.5
A-weighted sound power level, $L_{W\mathrm{A}}$ in decibels
the sound power level of the equipment, determined for a particular unit in accordance with ECMA-74, with A-weighting applied

3.6
A-weighted emission sound pressure level, L_{pA} in decibels
the emission sound pressure level of the equipment, determined for a particular unit in accordance with ECMA-74, with A-weighting applied, at the operator position(s), or at the bystander positions if no operator position is specified

3.7

sample mean A-weighted sound power level, $\overline{L_{WA}}$ in decibels

the arithmetic average of the A-weighted sound power levels determined for a random sample of machines taken from the batch

NOTE This is not a declared value, but is an interim value to be used for the purpose of calculating sample standard deviation of production, s_p of the batch under consideration (see 3.15).

3.8
mean A-weighted sound power level, $L_{WA.m}$ in bels
the arithmetic average of the A-weighted sound power levels for the batch of equipment, given in bels, and rounded to the nearest 0,05 B

3.9

sample mean A-weighted emission sound pressure level, $\overline{L_{pA}}$ in decibels

the arithmetic average of the A-weighted emission sound pressure levels determined for a random sample of machines taken from the batch

3.10
mean A-weighted emission sound pressure level, $L_{pA,m}$ in decibels
the arithmetic average of the A-weighted emission sound pressure levels for the batch of equipment, rounded to the nearest 0,5 dB

3.11
declared noise emission values
the value of the mean A-weighted sound power level, $L_{WA,m}$ in bels (rounded to the nearest 0,05 B), or the mean A-weighted emission sound pressure level, $L_{pA,m}$ in decibels (rounded to the nearest 0,5 dB), or both, and statistical adder, K_v in bels (rounded to the nearest 0,05 B), declared for all equipment in a batch, when the equipment is new

NOTE 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.

3.12
statistical upper limit A-weighted sound power level, $L_{WA,c}$ in bels
the "limit" of the A-weighted sound power level, in bels (rounded to the nearest 0,05 B), declared for all equipment in a batch, when the equipment is new, which indicates the value below which a specified large proportion (93,5%) of the A-weighted sound power levels of the batch, are expected to lie

NOTE 1 $L_{WA,c}$ corresponds to the labelled value, L_c in ISO 7574-1 and ISO 7574-4. The assumptions and verification procedures of Clause 7 of this Standard for a batch of equipment result in a 95% probability of acceptance if no more than 6,5% of the equipment in a batch has A-weighted sound power levels greater than $L_{WA,c}$.

NOTE 2 The statistical upper limit A-weighted sound power level, $L_{WA,c}$ was called the declared A-weighted sound power level, L_{WAd} in previous versions of this Standard.

Statistical definitions

3.13
standard deviation of repeatability, σ_r
the 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)

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

3.14
standard deviation of reproducibility, σ_R
the standard deviation of sound power level values obtained under reproducibility conditions, that is, the repeated application of the same measurement method on the same equipment at different times and under different conditions (different laboratory, different operator, different apparatus)

NOTE The standard deviation of reproducibility, σ_R, therefore, includes the standard deviation of repeatability, σ_r.

3.15
standard deviation of production, σ_p
the standard deviation of sound power level values obtained on different equipment from a batch of the same family, using the same measurement method under repeatability conditions (same laboratory, same operator, and same apparatus)

3.16
total standard deviation, σ_t
the 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

$$\sigma_t = \sqrt{\sigma_R^2 + \sigma_p^2} \quad (1)$$

3.17
reference standard deviation, σ_M
the total standard deviation in sound power level, specified for the family of machines under consideration which is considered typical for batches from this family

NOTE 1 For the purposes of this Standard, the reference standard deviation for the family of information technology and telecommunications equipment is 2,0 dB. See 7.1.

NOTE 2 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 may estimate his risk of rejection on the basis of both standard deviations, σ_t and σ_M (see ISO 7574-4).

3.18
statistical adder for verification, K_v **in bels**
a factor to be added to the mean A-weighted sound power level, $L_{WA,m}$ in bels, such that there will be a 95% probability of acceptance, when using the verification procedures of this Standard, if no more than 6,5% of the equipment in a batch, when the equipment is new, has A-weighted sound power levels greater than ($L_{WA,m} + K_v$)

NOTE 1 The statistical adder, K_v is determined by the procedures in Annex A.

NOTE 2 The statistical adder for verification, K_v should not be confused with a type of “uncertainty”[9]. Uncertainty is usually well-documented in the underlying measurement standards and generally represents a plus-or-minus variation about 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 Conformance requirements

4.1 For declaration

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

a) for the acoustical noise measurements, the measurement procedures and the installation and the operating conditions are in full conformance with ECMA-74, and

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

4.2 For verification

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

a) for the verification of the statistical upper limit A-weighted sound power level, $L_{W\mathrm{A,c}}$, 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

In order to determine the declared noise emission values for a batch of equipment, a random sample shall be drawn from the batch of new machines under consideration. The mean A-weighted sound power level, $L_{W\mathrm{A,m}}$ and the mean A-weighted emission sound pressure level, $L_{p\mathrm{A,m}}$ (see 3.8 and 3.10, respectively) shall be determined for one or more idle modes and one or more operating modes as defined in ECMA-74. Noise emission levels used to determine these mean values shall be obtained in accordance to ECMA-74. Based on the measured values, declared noise emission values of both $L_{W\mathrm{A,m}}$ and $L_{p\mathrm{A,m}}$, along with the statistical adder for verification, K_{v}, shall be determined in accordance with the procedures of 5.2 through 5.5.

NOTE 1 There are essentially two broad applications of product noise declarations. First, prospective customers may want to know the basic noise emission levels of the IT products 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 ECMA-74 and its underlying standards ISO 3741[1], 3744[2], and ISO 11201[5], are the appropriate quantities for this application. This Standard requires that the mean values of these two quantities for a batch of machines 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 products 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 is the appropriate quantity for this application, and this Standard includes procedures for its determination and for its verification.

NOTE 2 Informally, the terms "declared noise emission values" or "declared values" may be applied to any or all of the quantities $L_{W\mathrm{A,m}}$, $L_{p\mathrm{A,m}}$, $L_{W\mathrm{A,c}}$ and K_{v}. However, when differentiation or specific citation is necessary, the appropriate terminology for each quantity from 3.8, 3.10, 3.12, or 3.18 should be used.

5.2 Determination of the sample mean A-weighted sound power level, $\overline{L_{W\mathrm{A}}}$ in decibels

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

The sample mean A-weighted sound power level, $\overline{L_{W\mathrm{A}}}$ is calculated by taking a random sample from the batch of new equipment under consideration, and determining the A-weighted sound power level, $L_{W\mathrm{A},i}$ in decibels, for each machine in the sample in accordance with ECMA-74. The value of $\overline{L_{W\mathrm{A}}}$ in decibels is then calculated as follows:

$$\overline{L_{WA}} = \frac{1}{M}\sum_{i=1}^{M} L_{WA,i} \text{ dB} \qquad (2)$$

where M is the number of machines in the sample. The values of $L_{WA,i}$ in the summation are not rounded.

NOTE The sample mean $\overline{L_{WA}}$ becomes a better estimate of the true mean μ as the number of machines M in the sample increases.

5.3 Determination of the mean A-weighted sound power level, $L_{WA,m}$ in bels

The value to declare for the mean A-weighted sound power level, $L_{WA,m}$ shall be the value of the sample mean A-weighted sound power level, $\overline{L_{WA}}$ determined in accordance with 5.2, but given in bels, rather than decibels, and rounded to the nearest 0,05 B. That is:

$$L_{WA,m} = \frac{1}{10}\overline{L_{WA}} \text{ B} \qquad (3)$$

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

5.4 Determination of the mean A-weighted emission sound pressure level, $L_{pA,m}$ in decibels

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 calculating the arithmetic mean of the A-weighted emission sound pressure levels for the machines in the random sample by analogy with Equation (2).

$$\overline{L_{pA}} = \frac{1}{M}\sum_{i=1}^{M} L_{pA,i} \text{ dB} \qquad (4)$$

The value declared for $L_{pA,m}$ shall be the value of $\overline{L_{pA}}$ rounded to the nearest 0,5 dB.

5.5 Determination of the value to declare for the statistical adder for verification, K_v in bels

The value of the statistical adder for verification, K_v in bels (see 3.18) shall be determined in accordance with Annex A.

6 Presentation of declared noise emission values

6.1 Required information

The declared noise emission values, $L_{WA,m}$, $L_{pA,m}$ and K_v, determined in accordance with Clause 5, shall each be stated or “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 IT 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 1 The statistical upper limit A-weighted sound power level, $L_{WA,c}$ is easily computed from the declared values $L_{WA,m}$ and K_v, as stated in 7.2. 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 Standard 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 ECMA-109” followed by the values of $L_{WA,m}$, $L_{pA,m}$ and K_v;

- identification of whether $L_{pA,m}$ as defined in ECMA-74 refers to the operator position(s) or to the bystander positions;

- if more than one operating mode in accordance with ECMA-74 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}) may be computed from the sum of $L_{WA,m}$ and K_v.”.

NOTE 2 Declared noise emission values should be given in sales, marketing, technical, or other literature supplied to the user, 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 information technology and telecommunication equipment are applicable only to the statistical upper limit A-weighted sound power level, $L_{WA,c}$, and 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 noise emission measurements and equipment installation and operating conditions that are in accordance with ECMA-74. 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 is consistent with ISO 7574-4, using the single sampling inspection procedure with a verification sample size of n = 3 and with the reference standard deviation σ_M specified as 2,0 dB for the family of information technology and telecommunications equipment.

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

The following procedure is designed for inspection under reproducibility conditions (see 3.14). It may be applied for inspection under repeatability conditions (see 3.13) if there is confidence that there is no significant 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, and measure the A-weighted sound power levels for each in accordance with ECMA-74. The measured values are denoted $L_{WA,1}$, $L_{WA,2}$, and $L_{WA,3}$ in decibels, and their arithmetic mean value, $\overline{L}$ in decibels is given as follows:

$$\overline{L} = \frac{1}{3}\left(L_{WA,1} + L_{WA,2} + L_{WA,3}\right)\text{dB}. \quad (5)$$

The value of the statistical upper limit A-weighted sound power level, $L_{WA,c}$ in bels is computed from the declared mean A-weighted sound power level, $L_{WA,m}$ in bels, and the declared statistical adder for verification, K_v in bels, as follows:

$$L_{WA,c} = L_{WA,m} + K_v \text{ B.} \quad (6)$$

NOTE 1 The value of $L_{WA,c}$ computed from Equation (6) should not be rounded. However, it should be noted that since $L_{WA,m}$ and K_v are each individually rounded to the nearest 0,05 B, the value of $L_{WA,c}$ will be computed to the nearest 0,05 B by default.

NOTE 2 The manufacturer or declarer may have already performed the above calculation 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 0,05 B.

The decision on the acceptability of the statistical upper limit A-weighted sound power level $L_{WA,c}$ for the batch is governed by the following rules:

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

Annex A
(normative)

Procedure for determining the statistical adder for verification, K_v

A.1 General

The procedures in A.2 shall be followed for the determination of the statistical adder for verification, K_V. These procedures are given in order to provide uniform noise declarations for the information technology and telecommunications equipment industry 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 stated or declared by this Standard, but it is easily computed from the 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 manufacturer or product supplier shall take into account the following:

i) The standard deviation of reproducibility, σ_R for sound power level determinations carried out in accordance with ECMA-74: The standard deviation of reproducibility for the A-weighted sound power level is estimated to be 1,5 dB in ECMA-74 for most information technology and telecommunications equipment, and this value is used below for the purposes of this Standard.

ii) The standard deviation of production, σ_p: This is the standard deviation of the A-weighted sound power levels determined from different machines in the batch carried out in accordance with ECMA-74 under repeatability conditions (same laboratory, same operator, same apparatus).

iii) The total standard deviation σ_t for the batch: This 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 equipment (see 3.16).

NOTE The total standard deviation, σ_t for the batch 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.

iv) The procedure for verifying the statistical upper limit A-weighted sound power level, $L_{WA,c}$: This is given in Clause 7 and is consistent with ISO 7574-4 using 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 information technology and telecommunications equipment. 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 mean A-weighted sound power level for the batch, $L_{WA,m}$ is expected to lie approximately $1,5\sigma_M$ below this stated value, $L_{WA,c}$.

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

The declaration and verification procedures of ISO 7574-4 upon which the procedures in this Standard are based assume that the measured values of A-weighted sound power levels of the machines 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, $\overline{L_{WA}}$ (see 5.2) and the sample total standard deviation, s_t defined in Equation (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 machines in the sample is computed as follows:

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

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 ECMA-74:

$$s_t = \sqrt{s_p^2 + \sigma_R^2} = \sqrt{s_p^2 + 1{,}5^2} \quad \text{(A.2)}$$

The values of $\overline{L_{WA}}$ (as computed in 5.2) 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, there may be deviations between the sample mean and the true mean such that the statistical assumptions that yield a known and predictable probability of acceptance may no longer hold. In such cases, an additional “guard band” (described below) may be added when determining the statistical adder for verification, K_v by those declarers who want to maintain or approximate the 95% probability of making a declaration that will be verified even for small sample sizes.

The sample standard deviation of production, s_p may alternatively 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 machines are measured in computing the sample mean $\overline{L_{WA}}$ and sample standard deviation of production, s_p, 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 total standard deviation, σ_t will equal the reference standard deviation, σ_M of 2,0 dB). Higher values may be warranted when the product emits prominent discrete tones, there is significant structure-borne noise, or there is fan speed control that is sensitive to the test temperature.

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

Once the 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 calculated from Equation (A.3). The calculated value shall be given in bels, rounded to the nearest 0,05 B. The reference standard deviation for information technology and telecommunication equipment is σ_M = 2,0 dB (see 3.17).

For all sample sizes:

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

NOTE 1 This equation is based on ISO 7574-4 and for large sample sizes (M > 5) will result in a probability of acceptance of 95%.

NOTE 2 For $M \leq 5$, the probability of making a declaration that will be successfully 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 that will be successfully verified of 95%, the following equation and table may be used by analogy with Equation (A.3):

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

Guard band value, G

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

NOTE 3 The term, G is a guard band as given in this table as a function of the sample size, M. Reference [8] 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 Standard.

Annex B
(informative)

Examples of noise emission declarations

Example 1: Presentation of Single Product or Configuration in One Table

Declared acoustical noise emissions in accordance with ECMA-109		
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**
Mean A-weighted sound power level[1], $L_{WA,m}$ (B)	7,35	7,20
Mean A-weighted emission sound pressure level[2], $L_{pA,m}$ (dB) :	58,5	57,0
Statistical adder for verification, K_v (B) :	0,35	0,35

NOTES:

1. The 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 0,05 B.
2. The 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 0,5 dB.
3. The statistical adder for verification, K_v in bels is a factor to be added to the mean A-weighted sound power level, $L_{WA,m}$, in bels, such that there will be a 95% probability of acceptance, when using the verification procedures of ECMA-109, if no more than 6,5% of the equipment in a batch, when the equipment is new, has A-weighted sound power levels greater than ($L_{WA,m}$ + K_v).
4. The quantity, $L_{WA,c}$ (formerly called L_{WAd}) may be computed from the sum of $L_{WA,m}$ and K_v.
5. All measurements made in conformance with ECMA-74 and declared in conformance with ECMA-109.
6. B, dB, abbreviations for bels and decibels, respectively, where 1 B = 10 dB.

Example 2: Presentation of multiple configurations in one table

Declared noise emission values in accordance with ECMA-109						
Product configuration or variation	**Mean A-weighted sound power level,** $L_{WA,m}$ (B)		**Mean A-weighted emission sound pressure level,** L_{pAm} (dB)		**Statistical adder for verification,** K_v (B)	
	Operating	**Idle**	**Operating**	**Idle**	**Operating**	**Idle**
Server model XYZ, 4.2-GHz, Typical configuration with acoustical door set: Five processor nodes (40-core), two I/O drawers, and bulk power assembly. Air moving devices at nominal speeds.	6,75	6,75	53,0	53,0	0,30	0,30
Server model XYZ 4.2-GHz, Typical configuration with standard, non-acoustical door set: Five processor nodes (40-core), two I/O drawers, and bulk power assembly. Air moving devices at nominal speeds.	7,50	7,50	61,5	61,5	0,30	0,30
Server Model XYZ, 4.2-GHz, Maximum configuration with acoustical door set: Eight processor nodes (40-core), four I/O drawers, and bulk power assembly. Air moving devices at nominal speeds.	7,15	7,15	60,0	60,0	0,30	0,30
Server model XYZ 4.2-GHz, Maximum configuration with standard, non-acoustical door set: Eight processor nodes (40-core), four I/O drawers, and bulk power assembly. Air moving devices at nominal speeds.	7,90	7,90	67,5	67,5	0,30	0,30

NOTES:

1. The 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 0,05 B.
2. The 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 0,5 dB.
3. The statistical adder for verification, K_v in bels is a factor to be added to the mean A-weighted sound power level, $L_{WA,m}$ in bels, such that there will be a 95% probability of acceptance, when using the verification procedures of ECMA-109, if no more than 6,5% of the equipment in a batch, when the equipment is new, has A-weighted sound power levels greater than ($L_{WA,m}$ + K_v).
4. The quantity, $L_{WA,c}$ (formerly called L_{WAd}) may be computed from the sum of $L_{WA,m}$ and K_v.
5. All measurements made in conformance with ECMA-74 and declared in conformance with ECMA-109.
6. B, dB, abbreviations for bels and decibels, respectively, where 1 B = 10 dB.

Annex C
(informative)

Character of noise

C.1 General

This annex presents optional information which may be provided in addition to the declared noise emission values. Information on the character of the noise, that is, whether the noise is considered to be impulsive noise or whether it contains prominent discrete tones, may be of interest to the user of the equipment.

National and international organisations have been working on objective methods for rating the subjective character of noise, however a final consensus on the procedure to be applied has not yet been reached. Furthermore, statistical procedures have to be specified for determining a single description for the character of the noise of batches of equipment.

C.2 Annex status

Although this annex is informative, it contains requirements for fulfilment when the manufacturer has decided declaring characters of noise. These requirements are generally identified through the use of the prescriptive word “shall”.

C.3 Determination of the character of noise

For the specified operator or bystander position(s) it shall be determined whether the equipment emits impulsive noise and/or prominent discrete tones.

C.3.1 Impulsive noise parameter

ECMA-74 shall be used to determine whether the noise is impulsive.

C.3.2 Prominent discrete tones

ECMA-74 shall be used to determine whether a prominent discrete tone is present.

C.4 Information on impulsive noise and prominent discrete tones

The declared noise emission values may be supplemented by one of the following statements, which describe the character of the noise as determined according to C.3:

- no prominent discrete tones, no impulsive noise,
- no prominent discrete tones, impulsive noise,
- prominent discrete tones, no impulsive noise,
- prominent discrete tones and impulsive noise.

Bibliography

[1] ISO 3741, *Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Precision methods for reverberation test rooms*

[2] ISO 3744, *Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Engineering methods for an essentially free field over a reflecting plane*

[3] ISO 3745, *Acoustics — Determination of sound power levels of noise sources using sound pressure — Precision methods for anechoic and hemi-anechoic rooms*

[4] ISO 9296, *Acoustics — Declared noise emission values of computer and business equipment*

[5] ISO 11201, *Acoustics — Noise emitted by machinery and equipment — Determination of emission sound pressure levels at a work station and at other specified positions in an essentially free field over a reflecting plane with negligible environmental corrections*

[6] ECMA-160, *Determination of Sound Power Levels of Computer and Business Equipment using Sound Intensity Measurements; Scanning Method in Controlled Rooms*

[7] ECMA TR/27, *Method for the prediction of installation noise levels*

[8] Eric Baugh, Brian Kluge, and Kaleen Man, “Declared sound power level based on small sample size”, *Noise-Con Proc*. **218**, 2645, 2009.

[9] ISO/IEC Guide 98-3:2008, *Uncertainty of measurement — Part 3: Guide to the expression of uncertainty in measurement* (*GUM:1995*)