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 [9].

- 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. 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 may desire information on A-weighted emission sound pressure levels, L_{pA}. Therefore, this Standard specifies that optionally, A-weighted emission sound pressure levels may be declared in addition to A-weighted sound power levels. In the preparation of this Standard divergences of opinion have been found between various national and international organisations as to the most useful way of presenting noise emission values.

  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 Standard the procedure is restricted to verifying the statistical upper limit A-weighted sound power level, $L_{WA,c}$ only.

The first edition of Standard ECMA-109 was processed by ISO under the fast-track procedure and led to International Standard ISO 9296 [8]. 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 [11] (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 [14]. 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.

The 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.

The seventh edition changes the requirements of the declaration to make the inclusion of the emission sound pressure levels optional. Additionally, it is noted that the future direction of this Standard intends to use of decibels as opposed bels for the declaration of sound power levels. The seventh edition changed the rounding of the sound power levels to the nearest 0,1 B instead of 0,05 B and changed the rounding of emission sound pressure levels to the nearest 1 dB instead of 0,5 dB, both of which were introduced in the sixth edition.

The eighth edition changes the requirements of the declaration to reflect the following updates of ISO 9296:2017, 2nd edition:

— Clause 2, Normative references

- The references were updated and certain documents moved to Bibliography section;

— Clause 3, Terms and definitions

- The terms and definitions were technically revised and divided into 3 categories; 3.1 General definitions, 3.2 Definitions related to acoustics, and 3.3 Definitions related to statistics.

— Clause 4, Conformity requirements

- The title was changed from “Conformance requirements”.

— Annex A, Procedures for determining the statistical adder for verifications, K_v

- For the case of sample size $M \leq 5$, application of guard band, G [using Formula (A.4) and Table A.1] became normative for determining statistical adder for verifications, K_v. However, this method is still option, not intended to mandate to apply the guard band.

— Annex C, Character of noise;

- Since, in Annex E of ECMA-74, the impulsive noise measurement procedure had been deleted, the scope of Annex C was amended to limit to the presence of prominent discrete tones.

— Bibliography

- The standards developed by ISO/TC43 Acoustics /SC1 Noise (i.e. ISO 4871, ISO 7574-1 and ISO 7574-4) were moved from Clause 2.

The ninth edition qualifies the sentence after Formula (2) which previously said to use unrounded values of sound power levels in Formula (2). The additional qualifier states that “if unrounded data are not available, round to 0,1 dB per ECMA-74.” This change is needed since the 17th ECMA-74 reports levels rounded to 0,1 dB, and therefore, unrounded values may not be available.

The tenth edition extends the rounding procedure introduced in the ninth edition for declared mean A-weighted sound power level $L_{W\mathrm{A,m}}$ to the mean A-weighted emission sound pressure level $L_{p\mathrm{A,m}}$.

In addition, some of typographical errors and non-consistent expressions are corrected (but, no technical changes).

This eleventh edition permits declaration of the operator position(s), bystander positions, or both positions. The text justifying the use of bels (B) for the sound power level is removed from the Introduction. Decibels (dB) is now used to declare the sound power level. It also integrates temperature and altitude (indicative of the ambient pressure) into the declaration for equipment with noise levels that vary based on these factors. Annex B was revised to include these changes in the example declarations.

This Ecma Standard was developed by Technical Committee 26 and was adopted by the General Assembly of June 2025.

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:

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 manufacturers or declarer.

NOTE The terms “manufacturer” and “declarer” are used in this Ecma standard 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 Ecma Standard.

The uniform methods in this Standard use the noise emission data obtained in accordance with ECMA-74, 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 level, $L_{WA,m}$. Optionally, the declared mean A-weighted emission sound pressure level at the operator position(s), bystander positions, or both positions, $L_{pA,m}$ can be declared. These are arithmetic mean values based upon measurements on a random sample taken from the batch of equipment, in accordance with ECMA-74.

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 Standard 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 [12].

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.

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*, 17th edition (December 2019)

NOTE This Standard (ECMA-109) together with ECMA-74 comprises the noise test code for ITT Equipment. These Standards are Ecma counterparts of ISO 9296 [8] and ISO 7779 [7], respectively. Both set of noise test codes (Ecma and ISO) are consistent with guidelines specified in ISO 12001 [10].

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.

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, sever installations, telecommunications installations or similar environments

[SOURCE: ISO 7779:2018 [7], 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 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 ECMA-74

NOTE 1 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 ECMA-74. 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 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 In this Ecma standard, 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 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.

3.1.5
idle mode
steady-state condition (one or more) specified in ECMA-74, 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 ECMA-74, with A-weighting applied

NOTE 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 of the equipment, determined for a particular unit of *ITT equipment* (3.1.1) in accordance with ECMA-74, with A-weighting applied, at the operator position(s) or at the bystander positions

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

NOTE 2 This is not a declared noise emission 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 3.3.3).

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

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 of taken from the *batch of equipment* (3.1.2)

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

NOTE 2 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
$L_{p\mathrm{A,m}}$
arithmetic average of the A-weighted emission sound pressure levels for *the batch of equipment* (3.1.2), used for noise emission declaration

NOTE The declared mean A-weighted emission sound pressure level, $L_{p\mathrm{A,m}}$ (re 20 μPa) is expressed in decibels.

3.2.7
declared noise emission values
value of *the declared mean A-weighted sound power level* (3.2.4), $L_{W\mathrm{A,m}}$, or *the declared mean A-weighted emission sound pressure level* (3.2.6), $L_{p\mathrm{A,m}}$, or both, and *the statistical adder for verification* (3.3.6), K_{v}, declared for the batch of new equipment

NOTE Based on $L_{W\mathrm{A,m}}$ and K_{v}, the statistical upper limit A-weighted sound power level, $L_{W\mathrm{A,c}}$ can be computed in accordance with Clause 7.

3.2.8
statistical upper limit A-weighted sound power level
$L_{W\mathrm{A,c}}$
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 The statistical upper limit A-weighted sound power level, $L_{W\mathrm{A,c}}$ (re 1 pW) is expressed in decibels.

NOTE 2 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 $L_{W\mathrm{A,c}}$, and the verification procedures therein are used. Strictly speaking, this statement is only true when $\sigma_{\mathrm{t}} = \sigma_{\mathrm{M}}$ (3.3.4 and 3.3.5).

NOTE 3 The statistical upper limit A-weighted sound power level, $L_{W\mathrm{A,c}}$ was called the declared A-weighted sound power level, $L_{W\mathrm{Ad}}$ in the 5th edition or earlier of this Standard.

NOTE 4 The percentile value of 93,5 % is fixed in this Standard to represent the statistical upper limit, but in principle any other percentile value can readily be determined from standard normal tables if the mean and total standard deviation (3.3.4) are known or closely approximated.

3.3 Definitions relating to statistics

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

3.3.1
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 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 equipment 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

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

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 For the purposes of this Standard, the reference standard deviation for the family of ITT equipment is fixed to 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 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* (3.2.4), $L_{WA,m}$, 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 batch of new equipment has A-weighted sound power levels greater than ($L_{WA,m}$ + K_v)

NOTE 1 The statistical adder for verification, K_v is expressed in decibels.

NOTE 2 K_v is determined by the procedures in Annex A.

NOTE 3 The statistical adder for verification, K_v should not be confused with a type of uncertainty [13]. 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.

NOTE 4 Strictly speaking, the probability statement given above is only true when $\sigma_t = \sigma_M$ (3.3.4 and 3.3.5). That is, if $\sigma_t > \sigma_M$, there will still be at least a 95 % probability of acceptance using the verification procedures in Clause 7, even if somewhat more than 6,5 % have A weighted sound power levels greater than ($L_{WA,m}$ + K_v). Similarly, if $\sigma_t < \sigma_M$, the percentage of A weighted sound power levels greater than ($L_{WA,m}$ + K_v) would have to be smaller than 6,5 % in order to have at least a 95 % probability of acceptance.

4 Conformity requirements

4.1 For declaration

Declarations are in conformity with this Standard 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 ECMA-74;

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 Standard 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 ECMA-74;

b) 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

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, $L_{W\mathrm{A}}$ shall be determined for one or more idle modes and one or more operating modes as defined in ECMA-74. Optionally, the A-weighted emission sound pressure level, $L_{p\mathrm{A}}$, 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, $L_{W\mathrm{A,m}}$, 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, $L_{p\mathrm{A,m}}$, 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 ECMA-74, are the appropriate quantities for this application. This Ecma Standard requires that the mean values of these two quantities, $L_{W\mathrm{A,m}}$ and $L_{p\mathrm{A,m}}$, for a batch of machines be declared.

Second, some prospective customers, or government regulators, especially those considering the purchase of large quantities of equipment, would like to be able to apply an acceptance sampling method on a small sample of units in order to verify that the declared noise emission value is valid for the entire batch, and thus be able to accept or reject the batch. The statistical upper limit A-weighted sound power level, $L_{W\mathrm{A,c}}$, is a useful quantity for this application, and this Standard 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 sample mean A-weighted sound power level, $\overline{L_{WA}}$ shall be 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 ECMA-74. The value of $\overline{L_{WA}}$, in decibels, is then computed using Formula (2):

$$\overline{L_{WA}} = \frac{1}{M} \sum_{i=1}^{M} L_{WA,i} \tag{2}$$

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

The values of $L_{WA,i}$ in the summation are not rounded; if unrounded data are not available, round to the nearest 0,1 dB per ECMA-74.

NOTE 1 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. ISO 7574-4 states that a "reasonably large number of measured values" should be used to compute the declared values.

NOTE 2 The "sample" described above should not be confused with the "sample" used for verification in Clause 7. The sample used to determine the values to declare should be as large as practical (expressed with symbol, M), whereas the sample used to verify the declared values is small (n = 3 in this Standard).

The declared 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 according to Formula (2), rounded to the nearest 1,0 dB.

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

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 the operator position(s), bystander positions, or both positions, as applicable, shall be computed by taking a random sample from the batch of new equipment under consideration, and determining the A-weighted emission sound pressure levels, $L_{pA,i}$ in decibels, for each unit in the sample in accordance with ECMA-74. The value of $\overline{L_{pA}}$, in decibels, shall be then computed using Formula (3).

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

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

The values of $L_{pA,i}$ in the summation are not rounded; if unrounded data are not available, round to the nearest 0,1 dB per ECMA-74.

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

See Annex B for examples of declaration meeting the requirements of this standard.

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, $L_{WA,m}$, K_v, and optionally the value $L_{pA,m}$ 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 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 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 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;
- for products that are known or reasonably likely to have varying noise emission values in a prescribed manner due to the ambient temperature and/or altitude, identify the values of the ambient temperature and/or altitude, respectively (the equivalent ambient pressure can alternatively be stated in lieu of the altitude);
- the words “Declared noise emission values in accordance with ECMA-109” followed by the values of $L_{WA,m}$, K_v, and optionally $L_{pA,m}$;
- identification of whether each $L_{pA,m}$, if declared, refers to the operator position(s) or to the bystander positions as defined in ECMA-74;
- 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.”.

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 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 noise emission measurements using the procedures of the installation and operating conditions 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 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 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. Measure the A-weighted sound power levels for each unit 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 in Formula (4):

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

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

The value of the statistical upper limit A-weighted sound power level, $L_{WA,c}$ in decibels is computed using Formula (5) from the declared mean A-weighted sound power level, $L_{WA,m}$, in decibels, and the statistical adder for verification, K_v in decibels, 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:

$$L_{WA,c} = L_{WA,m} + K_v \, . \qquad (5)$$

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 it has been rounded to the nearest 1,0 dB.

NOTE If the values for $L_{WA,c}$, $L_{WA,m}$, or K_v, are already provided, check to ensure that the values are in decibels, not bels.

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

- If $\bar{L} \leq (L_{WA,c} - 1{,}1\ \mathrm{dB})$, the value of $L_{WA,c}$ is confirmed as verified for the batch, (6A)
- If $\bar{L} > (L_{WA,c} - 1{,}1\ \mathrm{dB})$, the value of $L_{WA,c}$ is not confirmed as verified for the batch. (6B)

NOTE The above criterion formulae, which can be put in the form $\bar{L} \leq A$ and $\bar{L} > A$ are derived from ISO 7574-4:1985 [6], Formula (5) which can be written in the form:

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

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 σ_M =2,0 dB defined in this document, the above expressed in decibels, reduces to the following:

$$A = L_{WA,c} - 0{,}564\sigma_M = L_{WA,c} - 1{,}1\ dB$$

Annex A
(normative)

Procedure for determining the statistical adder for verification, K_v

A.1 General

This procedure 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 declared by this Standard, 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:

i) The standard deviation of reproducibility, σ_R (see 3.3.2) for A-weighted sound power level, L_{WA}, 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, (see 3.3.3) for the standard deviation of the A-weighted sound power levels determined from different units in the sample of 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 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 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.

iv) The procedure for verifying the statistical upper limit A-weighted sound power level, $L_{WA,c}$, (see Clause 7) is consistent with ISO 7574-4, the single sampling inspection procedure with a verification sample size n = 3 and a reference standard deviation σ_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 σ_M below $L_{WA,c}$.

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 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, $\overline{L_{WA}}$, 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 machines in the sample is computed according to Formula (A.1):

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

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:

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

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 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 sample total standard deviation, σ_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 decibels, rounded to the nearest 1,0 dB. The reference standard deviation for ITT equipment is σ_M = 2,0 dB (see 3.3.5).

For all sample sizes:

$$K_v = [1{,}514 s_t + 0{,}564(\sigma_M - s_t)] \quad \text{(A.3)}$$

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 % provided that 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 in Clause 7 are followed. The constant, 1,514, is the quantile value of the normal distribution curve corresponding to 93,5 % probability.

For M ≤ 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 ≤ 5 to maintain or approximate a probability of making a declaration that will be successfully verified of 95 %, Formula (A.4) and Table A.1 can be used by analogy with Formula (A.3):

$$K_v = [1{,}514 s_t + 0{,}564(\sigma_M - s_t) + G] \quad \text{(A.4)}$$

Table A.1 – 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 2 The term, G is a guard band as given in Table A.1 as a function of the sample size, M. Reference [14] 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 single configuration with sound pressure level data for bystander positions.

Declared noise emission values 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**
Declared mean A-weighted sound power level [a], $L_{WA,m}$ (dB) :	74	72
Declared mean A-weighted emission sound pressure level [b], $L_{pA,m}$ (dB) :	59	57
Statistical adder for verification [c], K_v (dB) :	4	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, rounded to the nearest 1,0 dB.

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, rounded to the nearest 1 dB.

c) The statistical adder for verification, K_v is a factor 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 ECMA-109, if no more than 6,5 % of the equipment in a batch, 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 ECMA-74 and declared in conformance with ECMA-109.

NOTE 3 dB is the abbreviation for decibels.

Example 2: Presentation of multiple configurations and ambient temperature conditions with sound pressure level data for bystander positions for a product that has its noise emissions vary with temperature and altitude.

Declared noise emission values in accordance with ECMA-109

Product configuration or variation [a)]	Declared mean A-weighted sound power level [b)], $L_{WA,m}$ (B)		Declared mean A-weighted emission sound pressure level [c)], $L_{pA,m}$ (dB)		Statistical adder for verification [d)], 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 operating under a typical workload and a 23 C ambient environment.	68	68	53	53	3	3
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 operating under a typical workload and a 25 C ambient environment.	75	75	61	61	3	3
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 operating under a typical workload and a 22 C ambient environment.	71	71	60	60	3	3
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 operating under a typical workload and a 28 C ambient environment.	79	79	68	68	3	3

a) System operation based on installation at an altitude of 200 m, corresponding to a 99 kPa ambient pressure.

b) 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, rounded to the nearest 1,0 dB.

c) 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, rounded to the nearest 1 dB.

d) The statistical adder for verification, K_v is a factor to be added to the 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 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).

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

NOTE 2 All measurements made in conformance with ECMA-74 and declared in conformance with ECMA-109.

NOTE 3 dB is the, abbreviation for decibels.

Example 3: Presentation of single product and single configuration with sound pressure level data for bystander and operator positions for a product that has its noise emissions vary with temperature and altitude.

Declared noise emission values 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 in a 24 °C ambient environment at an altitude of 500 m above sea level	
Quantities declared		**Operating mode**	**Idle mode**
Declared mean A-weighted sound power level a), $L_{WA,m}$ (dB)		74	72
Declared mean A-weighted emission sound pressure level b), $L_{pA,m}$ (dB)	Bystander	59	57
	Operator: Front	68	66
	Operator: Rear	63	60
Statistical adder for verification c), K_v (dB)		4	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.

b) The declared mean A-weighted emission sound pressure level, $L_{pA,m}$ is computed as the arithmetic average of the 1-meter bystander position measurements, or it is the maximum 0.5-meter operator position at the front or rear face with the doors opened.

c) The statistical adder for verification, K_v is a factor 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 ECMA-109, if no more than 6,5 % of the equipment in a batch, 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 ECMA-74 and declared in conformance with ECMA-109.

NOTE 3 dB is the abbreviation for decibels.

Example 4: Presentation of multiple configurations and meteorological conditions with sound pressure level data for bystander and operator positions for a product that has its noise emissions vary with temperature and altitude.

Declared noise emission values in accordance with ECMA-109

Product configuration or variation	**Declared mean A-weighted sound power level** a), $L_{WA,m}$ (dB)		**Declared mean A-weighted emission sound pressure level** b), $L_{pA,m}$ (dB) **Bystander** --------------------------- **Operator (Front)** --------------------------- **Operator (Rear)**		**Statistical adder for verification** c), K_v (dB)	
	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 operating under a typical workload in a 23 C ambient temperature at sea level (101.3 kPa ambient pressure).	68	68	53 ----- 66 ----- 62	53 ----- 66 ----- 62	3	3
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 operating under a typical workload in a 35 C ambient temperature and 3000 m above sea level (71.9 kPa ambient pressure).	75	75	61 ----- 74 ----- 70	61 ----- 74 ----- 70	3	3
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 operating under a typical workload in a 23 C ambient temperature at sea level (101.3 kPa ambient pressure).	71	71	60 ----- 73 ----- 70	60 ----- 73 ----- 70	3	3
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 operating under a typical workload in a 35 C ambient temperature and 3000 m above sea level (71.9 kPa ambient pressure).	79	79	68 ----- 80 ----- 76	68 ----- 80 ----- 76	3	3

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.

b) The declared mean A-weighted emission sound pressure level, $L_{pA,m}$ is computed as the arithmetic average of the 1-meter bystander position measurements, or it is the maximum 0.5-meter operator position at the front or rear face with the doors opened.

c) The statistical adder for verification, K_v is a factor to be added to the 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 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).

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

NOTE 2 All measurements made in conformance with ECMA-74 and declared in conformance with ECMA-109.

NOTE 3 dB is the abbreviation for decibels.

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 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 shall 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

C.3.1 General

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

C.3.2 Procedure for detecting prominent discrete tones

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

C.4 Information on 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:

1) no prominent discrete tones;

2) prominent discrete tones;

Items 1) through 2) shall be supplemented with a statement of the method used to identify prominent discrete tones.

Bibliography

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

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