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Acoustics — Declaration and verification of noise emission values of machinery and equipment

Acoustique — Déclaration et vérification des valeurs d'émission sonore des machines et équipements

Reference number
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Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 4871 was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 1, *Noise*.

This second edition cancels and replaces the first edition (ISO 4871:1984), which has been technically revised.

Annexes A, B, C and D of this International Standard are for information only.

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Introduction

Information on the acoustic noise emitted by machinery and equipment is needed by users, planners, manufacturers and authorities. This information is required for comparing the noise emitted by different products, for assessing noise emissions against noise limits, for planning workplace noise levels, as well as for checking noise reduction achievements, and may be used for estimating requirements for workplace noise immission.

In order for machinery noise emission data to be useful, uniform methods of measurement and declaration are necessary to achieve the following purposes.

a) **Measurement of noise emission**

The ISO 3740 series specifies methods for determining the sound power levels of noise sources from sound pressure level measurements; the ISO 9614 series specifies methods for determining the sound power levels from sound intensity level measurements; the ISO 11200 series describes methods for determining emission sound pressure levels at specified positions in the vicinity of machinery and equipment. Many other standards give test codes for the measurement of the noise emissions of individual types of machinery which are based on these methods.

b) **Determination of the noise emission value to be declared**

The ISO 7574 series gives methods for determining declared noise emission values which are based primarily on the sound power levels of noise sources. For a complete presentation of declared noise emission values, it is necessary to state the sound pressure levels at specified positions as well as the sound power level. Because of the possible confusion in terminology with respect to sound pressure levels used to define noise immission, the term "emission sound pressure level" is used in this International Standard.

c) **Presentation of declared noise emission values**

It is of prime importance to declare sound power levels. It is recognized, however, that information on emission sound pressure levels is sometimes required. It is recommended, therefore, that both kinds of quantity be declared, unless otherwise specified. Noise emission declarations can take the form of either a single-number or dual-number presentation; the choice is made in the noise test code appropriate to the particular family.

d) **Verification of declared noise emission values**

The ISO 7574 series gives procedures for the verification of a declared noise emission value. In that International Standard, the procedures are applied to verification of declared sound power levels. The procedures of this International Standard are applied to the verification of both sound power levels and emission sound pressure levels. The information in this International Standard on the verification of declared noise emission values may be used both by a buyer of equipment to compare the relative noise levels of various products, and by a manufacturer as part of a statistical quality control programme.

Requirements on the declaration of noise emission values are given in clause 4.

As the declaration of noise emission of machinery and equipment is the responsibility solely of the manufacturer or supplier, guidelines concerning the declaration are found in annex A.

Requirements on the presentation of declared noise emission values are given in clause 5 and annex B, and those on verification are given in clause 6 and annex C.

Acoustics — Declaration and verification of noise emission values of machinery and equipment

1 Scope

This International Standard

— gives information on the declaration of noise emission values,

— describes acoustical and product information to be presented in technical documents for the purposes of noise emission declaration, and

— specifies a method for verifying the noise emission declaration.

It is applicable to machinery and equipment.

The values to be used for the purposes of noise emission declaration are either declared single-number noise emission values, L_d, or declared dual-number noise emission values, L and K. L is a noise emission value determined directly from measurements and K is the uncertainty associated with those measurements. L_d is the sum of L and K and represents an upper limit which values from repeated measurements are unlikely to exceed at a given confidence level; L_d corresponds to the stated or labelled value, L_c, defined in ISO 7574-1.

The two forms of noise declaration are alternative means of representing any or all of the A-weighted sound power level, L_{WA}, the A-weighted emission sound pressure level at specified positions, L_{pA}, and the C-weighted peak emission sound pressure level at specified positions, $L_{pC,peak}$. The choice as to which of the two forms is used in a particular case depends upon the requirements to be fulfilled. This selection is made, and guidance on the values of K is given, in the appropriate noise test code.

Guidelines for determining declared noise emission values are given in annex A.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 3740:1980, *Acoustics — Determination of sound power levels of noise sources — Guidelines for the use of basic standards and for the preparation of noise test codes.*

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

ISO 3743-1:1994, *Acoustics — Determination of sound power levels of noise sources — Engineering methods for small, movable sources in reverberant fields — Part 1: Comparison method for hard-walled test rooms.*

ISO 3743-2:1994, *Acoustics — Determination of sound power levels of noise sources using sound pressure — Engineering methods for small, movable sources in reverberant fields — Part 2: Methods for special reverberation test rooms.*

1) To be published. (Revision of ISO 3741:1988 and ISO 3742:1988)

ISO 3744:1994, *Acoustics — Determination of sound power levels of noise sources using sound pressure — Engineering method in an essentially free field over a reflecting plane.*

ISO 3745:1977, *Acoustics — Determination of sound power levels of noise sources — Precision methods for anechoic and semi-anechoic rooms.*

ISO 3746:1995, *Acoustics — Determination of sound power levels of noise sources using sound pressure — Survey method using an enveloping measurement surface over a reflecting plane.*

ISO 3747:1987, *Acoustics — Determination of sound power levels of noise sources — Survey method using a reference sound source.*

ISO 7574-1:1985, *Acoustics — Statistical methods for determining and verifying stated noise emission values of machinery and equipment — Part 1: General considerations and definitions.*

ISO 7574-2:1985, *Acoustics — Statistical methods for determining and verifying stated noise emission values of machinery and equipment — Part 2: Methods for stated values for individual machines.*

ISO 7574-4:1985, *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.*

ISO 9614-1:1993, *Acoustics — Determination of sound power levels of noise sources using sound intensity — Part 1: Measurement at discrete points.*

ISO 9614-2:1996, *Acoustics — Determination of sound power levels of noise sources using sound intensity — Part 2: Measurement by scanning.*

ISO 11200:1995, *Acoustics — Noise emitted by machinery and equipment — Guidelines for the use of basic standards for the determination of emission sound pressure levels at a work station and at other specified positions.*

ISO 11201:1995, *Acoustics — Noise emitted by machinery and equipment — Measurement of emission sound pressure levels at a work station and at other specified positions — Engineering method in an essentially free field over a reflecting plane.*

ISO 11202:1995, *Acoustics — Noise emitted by machinery and equipment — Measurement of emission sound pressure levels at a work station and at other specified positions — Survey method in situ.*

ISO 11203:1995, *Acoustics — Noise emitted by machinery and equipment — Determination of emission sound pressure levels at a work station and at other specified positions from the sound power level.*

ISO 11204:1995, *Acoustics — Noise emitted by machinery and equipment — Measurement of emission sound pressure levels at a work station and at other specified positions — Method requiring environmental corrections.*

IEC 651:1979, *Sound level meters*, and Amendment 1:1993.

IEC 804:1985, *Integrating-averaging sound level meters*, and Amendment 1:1989 and Amendment 2:1993.

3 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1 machinery and equipment: An assembly of linked parts or components with the appropriate actuators, control and power circuits, etc., joined together for a specific application. Also included in this definition is an assembly of machines which, in order to achieve the same end, are arranged and controlled so that they function as a whole.

3.2 family of machinery or equipment: Machinery or equipment of similar design or type, intended to perform the same functions.

3.3 batch (lot) of equipment: A number of units of machinery or equipment of the same family produced in quantity, manufactured to the same technical specifications and characterized by the same declared noise emission values.

NOTE 1 The batch may be either an entire production series or a portion thereof.

3.4 operating mode: A condition in which the machinery or equipment is performing its intended function for the purpose of determining its noise emission values.

3.5 emission: Airborne sound radiated by a well-defined noise source (e.g. the machine under test) under specified operating and mounting conditions.

NOTE 2 Emission values may be incorporated in a product label and/or product specification. The basic noise emission quantities are the sound power level of the source itself and the emission sound pressure levels at a work station and/or at other specified positions (if any) in the vicinity of the source.

3.6 emission sound pressure, p: The sound pressure, at a specified position near a noise source, when the source is in operation under specified operating and mounting conditions on a reflecting plane surface, excluding the effects of background noise and of reflections other than those from the plane or planes permitted for the purpose of the test. It is expressed in pascals.

3.7 emission sound pressure level, L_p: Ten times the logarithm to base 10 of the ratio of the square of the emission sound pressure, $p^2(t)$, to the square of the reference sound pressure, p_0^2, measured with a particular time weighting and a particular frequency weighting, selected from those defined in IEC 651. It is expressed in decibels. The reference sound pressure is 20 μPa.

NOTES

3 Examples include:

— maximum A-weighted emission sound pressure level with time weighting F: L_{pAFmax};

— C-weighted peak emission sound pressure level, $L_{pC,peak}$.

4 The single-event emission sound pressure level is sometimes used and is defined in ISO 11201 to ISO 11204.

The emission sound pressure level shall be determined at a specified position and in accordance with either a test code for a specific family of machines or, if no code exists, a method that complies with the ISO 11200 series.

3.8 time-averaged emission sound pressure level, L_{peqT}: Emission sound pressure level of a continuous steady sound that, within a measurement time interval, T, has the same mean square sound pressure as a sound under consideration which varies with time. It is expressed in decibels.

It is given by the following equation:

$$L_{peqT} = 10 \lg \frac{1}{T} \int_0^T \frac{p^2(t)}{p_0^2} \mathrm{d}t \quad \text{dB} \qquad \ldots (1)$$

A-weighted time-averaged emission sound pressure levels are denoted by L_{pAeqT}, which is usually abbreviated to L_{pA}. L_{pAeqT} shall be measured with an instrument which complies with the requirements of IEC 804.

NOTES

5 In general, the subscripts "eq" and "T" are omitted since time-averaged emission sound pressure levels are necessarily determined over a certain measurement time interval.

6 Equation (1) is identical to that for the familiar ISO environmental noise descriptor "equivalent continuous sound pressure level" defined in ISO 1996-1. However, the emission quantity defined above is used to characterize the noise emitted by a machine under test and assumes that standardized measurement and operating conditions as well as a controlled acoustical environment are used for the measurements.

3.9 sound power, W: The rate per unit time at which airborne sound energy is radiated by a source. It is expressed in watts.

3.10 sound power level, L_W: Ten times the logarithm to the base 10 of the ratio of the sound power radiated by the source under test to the reference sound power. It is expressed in decibels.

The frequency weighting or the width of the frequency band used shall be indicated. The reference sound power is 1 pW (10^{-12} W).

NOTE 7 For example, the A-weighted sound power level is L_{WA}.

3.11 noise emission value: A general term by which any one or more of the A-weighted sound power level, L_{WA}, or the A-weighted time-averaged emission sound pressure level, L_{pA}, or the C-weighted peak emission sound pressure level, $L_{pC,peak}$, is inferred.

3.12 measured noise emission value, L: The A-weighted sound power level, or the A-weighted time-averaged emission sound pressure level, or the C-weighted peak emission sound pressure level, as determined from measurements. Measured values may be determined either from a single machine or from the average of a number of machines, and are not rounded.

3.13 noise emission declaration: Information on the noise emitted by the machine, given by the manufacturer or supplier in technical documents or other literature concerning noise emission values. The noise emission declaration may take the form of either the declared single-number noise emission value or the declared dual-number noise emission value.

3.14 uncertainty, K: Value of the measurement uncertainty associated with a measured noise emission value. It is expressed in decibels.

NOTE 8 Guidance on appropriate values for K is given in annex A.

3.15 declared single-number noise emission value, L_d: The sum of a measured noise emission value and the associated uncertainty, rounded to the nearest decibel:

$$L_d = L + K$$

NOTE 9 ISO 9296 requires that the declared A-weighted sound power level, L_{WAd}, of computers and business equipment be expressed in bels using the identity 1 B = 10 dB, rounded to the nearest 0,1 B.

3.16 declared dual-number noise emission value, L and K: A measured noise emission value, L, and its associated uncertainty K, both rounded to the nearest decibel.

NOTE 10 If a specific noise test code requires that the mean emission sound pressure level from a number of specified positions be declared, it is denoted by L_{pAm}.

3.17 work station; operator's position: A position in the vicinity of the machine under test which is intended for the operator.

3.18 operator: An individual whose work station is in the vicinity of a machine and who is performing a work task associated with that machine.

3.19 specified position: A position defined in relation to a machine, including, but not limited to, an operator's position. The position can be a single, fixed point, or a combination of points along a path or on a surface located at a specified distance from the machine, as described in the relevant noise test code, if any.

NOTE 11 In ISO 7779 and ISO 9296, positions on the path are identified as "bystander positions".

3.20 standard deviation of repeatability, σ_r: Standard deviation of noise emission values obtained under repeatability conditions; that is the repeated application of the same noise emission measurement method on the same noise source within a short interval of time under the same conditions (same laboratory, same operator, same apparatus).

NOTE 12 In this International Standard, the symbol σ is used for a standard deviation of a population and the symbol s for a standard deviation of a sample.

3.21 standard deviation of reproducibility, σ_R: Standard deviation of noise emission values obtained under reproducibility conditions; that is, the repeated application of the same noise emission measurement method on the same noise source at different times and under different conditions (different laboratory, different operator, different apparatus). The standard deviation of reproducibility, therefore, includes the standard deviation of repeatability.

3.22 standard deviation of production, σ_P: Standard deviation of noise emission values obtained on different equipment from a batch of the same family, using the same noise emission measurement method under repeatability conditions (same laboratory, same operator, same apparatus).

3.23 total standard deviation σ_t: Square root of the sum of the squares of the standard deviation of reproducibility and the standard deviation of production:

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

3.24 reference standard deviation, σ_M: A total standard deviation specified for the family of machinery and equipment, which is considered typical for batches of equipment from this family.

NOTE 13 The use of a fixed value for σ_M for each family enables the application of a statistical method to deal with small sample sizes. If the total standard deviation, σ_t, is different from the reference standard deviation, σ_M, the risk of rejection should be estimated on the basis of both standard deviations, σ_t and σ_M.

Typical values of σ_M range from 1,5 dB to 3,5 dB if the measurement test code is of grade 1 or grade 2 accuracy (employing precision or engineering methods, respectively); if the test code is of grade 3 accuracy (employing a survey method), then typical values of σ_M may be much higher. Extensive testing may be required to establish the value of σ_M for a family of machines.

4 Noise emission declarations

Noise emission declarations shall consist of either declared single-number noise emission values or declared dual-number noise emission values. The selection of the appropriate form of noise declaration is made in the relevant noise test code. The noise emission values to be declared are one or more of the A-weighted sound power level, L_{WA}, the A-weighted time-averaged emission sound pressure level, L_{pA}, or the C-weighted peak emission sound pressure level, $L_{pC,peak}$, from measurements of the highest practicable grade of accuracy.

NOTE 14 It is recommended to use engineering grade accuracy (grade 2) or better.

Noise emission values shall be declared for each operating mode specified in the appropriate noise test code. If no noise test code exists, the guidance given in the relevant basic standards (the ISO 3740 or ISO 9614 series, and the ISO 11200 series) shall be followed.

The noise emission declarations shall be such as to allow the values to be verified according to the procedures of this International Standard. Guidelines for determination of declared noise emission values, consistent with ISO 7574-2 and ISO 7574-4, are given in annex A.

NOTE 15 The specifications of ISO 7574-2 and ISO 7574-4, giving greater detail on noise declaration than annex A of this International Standard, may be followed if required in the case of a particular family of machinery or equipment.

5 Presentation of noise emission declarations

Noise emission declarations shall contain the following:

a) identification of the machinery and equipment with sufficient detail to determine the applicability of the declared noise emission values;

b) identification of the respective noise test code, if any, and the basic standards;

c) identification of the respective operating modes; and

d) either

   1) the words "DECLARED SINGLE-NUMBER NOISE EMISSION VALUES in accordance with ISO 4871", followed by one or more of the declared single-number noise emission values L_{WAd}, L_{pAd} and $L_{pC,peak,d}$ (see B.1), or

   2) the words "DECLARED DUAL-NUMBER NOISE EMISSION VALUES in accordance with ISO 4871", followed by one or more of the declared dual-number noise emission values L_{WA}, L_{pA} and $L_{pC,peak}$ and their respective uncertainties K_{WA}, K_{pA} and $K_{pC,peak}$ (see B.2).

In the event of the use of the dual-number noise emission declaration, the measured noise emission value L, and the associated uncertainty K, shall always be given together. If the single-number noise emission declaration is used, it shall always consist of L_d.

NOTES

16 The manufacturer or supplier may optionally provide frequency band data, in addition to the information which has to be declared.

17 The preferred declared noise emission quantity is the declared A-weighted sound power level, either L_{WAd} or L_{WA} and K_{WA}. The A-weighted sound power level is the basic noise emission quantity adopted in the ISO 7574 series, and the one which most accurately tracks changes in noise emission from one piece of machinery and equipment to another.

18 Noise declaration for computer and business equipment should be in accordance with ISO 9296.

19 The C-weighted peak emission sound pressure levels yielded by the products of many industries are so low as to make declaration of this quantity unnecessary. In such cases, general information on the C-weighted peak emission sound pressure levels should be contained in the noise test codes for the specific families of machinery and equipment produced by these industries.

6 Verification of noise emission declarations

6.1 General

The quantity to be verified is either the declared single-number noise emission value L_d, or the sum of the measured noise emission value L, and the uncertainty K, depending on the form of the noise emission declaration. Verification shall be effected by means of noise measurements made according to the same noise test code, or, if there is no noise test code, according to a basic measurement standard with the same or better grade of accuracy, and under the same machinery or equipment operating conditions as those to which the declared noise equation values refer.

NOTE 20 Verification of the noise emission declaration using a basic test method with a lower grade of accuracy may be effected by agreement between the manufacturer and user, providing allowance is made for the lower accuracy.

The choice of verification on a single machine or a batch of machines is made in the relevant noise test code.

The procedures given in 6.2 and 6.3 are designed for inspection under reproducibility conditions.

The following procedure for verifying L_d or $(L + K)$ for an individual machine is consistent with ISO 7574-2.

The procedures for batches of machines are consistent with ISO 7574-4 using double sampling inspection, the sample size of three machines being equivalent to that of the single sampling inspection procedure. The verification procedures ensure that there is a 95 % probability of acceptance for batches of machines if no more than 6,5 % of the equipment in a batch has measured noise emission values greater than L_d or $(L + K)$, as appropriate. The criteria given in 6.3 for batches of machines are based on the double sampling inspection procedure of ISO 7574-4 and a reference standard deviation (defined in 3.24) of 2,5 dB.

NOTES

21 In the calculations in 6.3, a reference standard deviation, σ_M, of 2,5 dB has been used and the result has been rounded to the nearest 0,5 dB.

22 For a certain family of machines, if a specific value of σ_M has been determined (e.g. by interlaboratory tests) and is given in a relevant noise test code, it may be more appropriate to use that value for the verification.

6.2 Verification procedure for a single machine

If one machine is evaluated, yielding a measured noise emission value of the verification, L_1, the criterion to be satisfied in order for the noise emission declaration of this single machine to be verified is either

$$L_1 \leqslant L_d$$

or

$$L_1 \leqslant (L + K)$$

as appropriate.

This procedure is consistent with the procedure for verifying L_c for an individual machine given in ISO 7574-2.

6.3 Verification procedure for a batch of machines

6.3.1 Verification based on measurements on one machine from a batch

If one machine is evaluated in order to verify the noise emission declaration for a batch of machines, yielding a measured noise emission value of the verification, L_1, the criterion to be satisfied in order that the declaration for the whole batch is verified is either

$$(L_d - L_1) \geqslant 3{,}0 \text{ dB}$$

or

$$[(L + K) - L_1] \geqslant 3{,}0 \text{ dB}$$

as appropriate.

The batch is rejected if the measured noise emission value of the verification, L_1, satisfies either the criterion

$$(L_d - L_1) < -0{,}5 \text{ dB}$$

or

$$[(L + K) - L_1] < -0{,}5 \text{ dB}$$

as appropriate.

If

$$-0{,}5 \leqslant (L_d - L_1) < 3{,}0 \text{ dB}$$

or

$$-0{,}5 \leqslant [(L + K) - L_1] < 3{,}0 \text{ dB}$$

the decision for the verification of the batch of machines cannot be made based on the measurement on one machine only. In that case, refer to 6.3.2. The single machine used for the measurements is, however, verified individually if it fulfils the requirement given in 6.2.

NOTE 23 The derivations of the above values 3,0 dB and 0,5 dB are given in C.1.

6.3.2 Verification based on measurements on three machines from a batch

If the decision for the verification of the batch cannot be made based on the measurements on one machine, an additional two machines from the batch shall be evaluated. The noise emission declaration for the whole batch is verified if the average noise emission value $\bar{L}$, calculated from the three individual values L_i using the equation

$$\bar{L} = \frac{1}{3}\sum_{i=1}^{3} L_i$$

satisfies either the criterion

$$(L_d - \bar{L}) \geqslant 1{,}5 \text{ dB}$$

or

$$[(L + K) - \bar{L}] \geqslant 1{,}5 \text{ dB}$$

as appropriate.

Even if the noise emission declaration of the batch is not verified, those of the individual machines on which measurements have been made are still verified individually if they fulfil the requirement given in 6.2.

NOTE 24 The derivation of the value 1,5 dB above is given in C.2.

Annex A
(informative)

Guidelines for declaration of the noise emission of machinery and equipment

A.1 General

The information in this annex is based on ISO 7574-2 and ISO 7574-4.

Since the verification procedures given in 6.3 are based on a reference standard deviation, σ_M, of 2,5 dB, care shall be exercised in performing a noise emission declaration when the reference standard deviation for a particular family of machinery and equipment exceeds 2,5 dB. The declaration procedure of A.2.3 gives guidance on the selection of declared values.

In general, the A-weighted sound power level, L_{WA}, and the time-averaged A-weighted emission sound pressure level, L_{pA}, will have different values of standard deviations. Care shall therefore be exercised in performing declarations of emission sound pressure levels and the procedures of A.2 should be followed.

A.2 Determination of declared noise emission values

A.2.1 General

Measured noise emission values should be determined for each operating mode specified in the noise test code for the individual type of machinery or equipment, or, if no noise test code exists, for selected operating conditions taken from the appropriate basic standard. The measured values should not be rounded, but should be of a precision consistent with the calculations to be performed in accordance with this International Standard.

The declared noise emission values of a single machine or a production series of machines are determined from the measured values, using procedures which are based upon those described in clause 6 for verification, together with a knowledge of the accuracy with which measurements can be made. For a production series of machines, the standard deviation of production shall be taken into account.

A.2.2 Determination of declared noise emission values for a single machine

If the measured noise emission value L of one machine is available, the declared single-number noise emission value L_d can be calculated from

$$L_d = L + K$$

The declared dual-number noise emission value is the two values L and K, stated together but separately, where $K = 1{,}645\sigma_R$.

Values of σ_R, the standard deviation of reproducibility, are normally to be found in the noise test code. If no noise test code exists, estimated values of K which may be used for the sound power level are 2,5 dB for engineering grade accuracy (grade 2) measurements and 4 dB for survey grade accuracy (grade 3) measurements. Guidance on values of K in the case of emission sound pressure levels may be found in ISO 11201 to ISO 11204.

A.2.3 Determination of declared noise emission values for a batch of machines

The declared noise emission value for a production series of machines can be determined if an arithmetic average measured noise emission value of the series, $\overline{L}$, can be estimated. The declared single-number noise emission value is calculated from

$$L_d = \overline{L} + K$$

and the declared dual-number noise emission value is $\overline{L}$ and K, where the value of K has to be determined. Guidance is given below on the determination of K, but its value is usually between 1,5 dB and 4 dB when precision grade accuracy (grade 1) or engineering grade accuracy (grade 2) measurements are used, and between 4 dB and 6 dB when survey grade accuracy (grade 3) measurements are used.

To determine the value of K for a batch of machines, the following should be taken into account.

a) The uncertainty of the measurement with respect to the accuracy of the measurement method, considering reproducibility. Values of the standard deviation of reproducibility, σ_R, are given in the test codes and in the basic measurement standards.

b) The production variation; i.e. measurements on many machines from one batch carried out in accordance with the appropriate test code or basic measurement method in one laboratory under conditions as near to identical as possible (repeatability conditions). For each machine, the mean value from two or more measurements is determined. These values are used to estimate the standard deviation of production for the batch, σ_P.

c) The total standard deviation, σ_t, for the measured noise emission values.

d) The procedures for verifying the declared noise emission values given in clause 6.

If a sample of three or more machines is available, the following procedure may be used to estimate the total standard deviation of the noise emission values of a batch of machines.

a) Take two or more (up to a number j) measurements, under repeatability conditions, of noise emission values (for L_{WA}, L_{pA} and $L_{pC,peak}$ separately) of each of the n machines in the sample. Then calculate n respective arithmetic mean values, using the following formula in the case of the m^{th} machine:

$$\overline{L_m} = \frac{1}{j} \sum_{i=1}^{j} L_{mi}$$

where

L_{mi} is the i^{th} individual measurement of the noise emission value of the m^{th} machine;

j is the number of repeated measurements on the m^{th} machine;

$\overline{L_m}$ is the mean noise emission value for the m^{th} machine.

b) Determine the arithmetic mean of the measured noise emission values of all machines in the sample, $\bar{L}$, as follows:

$$\bar{L} = \frac{1}{n} \sum_{m=1}^{n} \overline{L_m}$$

c) Estimate the standard deviation of production, s_P, as follows:

$$s_P = \sqrt{\frac{1}{n-1} \sum_{m=1}^{n} (\overline{L_m} - \bar{L})^2}$$

d) Estimate the total standard deviation, s_t, from the standard deviation of production, s_P, and the standard deviation of reproducibility, s_R, if necessary using an estimated value for the latter from the test code or the basic measurement standard, as follows:

$$s_t = \sqrt{s_R^2 + s_P^2}$$

NOTE 25 The values of $\bar{L}$ and s_t are estimates of, respectively, the true mean value, μ, and the true total standard deviation, σ_t, for the batch.

If there is no prior knowledge of the standard deviation of production or if there is no reference standard deviation determined for the family of machines under consideration, the uncertainty K, in decibels, should be determined as follows:

$$K \geqslant 1{,}5\sigma_M$$

with σ_M = 2,5 dB, if the measurements are performed using a method of engineering grade of accuracy.

The value of K, in decibels, for a sample size of three machines, is

$$K = 1{,}5 s_t + 0{,}564(\sigma_M - s_t)$$

Values of s_t and σ_M depend upon the grade of accuracy and the variability of the noise emission values of the machines in a batch.

Estimated values of s_t and σ_M, which may be used when values are not given in the test code, are given in table A.1.

Table A.1

Accuracy grade of measurement method	Estimated values, dB	
	s_t	σ_M
Engineering (grade 2)	2,0	2,5
Survey (grade 3)	3,5	4,0

NOTES

26 Selection of the factor 0,564 is consistent with the verification procedure given in 6.3 for a sample size of three machines.

27 The value of K determined above is based on ISO 7574-4 and results in a 5 % risk of rejection for a sample of three machines.

28 If a sample of three or more machines is not available, the value of s_t may be estimated from previous experience.

Annex B
(informative)

Examples of noise emission declarations for machinery and equipment

B.1 Declared single-number noise emission values

An example of a single-number declaration is given below. The noise emission values given are typical values, only for illustration.

If there is no noise test code or if the operating conditions are not in accordance with the test code given in ISO *XXXX*, further information about the operating conditions should be given.

Machine model number, operating conditions, and other identifying information: Type 990, Model 11-TC, 50 Hz, 230 V, rated load		
DECLARED SINGLE-NUMBER NOISE EMISSION VALUES **in accordance with ISO 4871**		
	Operating mode 1	**Operating mode 2**
A-Weighted sound power level, L_{WAd} (ref. 1 pW), in decibels	90	97
A-Weighted emission sound pressure level, L_{pAd} (ref. 20 μPa) at the operator's position, in decibels	80	88
Values determined according to noise test code given in ISO *XXXX*, using the basic standards ISO *YYYY* and ISO *ZZZZ*. NOTE — Declared single-number noise emission values are the sum of measured values and the associated uncertainty, and they represent upper boundaries of the range of values which is likely to occur in measurements.		

B.2 Declared dual-number noise emission values

An example of a dual-number declaration is given below. The noise emission values given are typical values, only for illustration.

If there is no noise test code or if the operating conditions are not in accordance with the test code given in ISO *XXXX*, further information about the operating conditions should be given.

Machine model number, operating conditions, and other identifying information: Type 990, Model 11-TC, 50 Hz, 230 V, rated load		
DECLARED DUAL-NUMBER NOISE EMISSION VALUES **in accordance with ISO 4871**		
	Operating mode 1	**Operating mode 2**
Measured A-weighted sound power level, L_{WA} (ref. 1 pW), in decibels	88	95
Uncertainty, K_{WA}, in decibels	2	2
Measured A-weighted emission sound pressure level, L_{pA} (ref. 20 μPa) at the operator's position, in decibels	78	86
Uncertainty, K_{pA}, in decibels	2	2
Values determined according to noise test code given in ISO *XXXX*, using the basic standards ISO *YYYY* and ISO *ZZZZ*. NOTE — The sum of a measured noise emission value and its associated uncertainty represents an upper boundary of the range of values which is likely to occur in measurements.		

Annex C
(informative)

Verification of the declared noise emission value for a batch of machines

C.1 Verification using one machine from a batch

Refer to the double-sampling procedure of ISO 7574-4 with the first sample $n_1 = 1$.

The declared value is verified if either

$$(L_d - L_1) \geqslant k_a \sigma_M$$

or

$$[(L + K) - L_1] \geqslant k_a \sigma_M$$

Then, with $k_a = 1{,}194$ and $\sigma_M \approx 2{,}5$ dB:

$$k_a \sigma_M = 1{,}194 \times 2{,}5 \text{ dB} \approx 3 \text{ dB}$$

The declared value is not verified if either

$$(L_d - L_1) < k_r \sigma_M$$

or

$$[(L + K) - L_1] < k_r \sigma_M$$

Then, with $k_r = -0{,}201$ and $\sigma_M \approx 2{,}5$ dB:

$$k_r \sigma_M = -0{,}201 \times 2{,}5 \text{ dB} \approx -0{,}5 \text{ dB}$$

NOTE 29 k, k_a and k_r are acceptability constants (see ISO 7574-4).

C.2 Verification using three machines from a batch

Use the single-sampling procedure of ISO 7574-4 with $n = 3$ and $\sigma_M \approx 2{,}5$ dB, which is equivalent to the double-sampling procedure with the second sample $n_2 = 2$.

The declared value is verified if either

$$(L_d - \bar{L}) \geqslant k \sigma_M$$

or

$$[(L + K) - \bar{L}] \geqslant k \sigma_M$$

Then, with $k = 0{,}564$ and $\sigma_M \approx 2{,}5$ dB:

$$k \sigma_M = 0{,}564 \times 2{,}5 \text{ dB} \approx 1{,}5 \text{ dB}$$

Annex D
(informative)

Bibliography

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