International Standard 7574/1

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

Acoustique — Méthodes statistiques pour la détermination et le contrôle des valeurs déclarées d'émission acoustique des machines et équipements — Partie 1: Généralités et définitions

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Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

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Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.

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

0 Introduction to ISO 7574

In order to state the noise emission value for a machine or a batch of machines in an unambiguous manner, this four-part series of International Standards provides guidelines for determining the noise emission value to be stated (e.g. as a labelled value) and specifies verification procedures. These methods are based on the premise of clearly defined acoustical measurement methods and describe the handling of the variability of the measurement results and, if relevant, of the noise emissions of the machines in a batch.

The methods presented in this series of International Standards are compatible with the requirements specified in ISO 4871, i.e.,

— the stated (e.g. labelled) value indicates the limit below which the noise emission value of the individual machine and/or a specified large proportion of the noise emission values of the batch lies;

— the basic noise emission quantity used is the A-weighted sound power level.

Although this series of International Standards is drafted mainly in terms of A-weighted sound power level as a noise emission quantity, it is equally applicable to other quantities.

In this series of International Standard the term "label" is considered to include all means for providing information on the noise emission values to potential users of the equipment; this includes labels, brochures, advertisements, commercial literature, etc. Requirements for this may be stipulated, for example in a contract or in regulations.

The methods described may be applied not only to values stated for labelling purposes, but also to values stated for other purposes, for example :

— to the upper noise limit set by an authority or specified in a technical standard for a specific family of machines;

— to contract values as agreed by the manufacturer and purchaser of the machine(s).

This series of International Standards does not specify whether, or for which specific family of machines, the purposes mentioned above are relevant or whether the methods for determining and verifying stated noise emission values should be applied. This is left to a labelling code specific to the machinery or equipment concerned or, if this does not exist, to an agreement between the users of the standards (e.g. in a contract).

Two cases are considered:

— the stated value is given for one individual machine;

— the stated value is given for an entire batch of machines.

For economic reasons, the stated values for batches of series-produced machines may be verified by sampling procedures.

This four-part series of International Standards does not deal with the consequences that ensue if the stated value is not verified for a single machine or for a batch (lot) of machines.

This series of International Standards which comprise ISO 7574 requires that the labelled value be determined using the same measurement test code as that specified for verification. It therefore applies to families of machines or equipment for which special measurement test codes for the determination of noise emission quantities are prepared. If no special test code for a particular family exists, the methods specified in ISO 3741, ISO 3742, ISO 3743, ISO 3744 and ISO 3745 may be appropriate.

NOTE — This does not preclude the use of other International Standards, e.g. ISO 3746, which may form the basis of special measurement test codes.

In each case the installation and operating conditions typical for normal use shall be clearly specified or agreed.

The relevant measurement conditions may provide information, in the form of standard deviations, on the dispersion of measurement results. A measure for the dispersion of the emission values due to the different emissions of the different machines is the standard deviation of production (see 3.18).

The series of International Standards which make up ISO 7574 comprises the following four parts:

Part 1: General considerations and definitions

Part 2: Methods for stated values for individual machines

Part 3: Simple (transition) method for stated values for batches of machines

Part 4: Methods for stated values for batches of machines

1 Scope and field of application

This part of ISO 7574 defines terms relating to methods for determining and verifying the stated (e.g. labelled) values of the noise emitted by machinery and equipment.

This four-part series of International Standards applies both to machines which are produced in very small quantities as well as to machines which are produced by mass production methods.

2 References

ISO 3534, *Statistics — Vocabulary and symbols.*

ISO 3741, *Acoustics — Determination of sound power levels of noise sources — Precision methods for broad-band sources in reverberation rooms.*

ISO 3742, *Acoustics — Determination of sound power levels of noise sources — Precision methods for discrete-frequency and narrow-band sources in reverberation rooms.*

ISO 3743, *Acoustics — Determination of sound power levels of noise sources — Engineering methods for special reverberation test rooms.*

ISO 3744, *Acoustics — Determination of sound power levels of noise sources — Engineering methods for free-field conditions over a reflecting plane.*

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

ISO 3746, *Acoustics — Determination of sound power levels of noise sources — Survey method.*

ISO 3951, *Sampling procedures and charts for inspection by variables for percent defective.*

ISO 4871, *Acoustics — Noise labelling of machinery and equipment.*

ISO 5725, *Precision of test methods — Determination of repeatability and reproducibility by inter-laboratory tests.*

IEC Publication 651, *Sound level meters.*

3 Definitions

3.1 sound power level, L_W, in decibels: Ten times the logarithm to the base ten of the ratio of a given sound power to the reference sound power. The reference sound power is 1 pW.

3.2 A-weighted sound power level, L_{WA}, in decibels: The sound power level of a noise source, determined according to an appropriate measurement test code with frequency weighting A (see IEC 651) selected on the measuring instruments.

3.3 noise emission quantity; noise emission value: The basic noise emission quantity is the A-weighted sound power level, L_{WA}.

A single value of the noise emission quantity is called a noise emission value.

NOTE — Henceforth, the subscripts WA are left out both for reasons of simplicity and so as not to exclude the use of another noise emission quantity.

3.4 measured value: The noise emission value for an individual machine actually determined in accordance with an appropriate measurement test code.

NOTE — Measured values shall not be rounded. According to this part of ISO 7574, the term "measured value" is used as a result of the measurement test code being applied.

3.5 family of machines: Machines or equipment of similar design or type, or intended to perform the same functions.

NOTES

1 A family may include different designs which meet the same performance requirements, different production batches of a given design from one manufacturer, comparable products from different manufacturers in various countries designed to fulfil the same purpose or machines of different sizes but of similar design.

2 Examples of families of machines are a group of rotating electrical machines of a given range of power and speed, a group of concrete mixers with a certain range of volumetric capacities.

3.6 stated value; labelled value, L_c: The value, expressed as an integer, of the noise emission quantity stated for an individual machine or for all machines in a batch. The stated (labelled) value indicates the limit below which the noise emission value of the individual machine and/or a specified large proportion of the noise emission values of the batch lies when the machines are new.

NOTES

1 The term "labelled value" stands for all kinds of stated values for which the methods described may be applied.

2 When using the A-weighted sound power level as the noise emission quantity, the labelled value may be expressed as the numerical value of the A-weighted sound power level limit (see above), in decibels, divided by ten, given to one decimal place.

3.7 label: A statement of the labelled value, L_c, which is included in product literature and/or affixed to a machine or a piece of equipment.

3.8 batch (lot) of machines: A group of the same family produced in quantity, manufactured to the same technical specifications and characterized by the same labelled value, L_c.

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

3.9 size of the batch (or of the population), N: Number of items (machines in the batch or noise emission values in the population).

3.10 sample: One or more machines (or measured values) randomly selected (or determined) from a lot (or population).

3.11 sample size, n: Number of items in the sample.

3.12 arithmetic mean of a batch (or of a population), μ: The sum of the noise emission values in a batch (or in a population) divided by the size of the batch (or of the population):

$$\mu = \frac{1}{N} \sum_{i=1}^{N} L_i$$

3.13 arithmetic mean of a sample, $\bar{L}$: The sum of the measured values, L_i, in a sample divided by sample size:

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

The arithmetic mean value of the sample, $\bar{L}$, is used as an estimator of the mean value of a lot (or of a population), μ.

3.14 standard deviation of a batch (or of a population), σ: The standard deviation of the noise emission values of the batch (or of the population) of size N is given by the equation:

$$\sigma = \sqrt{\frac{1}{N} \sum_{i=1}^{N} (L_i - \mu)^2}$$

3.15 standard deviation of a sample, s: The standard deviation of the sample is given by the equation:

$$s = \sqrt{\frac{1}{n-1} \sum_{i=1}^{n} (L_i - \bar{L})^2}$$

The standard deviation of the sample, s, is used as an estimator of the standard deviation of a batch (or of a population), σ.

3.16 standard deviation of repeatability, σ_r (see ISO 5725): 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).

3.17 standard deviation of reproducibility, σ_R (see ISO 5725): 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 (see 3.16).

NOTE — An estimate of σ_R to be given in the measurement test code for the family of machines should preferably be derived from an inter-laboratory test. In the absence of such a test, σ_R may be agreed upon provisionally.

3.18 standard deviation of production, σ_P: Standard deviation of the different means (of noise emission values) obtained on different machines from a batch (see 3.8), using the same noise emission measurement method under repeatability conditions (same laboratory, same operator, same apparatus).

NOTE — The following formula applies, but in practice the value of the term σ_r^2/k becomes negligible:

$$\sigma_P = \sqrt{\sigma'^2 - \frac{\sigma_r^2}{k}}$$

where

σ' is the standard deviation of the means;

σ_r is the standard deviation of repeatability (see 3.16);

k is the number of measured values for the determination of the mean for one machine.

3.19 total standard deviation, σ_t: The square root of the sum of the squares of the standard deviation of reproducibility (see 3.17) and of the standard deviation of production (see 3.18):

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

3.20 reference standard deviation, σ_M: A total standard deviation (see 3.19) specified for the family of machines under consideration which is considered to be typical for batches from this family.

NOTE — The use of a fixed σ_M for each family enables the application of a statistical method to deal with small sample sizes. If the actual total standard deviation σ_t is known to be different from σ_M, the labeller estimates his risk of rejection on the basis of both standard deviations, σ_t and σ_M.

Typical values of σ_M range from 1,5 to 3,5 dB depending on the precision of the measurement method used and on the complexity of the noise source. Extensive tests may be needed to establish σ_M for a family of machines.

3.21 single sampling (see ISO 3534): A type of sampling which consists of taking only one sample from the batch.

3.22 double sampling (see ISO 3534): A type of sampling which consists of taking possibly a second sample according to the information given by the first.

3.23 sequential sampling (see ISO 3534): A type of sampling which consists of taking successive items, but without fixing their number in advance, the decision to accept or reject the lot being taken as soon as the results permit, according to rules laid down in advance.

3.24 inspection by variables (see ISO 3534): A method which consists of measuring a quantitative characteristic for each item of a population or of a sample taken from this population. The quantitative characteristic is the noise emission quantity.

NOTES

1 The method used in this four-part series of ISO 7574 for assessing the acceptability of a batch using previous knowledge of its standard deviation is called the σ-method. The s-method (assessing the acceptability of a batch using the standard deviation based on measurements of all the items in a sample) is not considered in this four-part series of ISO 7574.

2 Inspection by attributes [a method which consists in taking note, for every item in a population or in a sample taken from this population, of the presence or absence of a certain qualitative characteristic (attribute) and in counting how many items have or do not have this characteristic] is not considered in this four-part series of ISO 7574.

3.25 probability of acceptance, P_a (see ISO 3534): The probability that a batch of a given quality (expressed by its proportion p of noise emission values exceeding the labelled value) will be accepted by a given sampling plan.

NOTE — $(1 - P_a)$ is called "probability of rejection". If $(1 - P_a)$ has the fixed value α (see 3.27), this is called the "producer's risk". If P_a has the fixed value β (see 3.28), this is called the "consumer's risk".

3.26 operating characteristic curve, OC: A curve showing, for a given sampling plan, the probability of acceptance P_a of a batch as a function of its proportion p of noise emission values exceeding the labelled value.

NOTE — The operating characteristic curve is fully determined by two specified points [for example, the producer's risk point (see 3.27) and the consumer's risk point (see 3.28) or by one point (for example the producer's risk point) and the sample size n.

3.27 producer's risk point (see ISO 3534): A point on the operating characteristic curve corresponding to a predetermined and usually low probability of rejection α. This probability of rejection is called the "producer's risk".

The corresponding quality level is the proportion $p_{1-\alpha}$ of noise emission values of the batch exceeding the labelled value.

NOTES

1 According to ISO 7574/4, the producer's risk point is fixed, α and $p_{1-\alpha}$ therefore form a pair of fixed values.

2 For continuous production of batches, the acceptable quality level (AQL) (see ISO 3951) would be approximately equal to $p_{1-\alpha}$.

3.28 consumer's risk point (see ISO 3534): A point on the operating characteristic curve corresponding to a predetermined and usually low probability of acceptance β. This probability of acceptance is then called the "consumer's risk". The corresponding batch quality is the proportion p_β of noise emission values of the batch exceeding the labelled value and this is called the limiting quality.

3.29 level difference, ΔL: A value which, for a fixed producer's risk point, is used to take the consumer's viewpoints into consideration, and this is done principally by selecting an appropriate sample size, n. ΔL, when subtracted from the labelled value L_c (i.e. $L'_c = L_c - \Delta L$), would give a low labelled value L'_c with such a high proportion, p_β, of noise emission values exceeding L'_c that acceptance would only be possible with a very low probability, β (see 3.28).