DRAFT AMENDMENT ISO 3743-2:1994/DAM 1

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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

AMENDMENT 1

Acoustique — Détermination des niveaux de puissance acoustique émis par les sources de bruit à partir de la pression acoustique — Méthodes d'expertise en champ réverbéré applicables aux petites sources transportables —

Partie 2: Méthodes en salle d'essai réverbérante spéciale

AMENDEMENT 1

ICS 17.140.01

ISO/CEN PARALLEL PROCESSING

This draft has been developed within the International Organization for Standardization (ISO), and processed under the **ISO-lead** mode of collaboration as defined in the Vienna Agreement.

This draft is hereby submitted to the ISO member bodies and to the CEN member bodies for a parallel five-month enquiry.

Should this draft be accepted, a final draft, established on the basis of comments received, will be submitted to a parallel two-month approval vote in ISO and formal vote in CEN.

To expedite distribution, this document is circulated as received from the committee secretariat. ISO Central Secretariat work of editing and text composition will be undertaken at publication stage.

Pour accélérer la distribution, le présent document est distribué tel qu'il est parvenu du secrétariat du comité. Le travail de rédaction et de composition de texte sera effectué au Secrétariat central de l'ISO au stade de publication.

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

Amendment 1 to ISO 3743-2:1994 was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 1, *Noise*.

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 — AMENDMENT 1

Page iii: Introduction, 0.1, second sentence:

Delete the phrase “as shown in table 0.1”.

Page v:

Delete Table 0.1

Page 2: 1.4 Measurement uncertainty

Replace the existing text in 1.4 with the following:

1.4 Measurement uncertainty

1.4.1 Methodology

The uncertainties of sound power levels, $u(L_W)$, in decibels, determined according to this part of ISO 3743 are estimated by the total standard deviation, σ_{tot}, in decibels:

$$u(L_W) \approx \sigma_{tot} \quad (1)$$

This total standard deviation is obtained using the modelling approach described in ISO/IEC Guide 98-3. This requires a mathematical model which in case of lack of knowledge can be substituted with results from measurements, including results from round robin tests.

In this context this standard deviation is expressed by the standard deviation of reproducibility of the method, σ_{R0}, in decibels, and the standard deviation, σ_{omc}, in decibels, describing the uncertainty due to the variations of the operating and mounting conditions of the source under test according to:

$$\sigma_{tot} = \sqrt{\sigma_{R0}^2 + \sigma_{omc}^2} \quad (2)$$

Equation (2) shows that variations of operating and mounting conditions expressed by σ_{omc} should be taken into account before a measurement procedure with a certain grade of accuracy (characterized by σ_{R0}) is selected for a specific machine family (see 1.4.5 and Annex D.3).

NOTE If different measurement procedures offered by the ISO 3740 series are used, systematic numerical deviations (biases) may additionally occur.

Derived from σ_{tot}, the expanded measurement uncertainty U, in decibels, shall be calculated from

$$U = k\,\sigma_{tot} \quad (3)$$

The expanded uncertainty depends on the degree of confidence that is desired. For a normal distribution of measured values, there is a 95% confidence that the true value lies within the range $[L_W - U]$ to $[L_W + U]$. This corresponds to a coverage factor of $k = 2$.

If the purpose of determining the sound power level is to compare the result with a limit value, it might be more appropriate to apply the coverage factor for a one-sided normal distribution. In that case, the coverage factor $k = 1{,}6$ corresponds to a 95 % confidence.

1.4.2 Determination of σ_{omc}

The standard deviation σ_{omc} [see Equation (D.1)] which describes the uncertainty associated with the variations of the operating and mounting conditions for the particular source under test shall be taken into account when determining the measurement uncertainty. It can be determined separately from repeated measurements carried out on the same source at the same location by the same persons, using the same measuring instruments and the same measurement position(s). To determine σ_{omc} repeated sound pressure levels are measured either at the microphone position associated with the highest sound pressure level, or measured and averaged over the entire measurement surface. Measured levels are then corrected for background noise. For each of these repeated measurements, the mounting of the machine and its operating conditions are to be readjusted. For the individual sound source under test, σ_{omc} is designated as σ'_{omc}. It is possible that a noise test code provides a value of σ_{omc} which is representative for the machine family concerned. This value should take into account all possible variations of operating and mounting conditions that are within the scope of the noise test code.

NOTE If the sound power has only a small variation with time and the measurement procedure is defined properly, a value of 0,5 dB for σ_{omc} may be applicable. In other cases, for example, a large influence of the material flow in and out of the machine or material flow that may vary in an unforeseeable manner, a value of 2 dB may be appropriate. However, in extreme cases such as strongly varying noise generated by the processed material (stone breaking machines, metal cutting machines and presses operating under load) a value of 4 dB may result.

1.4.3 Determination of σ_{R0}

1.4.3.1 General

The standard deviation σ_{R0} includes uncertainty due to all conditions and situations allowed by this part of ISO 3743 (different radiation characteristics of the source under test, different instrumentation, different realizations of the measurement procedure), except the influence due to variations of the sound power of the source under test. The latter is considered separately by σ_{omc}.

The values of σ_{R0} given in Table 1 reflect the current knowledge. They are typical upper bounds taking into consideration the great variety of machines and equipment covered by this part of ISO 3743. Machinery-specific values may be derived from round robin tests (see 1.4.3.2) or by using the mathematical modelling approach (see 1.4.3.3). They should be given in noise test codes specific to machinery families (see 1.4.2 and Annex D).

1.4.3.2 Round Robin Test

The round robin test for determining σ_{R0} has to be carried out according to ISO 5725, where the sound power level of the source under test is determined under reproducibility conditions i.e. different persons carrying out measurements at different testing locations with different measuring instruments. Such a test provides the total standard deviation σ'_{tot} relevant for the individual sound source which has been used for the round robin test. Participating laboratories in round robin tests should cover all possible practical situations.

This total standard deviation σ'_{tot}, in decibels, of all results obtained with a round robin test includes the standard deviation σ'_{omc} and allows σ'_{R0} to be determined by using Equation (4):

$$\sigma'_{R0} = \sqrt{{\sigma'_{\text{tot}}}^2 - \sigma'^2_{\text{omc}}} \tag{4}$$

If σ'_{R0} values obtained from many different pieces of machinery belonging to the same family deviate within a small range only, their mean value can be regarded as typical for the application of this part of ISO 3743 to this particular family and used as σ_{R0}. Whenever available, such value should be given in the noise test code specific to the machine family concerned (together with σ_{omc}) and used in particular for the purpose of declaring noise emission values.

If no round robin test has been carried out, the existing knowledge about the noise emission from a particular family of machines may be used to estimate realistic values of σ_{R0}.

For certain applications the effort for the round robin test can be reduced by omitting measurements for different locations, e.g. if machines under test usually are installed under conditions with a small background noise correction K_1, or if the noise emission of a machine should be checked at the same location again. Results of such delimited tests should be denoted by $\sigma_{R0,\text{DL}}$, and this designation should also be used for tests on large machines being not movable in space.

Values for $\sigma_{R0,\text{DL}}$ can be expected to be lower than those given in Table 1.

The determination of σ_{R0} using Equation (4) is imprecise if σ_{tot} is only slightly higher than σ_{omc}. In this case Equation (4) provides a small value of σ_{R0} but with a low accuracy. To limit this inaccuracy σ_{omc} should not exceed $\sigma_{\text{tot}} / \sqrt{2}$.

1.4.3.3 Modelling approach for σ_{R0}

Generally σ_{R0}, in decibels, is dependent upon several partial uncertainty components, $c_i \cdot u_i$, associated with the different measurement parameters such as uncertainties of instruments, environmental corrections, microphone positions, etc. If these contributions are assumed to be uncorrelated σ_{R0} can be described by the modelling approach presented in ISO/IEC Guide 98-3, as follows:

$$\sigma_{R0} \approx \sqrt{(c_1 u_1)^2 + (c_2 u_2)^2 + \ldots.. + (c_n u_n)^2} \tag{5}$$

In Equation (5) the uncertainty components due to the variations of the sound emission of the source are not included. These components are covered by σ_{omc}. Annex D discusses each component of the uncertainty σ_{R0} according to existing knowledge.

NOTE If the uncertainty components in the modelling approach are correlated Equation (5) does not apply. Furthermore, the modelling approach requires detailed knowledge to determine the individual terms in Equation (5).

By contrast, the estimation of σ_{R0} based on round robin tests does not require assumptions about possible correlations between the individual terms of Equation (5). Therefore estimation by round robin is presently more realistic than a modelling approach when possible correlations between terms and their dependency from all other influencing parameters are not well understood. However, round robin tests are not always possible and are often replaced by experience from earlier measurements.

1.4.4 Typical upper bound values of σ_{R0}

Table 1 shows typical upper bound values of the standard deviation σ_{R0} for accuracy grade 2 that may cover most of the applications of this part of ISO 3743 (References [12][13]). In special cases or if certain requirements of this part of ISO 3743 are not met for a machine family or if it is anticipated that actual values of σ_{R0} for a given family of machines are smaller than those given in Table 1, a round robin test is recommended to obtain machine-specific values of σ_{R0}.

Table 1 —Typical upper bound values of the standard deviation of reproducibility of the method, σ_{R0}, for octave band and A-weighted sound power levels determined in accordance with this part of ISO 3743

Frequency bandwidth	Octave mid-band frequency Hz	Standard deviation of reproducibility, σ_{R0} dB
Octave	125	5,0
	250	3,0
	500 – 4 000	2,0
	8 000	3,0
A-weighted		2,0 [a]

[a] Applicable to noise sources which emit sound with a relatively "flat" spectrum in the frequency range from 100 Hz to 10 000 Hz.

1.4.5 Total standard deviation σ_{tot} and expanded uncertainty U

The total standard deviation and the expanded uncertainty shall be determined using Equation (2) and Equation (3) respectively. For the purpose of this part of ISO 3743, a normal distribution is assumed. Thus a coverage factor of $k = 2$ shall be used corresponding to a coverage probability of 95%. The coverage factor and coverage probability have to be reported together with the expanded measurement uncertainty.

EXAMPLE Accuracy grade 2; σ_{omc} = 2,0 dB; coverage factor $k = 2$; measured L_{WA} = 82 dB. Machine-specific determinations of σ_{R0} have not been undertaken thus the value is taken from Table 1 (σ_{R0} = 2,0 dB). Using Equations (3) and (2) it follows

$$U = 2 \times \sqrt{2^2 + 2^2} \text{ dB} = 5{,}8 \text{ dB}$$

Additional examples of calculated values for σ_{tot} are given in D.3.

NOTE The expanded uncertainty as described in this part of ISO 3743 does not include the standard deviation of production which is used in ISO 4871 [8] for the purpose of making a noise declaration for batches of machines.

Page 3: Clause 2 Normative references

Add the following reference:

ISO 5725 (all parts), *Accuracy (trueness and precision) of measurement methods and results*

Correct the title of ISO 3741:1988 as follows:

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

Correct the title of ISO 3743-1 as follows:

ISO 3743-1, *Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Engineering methods for small movable sources in reverberant fields — Part 1: Comparison method for a hard-walled test room*

Correct the title of ISO 3745 as follows:

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

Correct the title of ISO 6926 as follows:

ISO 6926, *Acoustics — Requirements for the performance and calibration of reference sound sources used for the determination of sound power levels*

Add the following reference:

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

Replace IEC 225:1966 by the following:

IEC 61260:1995, *Electroacoustics — Octave-band and fractional-octave-band filters*

Replace IEC 651:1979 and IEC 804:1985 by the following:

IEC 61672-1:2002, *Electroacoustics — Sound level meters — Part 1: Specifications*

Replace IEC 942:1988 by the following:

IEC 60942:2003, *Electroacoustics — Sound calibrators*

Page 10: 8.2 Direct method for determining sound power levels

Add the following sentence at the end of 8.2:

Reduced atmospheric pressure creates a bias in the sound power level. At altitudes greater than 500 m, sound power levels, $L_{W\text{ref,atm}}$, corresponding to the reference barometric pressure of 101,325 kPa and reference atmospheric temperature 23,0 °C shall be calculated according to Annex E.

Page 11: 8.3 Comparison method for determining band power levels

Add the following sentence at the end of 8.3:

Reduced atmospheric pressure creates a bias in the sound power level. At altitudes greater than 500 m, sound power levels, $L_{W\text{ref,atm}}$, corresponding to the reference barometric pressure of 101,325 kPa and reference atmospheric temperature 23,0 °C shall be calculated according to Annex E.

Page 11:

Add the following new clause:

8.4 A-weighted sound power levels determined by the comparison method

Calculation of the A-weighted sound power level of the noise source under test from the measurements made in octave bands according to 8.3 shall be performed using the procedure given in Annex F.

Page 20: Annex D (informative) Bibliography

In the heading delete “Annex D (informative)”, and shift this annex to the end of the document.

Page 20: Bibliography

Delete all dates of issue.

Correct the title of ISO 1996-1 as follows:

ISO 1996-1, *Acoustics — Description, measurement and assessment of environmental noise — Part 1: Basic quantities and assessment procedures*

Correct the title of ISO 3740 as follows:

ISO 3740, Acoustics — *Determination of sound power levels of noise sources — Guidelines for the use of basic standards*

Delete ISO 3742.

Correct the title of ISO 3744 as follows:

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

Delete ISO 3745.

Correct the title of ISO 3746 as follows:

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

Correct the title of ISO 3747 as follows:

ISO 3747, *Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Engineering/survey methods for use in situ in a reverberant environment*

Correct the title of ISO 4871 as follows:

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

Add the following references:

[10] ISO 9613-1, *Acoustics — Attenuation of sound during propagation outdoors — Part 1: Calculation of the absorption of sound by the atmosphere*

[12] HELLWEG, R.D. International round robin test of ISO/DIS 7779. In: *Proceedings Inter-Noise 1988,* Avignon, 1988, pp. 1105-1108

[13] VORLÄNDER, M., RAABE, G. Intercomparison on sound power measurements by use of reference sound sources, BCR-project 3347/1/0/168/89/11 – BCR – D30, 1993

[14] DAVIES, R.S. Equation for the determination of the density of moist air. *Metrologia* 1992, **29**, pp. 67-70

[15] HÜBNER, G. Accuracy consideration on the meteorological correction for a normalized sound power level. In: *Proceedings Inter-Noise 2000*, Nice, 2000