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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

AMENDMENT 1

Acoustique — Détermination des niveaux de puissance acoustique et des niveaux d'énergie acoustique émis par les sources de bruit à partir de la pression acoustique — Méthodes de laboratoire pour les salles anéchoïques et les salles semi-anéchoïques

AMENDEMENT 1

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This document was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 1, *Noise*.

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

AMENDMENT 1

Page 1, Normative references

Add the following reference:

ISO 26101:2017, *Acoustics — Test methods for the qualification of free-field environments*

Page 29, Annex A

Replace Annex A with the following:

Annex A
(normative)
General procedures for qualification of anechoic and hemi-anechoic rooms

A.1 General

The performance of an anechoic or hemi-anechoic room is tested by comparing the spatial decrease of sound pressure emitted from a test sound source with the decrease of sound pressure that would occur in an ideal free sound field. The evaluation of this performance is based on the procedures outlined in ISO 26101.

This annex contains the qualification criteria and test parameters which are required to qualify test rooms to the requirements of this document. To conform to this document, when no specific criteria are given, the requirements appropriate for sound power measurements in ISO 26101 shall be met.

A check of the room performance is recommended after modification of the room absorbers and periodically at intervals not exceeding 5 years.

The following is a comparison of this annex with ISO 26101 and previous versions of this annex:

a) As in the previous version (ISO 3745:2012, Annex A), this annex requires that test rooms are qualified using discrete-frequency (e.g. pure tone) measurements unless it is known that the specific noise source under test radiates only broadband noise (see Note below).

b) Consistent with the wording in ISO 26101, this annex defines methods for “discrete-frequency” and “broadband” qualification of test rooms. Discrete-frequency qualification is essentially identical to the pure tone qualification used in the previous versions of this annex. In both cases, only one pure tone is analysed in each frequency band in Table A.1. The wording change from “pure tone qualification” is consistent with, for example, common fast Fourier transform methods such as the use of pseudo random noise and narrow bandwidth analysis; see Reference [37] and ISO 26101:2017, 5.1.4.1, 5.1.4.2.

c) For the purposes of this document, this annex does not require an evaluation of the position of the acoustic centre. In this annex, the term “acoustic centre” as originally used in ISO 3745:2012,

is interpreted as (or replaced by) either the mathematical origin of the microphone traverse (see A.3.3) or the primary sound radiating region of the test sound source.

d) This annex follows ISO 26101:2017, 5.1.3.2 in that it requires the mathematical origin for evaluation of the inverse square law to be restricted to a point that lies within the physical volume occupied by the test sound source. This is a change from the previous versions of this annex, and as a result, a reduction of the qualified frequency range and/or qualified distances may arise in test rooms that were previously qualified using calculation methods that allowed large acoustic centre offsets.

e) Based on the guidance given in ISO 26101, this annex requires different traverse paths than required in previous versions (see A.3.3).

f) Following the requirements in ISO 26101, background noise limits and requirements on the test sound source stability have been relaxed compared with the previous versions.

NOTE The general qualification procedure and criteria in this annex are unchanged from the 2012 and 1975 versions of this document. In particular, the default qualification method uses pure tones as a test signal (referred to as discrete-frequency qualification in this annex). This is a significant difference from ISO 3745:2003, Annex A where the default qualification procedure used a broadband signal. However, the qualification criteria (see Table A.1) have remained the same in all versions of this annex. As a result, in a test room qualified using only broadband noise according to ISO 3745:2003, Annex A, the frequency range and/or distances over which the test room can be qualified may be reduced when re-tested using discrete-frequency qualification.

A.2 Qualification criteria

A.2.1 General

In order for a space within an environment to be deemed anechoic or hemi-anechoic for measurements in accordance with this document, the following criteria and test parameters shall be used to qualify the test environment. The qualification measurements of the anechoic or hemi-anechoic space shall be made using a bandwidth (i.e. broadband or tonal) that is typical of the spectral characteristics of the type of sources that will be measured or evaluated.

A.2.2 Maximum allowable deviations from inverse square law

The deviations of the measured sound pressure levels from those estimated using the inverse square law, obtained according to ISO 26101:2017, 5.1 (but excluding 5.1.6), shall not exceed the values given in Table A.1.

Table A.1 — Maximum allowable deviation of measured sound pressure levels from theoretical levels using the inverse square law

Type of test room	One-third-octave mid-band frequency Hz	Allowable deviations dB
Anechoic	≤ 630	±1,5
	800 to 5 000	±1,0
	≥ 6 300	±1,5
Hemi-anechoic	≤ 630	±2,5
	800 to 5 000	±2,0
	≥ 6 300	±3,0

A.2.3 Frequency range to be qualified

For measurements conducted in accordance with this document, the frequency range of interest for qualification shall be at least 100 Hz to 10 000 Hz. The frequency range may be extended provided that the test environment shall meet the requirements of Table A.1 and the test sound source shall meet the requirements of ISO 26101 and instrument specifications are satisfactory for use over the extended frequency range. Below 125 Hz and above 4 000 Hz, deviations from the inverse square law shall be

evaluated in contiguous one-third-octave bands, and between 125 Hz and 4 000 Hz, these deviations shall be conducted at frequencies that correspond to the mid-band frequencies of contiguous octave bands (i.e. between 125 Hz and 4 000 Hz, not all one-third-octave bands need to be evaluated).

If the frequency range is not at least 100 Hz to 10 000 Hz (see 3.11), measurements taken in this test room are not in full conformity with this document. If the test room is qualified over a reduced frequency range, measurements may still be reported to be "in conformity" with this document provided that

a) the one-third-octave bands comprising the reduced frequency range are contiguous,

b) the report clearly states the reduced frequency range, and

c) the words "in full conformity with ISO 3745" are not used or implied.

Annex B provides an alternative qualification method that may be used for measurements of a specific noise source. However, the procedure in Annex B will not qualify the test room for general use with arbitrary noise sources.

A.2.4 Maximum qualified radius

The maximum qualified radius is the largest distance from the mathematical origin of the traverse over which the requirements of A.2.2 are met concurrently on all traverse paths of A.3.3 and at all frequencies of A.2.3. In the evaluation of this distance, any measured points on each traverse that lie outside the qualified radius may be excluded from consideration. Within each qualified radius, each microphone traverse shall meet the requirements for traverse length of ISO 26101:2017, 5.1.4.3 and for spatial resolution of ISO 26101:2017, A.4.3.

A.2.5 Properties of the reflecting plane in a hemi-anechoic room

The sound absorption coefficient of the reflecting plane shall not exceed 0,06 over the frequency range to be qualified.

NOTE A sealed concrete construction or a sealed lightweight construction with a surface density of 20 kg/m^2 or more, provided that there are no significant air mass or structural resonances in the frequency range of interest, complies with the requirement.

The reflecting plane shall extend at least a quarter of a wavelength and not less than 0,75 m beyond the projection of the measurement surface on the plane at the lowest frequency of the frequency range to be qualified (see A.2.3).

A.3 Installation of test sound sources and microphone traverses

A.3.1 Test sound source requirements

The design or selection of the test sound source is the responsibility of the laboratory or acoustical expert performing the qualification. The test sound source shall meet the overall requirements specified in ISO 26101:2017, Annex B. For the purpose of this document, the directionality measurement can be performed in the anechoic or hemi-anechoic space that is being qualified. The required microphone positions are specified in ISO 26101:2017, B.3.2.

NOTE 1 It can facilitate the analysis if the test sound source is installed and evaluated in a different anechoic or hemi-anechoic space than the one being qualified (e.g. one known to have good free sound field properties over the frequency range of interest).

NOTE 2 Test sound sources that can be suitable for use in qualification of anechoic and hemi-anechoic spaces are described in References [35] and [36] and in ISO 26101.

A.3.2 Test sound source location

A.3.2.1 General

The test sound source shall be located to coincide with the usual position of the noise source under test. In an anechoic space, this is preferably in the centre of the test environment. In a hemi-anechoic space, this is preferably in the centre of and on the surface of the reflecting plane.

A.3.2.2 Test sound source location in hemi-anechoic room

The test sound source should be located on the plane of the reflecting floor, so that the radiating area of the test sound source is situated as close as possible to, but in any case should not be greater than 150 mm from the reflecting floor. If possible, the acoustic centre of the test sound source should be within a tenth of a wavelength from the reflecting floor for all frequencies in the frequency range of interest. Therefore, it is recommended to install the test sound source in a cavity in the reflecting floor.

A.3.3 Microphone traverse paths

Microphone traverses shall be made along at least five (but not more than eight) straight paths away from the primary sound radiating region of the test sound source. All traverse paths shall have the same mathematical origin and this mathematical origin shall lie within the physical volume occupied by the test sound source.

The traverse paths shall be located in the working area of the environment, i.e. the part of the environment normally used for measurements.

The traverse paths shall be selected as follows:

a) at least one traverse path shall be towards a dihedral corner of the environment that has the most uniform acoustic treatment properties and is most likely to be representative of the overall free sound field performance;

b) at least one traverse path shall be towards a trihedral corner of the environment that has the most uniform acoustic treatment properties and is most likely to be representative of the overall free sound field performance;

c) at least one traverse path shall be towards the centre of the environment boundary surface that has the most uniform acoustic treatment properties and is most likely to be representative of the overall free sound field performance;

d) at least one traverse path shall be towards the closest boundary surface;

NOTE 1 In some cases, both conditions c) and d) can be associated with the same traverse path.

e) at least one traverse path shall be selected towards other boundary surfaces that contain unique features or non-uniformities in acoustic treatment that are judged to have the most effect on the sound field (e.g. doors, viewing ports, ventilation openings and sound transmission openings).

In a hemi-anechoic space, the paths selected in accordance with a) to e) shall lie within the angular limits over which the test sound source directionality was qualified as specified in ISO 26101:2017, Annex B.

NOTE 2 Previously, ISO 3745:2003 required four paths into trihedral corners. In the previous version of this annex (ISO 3745:2012, Annex A), there were three key paths into trihedral corners and one key path to the nearest boundary.

A.4 Test procedure

A.4.1 Analysis bandwidth

In general, the test room shall be qualified for discrete-frequency measurements. Discrete-frequency qualification may be accomplished by using either a single pure tone or multiple simultaneous pure tones that are each analysed separately in the frequency domain. At each frequency of interest, the

measurement bandwidth is preferably one-third octave or narrower and there shall be no more than one tone in each analysed band[37]. If a noise source under test radiates only broadband noise, then broadband qualification may be conducted instead of discrete-frequency qualification.

NOTE A test room to be qualified for discrete-frequency measurements is more costly both to construct and to qualify than one to be qualified for broadband measurements.

A.4.2 Generation of sound

The test sound source described in ISO 26101:2017, 5.1.2.2 shall be operated using the test signals of ISO 26101:2017, 5.1.4.2.

A.4.3 Spatial resolution of the measurement points

Sound pressure levels shall be measured along each microphone traverse described in A.3.3 using equally spaced measurement points at each frequency. At least 50 total measurement points are required within the qualified radius (see A.2.4) with at least 10 measurement points on each traverse. The spacing between points shall not exceed a tenth of a wavelength at each frequency of interest below 250 Hz and shall not exceed 100 mm at frequencies above 250 Hz.

Alternatively, for signals consisting of pure tone(s), the microphone may be moved slowly and continuously along the traverse and the sound pressure levels recorded. Sound pressure level versus distance data should be determined using the spatial sampling requirements for discrete-point measurements.

A spatial resolution of a tenth of a wavelength may be needed to fully characterize the spatial patterns in the reflections and to ensure that peak deviations are detected. If a 100 mm spatial resolution traverse indicates that the decibel deviation of the measured sound pressure level at any point on the traverse is within 10 % of the decibel value of the criterion being evaluated, then it is recommended that additional measurements are made near that point to ensure that the maximum deviation is detected.

A.5 Information to be recorded and reported

For test rooms qualified in accordance with this document, laboratories shall document all items outlined in ISO 26101:2017, 5.2 and 5.3, with the following exception: the requirement for a statement of the measurement uncertainty as in ISO 26101:2017, 5.3 k), is considered redundant as uncertainty is already covered by the recording and reporting requirements of Clauses 11 and 12.

Page 63, Bibliography

Delete Reference [21] and add the following references:

[35] Bethke C., Wittstock V. Technical aspects in the qualification of free-field environments. In: *Proceedings NAG/DAGA 2009, International Conference on Acoustics*, Rotterdam, Netherlands, CD-Proceedings, 2009

[36] Winker D., Phillips J., Chada A., Ristroph E. A precision grade, wide bandwidth source for the qualification of hemi-anechoic chambers. In: *Proceedings Noise-Con 2008*, Dearborn, USA, INCE Conference Proceedings, pp. 779–787

[37] Wittstock V., Bethke C. The influence of bandwidth on the qualification of anechoic and hemi-anechoic rooms. In: *Proceedings 33rd International Congress and Exposition on Noise Control Engineering*, Prague, Czech Republic, CD-Proceedings, 2004