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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

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

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

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

This second edition cancels and replaces the first edition (ISO 3743-2:1994), of which it constitutes a minor revision. The main changes are the following:

— Table 0.1 in the Introduction deleted;

— restructuring of the content of Clause 1;

— references updated;

— clause on measurement uncertainty revised to be in-line with the other standards of the ISO 3740 series (now Clause 11);

— new Annexes D, E, and F added;

— new entries in Bibliography added.

A list of all the parts in the ISO 3743 series can be found on the ISO website.

Introduction

ISO 3743 is one standard of the series ISO 3741 to ISO 3747 series, which specifies various methods for determining the sound power levels of machines, equipment and sub-assemblies. These basic standards specify the acoustical requirements for measurements appropriate for different test environments. When selecting one of the methods of the series ISO 3741 to ISO 3747, it is necessary to select the most appropriate for the conditions and purposes of the noise test. General guidelines to assist in the selection are provided in ISO 3740. The series ISO 3741 to ISO 3747 gives only general principles regarding the operating and mounting conditions of the machine or equipment under test. Reference should be made to the noise test code for a specific type of machine or equipment, if available, for specifications on mounting and operating conditions.

The method given in this document enables measurement of sound pressure levels with A-weighting and in octave bands at pre-scribed fixed microphone positions or along prescribed paths. It allows determination of A-weighted sound power levels or sound power levels with other weighting and octave-band sound power levels. Quantities which cannot be determined are the directivity characteristics of the source and the temporal pattern of noise radiated by sources emitting non-steady noise.

ISO 3743-1 and this document specify engineering methods for determining the A-weighted and octave-band sound power levels of small noise sources. The methods are applicable to small machines, devices, components and sub-assemblies which can be installed in a special reverberation test room or in a hard-walled test room with prescribed acoustical characteristics. The methods are particularly suitable for small items of portable equipment; they are not intended for larger pieces of stationary equipment which, due to their manner of operation or installation, cannot readily be moved into the test room and operated as in normal usage. The procedures are intended to be used when an engineering grade of accuracy is desired without requiring the use of laboratory facilities.

In ISO 3743-1, a comparison method is used to determine the octave-band sound power levels of the source. The spatial average (octave-band) sound pressure levels produced by the source under test are compared to the spatial average (octave-band) sound pressure levels produced by a reference sound source of known sound power output. The difference in sound pressure levels is equal to the difference in sound power levels if conditions are the same for both sets of measurements. The A-weighted sound power level is then calculated from the octave-band sound power levels.

The requirements to be fulfilled by the special reverberation test room for measurements in accordance with this document are significantly more restrictive than those placed on the hard-walled test room by the comparison method of ISO 3743-1.

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 Scope

This document specifies a relatively simple engineering method for determining the sound power levels of small, movable noise sources. The methods specified in this document are suitable for measurements of all types of noise within a specified frequency range, except impulsive noise consisting of isolated bursts of sound energy which are covered by ISO 3744 and ISO 3745.

NOTE A classification of different types of noise is given in ISO 12001.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

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*

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*

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

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

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

IEC 60942, *Electroacoustics — Sound calibrators*

IEC 61260 (all parts), *Electroacoustics — Octave-band and fractional-octave-band filters*

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 3743-1 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
special reverberation test room
room which meets the requirements of Clause 6 of ISO ISO 3743-2

Note 1 to entry: The requirements for a test room according to this document are significantly more restrictive than those placed on the hard-walled test room by the comparison method of ISO 3743-1.

4 Principle

The measurements are carried out when the source is installed in a specially designed room having a specified reverberation time over the frequency range of interest. The A-weighted sound power level of the source under test is determined from a single A-weighted sound pressure level measurement at each microphone position, rather than from a summation of octave-band levels. This direct method eliminates the need for a reference sound source, but requires the use of a special reverberation test room. The direct method is based on the premise that the sound pressure level, averaged in space and time in the test room, can be used to determine the sound power level emitted by the source. The properties of the special reverberation test room are chosen so that the room's influence on the sound power output of the equipment under test is small. The number of microphone positions and source locations required in the test room are specified. Guidelines for the design of special reverberation rooms are given in Annex B.

In addition to the direct method, a comparison method is also described (see 10.3). However, since the requirements on the test room for the comparison method of ISO 3743-1 are considerably less restrictive, it is recommended that the comparison method of ISO 3743-1 be used if a special reverberation test room is not available.

NOTE Precision methods for the determination of the sound power levels of small noise sources are specified in ISO 3741 and ISO 3745.

5 Noise source

The noise source may be a device, machine, component or sub-assembly.

The maximum size of the source under test and the lower limit of the frequency range for which the methods are applicable depend upon the size of the room used for the acoustical measurements. The volume of the noise sources should not exceed 1 % of the volume of the special reverberation test room. For the minimum test room volume of 70 m^3, the recommended maximum size of the source is 0,7 m^3. Measurements on sources emitting discrete-frequency components below 200 Hz are frequently difficult to make in such small rooms.

6 Requirements for special reverberation test room

6.1 General

Guidelines for the design of a suitable test room and an example of the determination of the nominal reverberation time of the room are given in Annex B. Methods of measurement of reverberation time are given in ISO 354.

6.2 Volume of test room

The volume of the test room shall be at least 70 m^3 and preferably greater if the 125 Hz octave band is within the frequency range of interest. If the 4 kHz and 8 kHz octave bands are within the frequency range of interest, the volume shall not exceed 300 m^3.

NOTE When using the comparison method, the use of larger room volumes is acceptable.

6.3 Reverberation time of test room

The calculation of sound power levels from measured values of the sound pressure levels requires a compensation for the frequency-dependent concentration of sound energy near the walls of the test room. To facilitate this compensation, the reverberation time should be slightly higher at low frequencies. The reverberation time of the test room shall fall within the limiting curves defined by $T = 0{,}9\ RT_{\text{nom}}$ and $1{,}1\ RT_{\text{nom}}$ where the reverberation parameter, R, is given by

$$R = 1 + \frac{257}{fV^{1/3}} \tag{1}$$

where

f is the frequency, in hertz;

V is the volume, in cubic metres.

NOTE The following is a more robust formula for R and is not limited to rooms that are nearly cubical:

$$R = 1 + \frac{c \cdot S}{f \cdot 8V}$$

where

c is the sound velocity, in metres per second;

S is the surface area of the test room, in square metres.

For frequencies above 6,3 kHz, constants 0,9 and 1,1 shall be replaced by 0,8 and 1,2 respectively. The nominal reverberation time of the room, T_{nom} is determined by centring the measured values of T (normalized to the reverberation time at 1 000 Hz) within the limiting curves specified above, and shall be between 0,5 s and 1,0 s (see Annex B for an example). For a room volume V of 70 m^3, the value of R is determined from Figure 1.

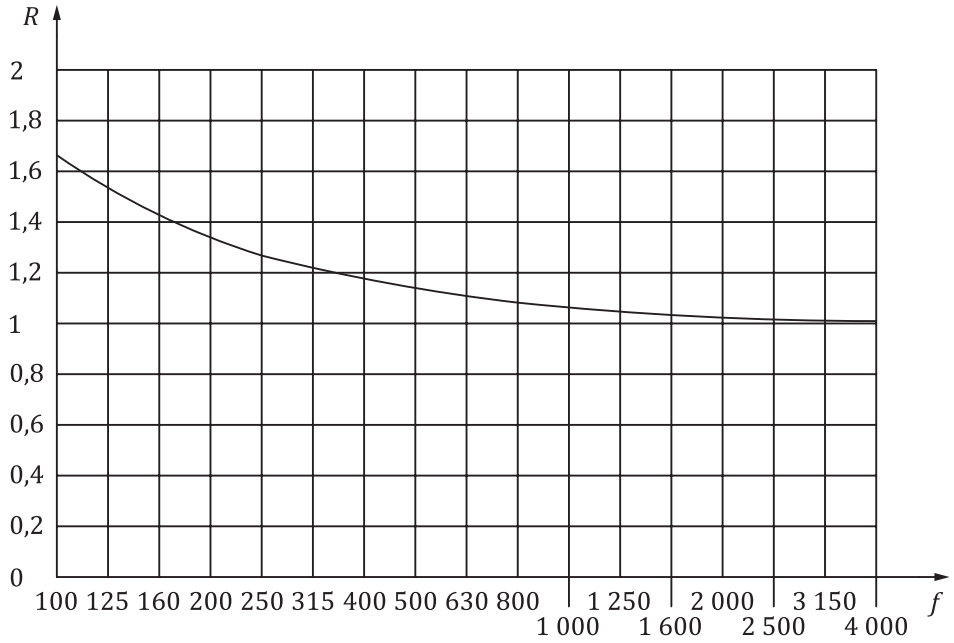
If, during the acoustical measurements, sound-absorptive structures support the source or if the source has absorptive surfaces, the reverberation time T shall be measured with these items present.

6.4 Surface treatment

The floor of the test room shall be reflective with an absorption coefficient less than 0,06. Except for the floor, none of the surfaces shall have absorptive properties significantly deviating from each other. For each octave band within the frequency range of interest, the mean value of the absorption coefficient of each wall and of the ceiling shall be within 0,5 and 1,5 times the mean value of the absorption coefficient of the walls and ceiling.

6.5 Criterion for background noise

At each microphone position, the sound pressure levels due to background noise shall be at least 4 dB and preferably more than 10 dB below the A-weighted sound pressure level or the band pressure levels produced by the source.



Key

f one-third-octave-band centre frequency, in hertz

R reverberation parameter

Figure 1 — Values of *R* at the one-third-octave-band centre frequencies for *V* = 70 m³

6.6 Criteria for temperature and humidity

The air absorption in the reverberation room varies with temperature and humidity, particularly at frequencies above 1 000 Hz. The temperature θ, in degrees Celsius, and the relative humidity (H), expressed as a percentage, shall be controlled during the sound pressure level measurements. The product

$$H \cdot (\theta + 5\,°\mathrm{C}) \tag{2}$$

shall not differ by more than ±10 % from the value of the product which prevailed during the measurement of the reverberation time of the test room.

NOTE To keep the reverberation time within the specified limits at the highest frequencies, a reduction of the air absorption is sometimes necessary. An increase in the humidity (for example by using a small humidifier) may be beneficial.

6.7 Evaluation of suitability of test room

Before a test room is used for sound power level determinations, its suitability shall be evaluated using the following procedure.

a) Step 1

Obtain a small broad-band reference sound source which has been calibrated in accordance with ISO 3741, or by following the procedures specified in ISO 6926 and ISO 3745.

b) Step 2

In the special reverberation test room, determine the octave-band power levels of the same reference sound source under identical operating conditions in accordance with the procedure given in this document.

c) Step 3

For each octave band within the frequency range of interest, calculate the difference between the sound power levels obtained in this way.

d) Step 4

Compare these differences with the values given in Table 1.

If the differences in octave-band power levels do not exceed those specified in Table 1, the room is suitable for sound power determinations of broad-band noise sources in accordance with the procedures of this document.

Table 1 — Maximum permitted differences between octave-band power levels of broad-band noise sources measured in accordance with 6.7 a)

Octave-band centre frequency Hz	Difference in band power levels dB
125	±5
250 to 4 000	±3
8 000	±4

7 Instrumentation

7.1 General

The basic instrumentation consists of a microphone, an amplifier with A-weighting network, a squaring and averaging circuit and an indicating device. A set of octave-band filters is also required. These elements may be separate instruments or they may be integrated into a complete unit, for example, a suitable sound level meter. For requirements on sound level meters, see IEC 61672-1.

The microphone shall, whenever possible, be physically separated from the rest of the instrumentation with which it is connected by means of a cable. Examples of suitable instrumentation systems are given in Annex C.

7.2 Microphone and its associated cable

The microphone shall have a flat frequency response for randomly incident sound over the frequency range of interest, as determined by the procedure given in 7.6.

NOTE 1 This requirement is not normally met by the microphone of a sound level meter which is calibrated for free field measurements.

NOTE 2 If several microphones are used, it is desirable to avoid the axis of each microphone being oriented in the same direction in space.

The frequency response and stability of the microphone system shall not be adversely affected by the cable connecting the microphone to the rest of the instrumentation system. If the microphone is moved, care shall be exercised to avoid introducing acoustical or electrical noise that could interfere with the measurements.

7.3 Amplifier and weighting network

The properties of the amplifier and the A-weighting network shall comply with the requirements of IEC 61672-1.

7.4 Octave-band filters

The octave-band filters shall comply with the requirements of IEC 61260 (all parts).

7.5 Squaring and averaging circuits and indicating device

Squaring and averaging the microphone output voltage may be performed by analogue or digital equipment as described in Annex C. In analogue systems, continuous averaging is generally performed by an RC-smoothing network with a time constant τ_A. For these systems, the time constant shall be at least 0,5 s and such that the indicated fluctuations are less than ±5 dB.

In digital systems and in some analogue systems, true integration over a fixed time/interval (integration time τ_D) is employed. The integration time shall be at least 1 s. The indication of the squaring and averaging (integrating) circuits and indicating device shall be within 3 % of the values.

7.6 Frequency response of the instrumentation system

The frequency response of the instrumentation calibrated for randomly incident sound shall be determined in accordance with the procedure in IEC 61672 with the acceptance limits given in Table 2.

Table 2 — Acceptance limits for the instrumentation system

Frequency Hz	**Acceptance limits** dB
100 to 4 000	±1
5 000	±1,5
6 300	+1,5 −2
8 000	+1,5 −3
10 000	+2 −4

NOTE Adapted from IEC 61672-1.

7.7 Calibration

During each series of measurements, a sound calibrator with an accuracy of ±0,3 dB (class 1 as specified in IEC 60942) shall be applied to the microphone to verify the calibration of the entire measuring system at one or more frequencies over the frequency range of interest.

The calibrator shall be checked annually to verify that its output has not changed. In addition, an electrical calibration of the instrumentation system over the entire frequency range of interest shall be carried out periodically, at intervals not exceeding 2 years.

8 Installation and operation of source under test

8.1 General

The acoustical properties of the special reverberation test room and the manner in which the source is operated may have a significant influence on the sound power emitted by the source.

8.2 Source location

Install the source in the test room in one or more locations as if it were being installed for normal usage. If no such location(s) can be defined, place the source on the floor of the test room with a minimum distance of 1 m between any surface of the source and the nearest wall.

