

INTERNATIONAL
STANDARD

ISO
3743-1

First edition
1994-02-15

**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

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

Partie 1: Méthode par comparaison en salle d'essai à parois dures



Reference number
ISO 3743-1:1994(E)

Contents

	Page
1 Scope	1
2 Normative references	2
3 Definitions	3
4 Requirements for hard-walled test room	4
5 Instrumentation	5
6 Installation and operation of source under test	5
7 Measurements in test room	6
8 Calculation of sound power levels	8
9 Information to be recorded	8
10 Information to be reported	9
 Annex	
A Bibliography	10

STANDARDSISO.COM : Click to view the full PDF of ISO 3743-1:1994

© ISO 1994

All rights reserved. No part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from the publisher.

International Organization for Standardization
Case Postale 56 • CH-1211 Genève 20 • Switzerland

Printed in Switzerland

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.

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 3743-1 was prepared by Technical Committee ISO/TC 43, *Acoustics*, Sub-Committee SC 1, *Noise*.

ISO 3743 consists of the following parts, under the general title *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*
- Part 2: *Methods for special reverberation test rooms*

Part 2 is a revision of ISO 3743:1988.

Annex A of this part of ISO 3743 is for information only.

Introduction

0.1 ISO 3743 is one of the ISO 3740 series, which specifies various methods for determining the sound power levels of machines, equipment and their sub-assemblies. These basic standards specify the acoustical requirements for measurements appropriate for different test environments as shown in table 0.1. When selecting one of the methods of the ISO 3740 series, 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 ISO 3740 series 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.

0.2 The method given in this part of ISO 3743 enables measurement of sound pressure levels in octave bands at prescribed fixed microphone positions or along prescribed paths. A comparison method is used which allows determination of sound power levels in octave bands. A-weighted sound power levels may be calculated from the 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.

0.3 Parts 1 and 2 of ISO 3743 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 hard-walled test room with prescribed acoustical characteristics or in a special reverberation test room. 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.

Table 0.1 — International Standards specifying various methods for determining the sound power levels of machines and equipment

International Standard	Classification of method ¹⁾	Test environment	Volume of source	Character of noise	Sound power levels obtainable	Optional information available
3741	Precision (grade 1)	Reverberation room meeting specified requirements	Preferably less than 1 % of test room volume	Steady, broad-band	In one-third-octave or octave bands	A-weighted sound power level
3742				Steady, discrete frequency or narrow-band		
3743-1	Engineering (grade 2)	Hard-walled test room		Steady, broad-band, narrow-band, or discrete frequency	A-weighted and in octave bands	Other weighted sound power levels
3743-2		Special reverberation test room				
3744	Engineering (grade 2)	Outdoors or in large room	Greatest dimension less than 15 m	Any	A-weighted and in one-third-octave or octave bands	Directivity information and sound pressure levels as a function of time; other weighted sound power levels
3745	Precision (grade 1)	Anechoic or semi-anechoic room	Preferably less than 0,5 % of test room volume	Any		
3746	Survey (grade 3)	No special test environment	No restrictions; limited only by available test environment	Any	A-weighted	Sound pressure levels as a function of time; other weighted sound power levels
3747	Survey (grade 3)	No special test environment; source under test not movable	No restrictions	Steady, broad-band, narrow-band, or discrete frequency	A-weighted	Sound power levels in octave bands

1) See ISO 2204.

STANDARDSISO.COM : Click to view the full PDF of ISO 3743-1:1994

0.4 In ISO 3743-2, the comparison method can also be used, but an alternative method permits the determination of the A-weighted sound power level of the source under test 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.

The requirements to be fulfilled by the special reverberation test room for measurements in accordance with the method given in ISO 3743-2 are significantly more restrictive than those placed on the hard-walled test room by the comparison method given in this part of ISO 3743.

STANDARDSISO.COM : Click to view the full PDF of 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

1 Scope

1.1 General

This part of ISO 3743 specifies a relatively simple engineering method for determining the sound power levels of small, movable noise sources. The measurements are carried out when the source is installed in a hard-walled test room. 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.

NOTE 1 Precision methods for the determination of sound power levels of small noise sources are specified in ISO 3741 and ISO 3745.

1.2 Types of noise

The method specified in this part of ISO 3743 is suitable for measurements of all types of noise within a specified frequency range, except intermittent noise consisting of isolated bursts of sound energy.

NOTES

2 A classification of different types of noise is given in ISO 2204.

3 For sources of intermittent noise consisting of short-duration noise bursts, the free-field methods specified in ISO 3744 and ISO 3745 should be used.

1.3 Noise source

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

The maximum size of the source under test depends upon the size of the room used for the acoustical measurements. (See also 4.1).

1.4 Measurement uncertainty

Determinations made in accordance with this part of ISO 3743 result, with few exceptions, in standard deviations of reproducibility of the A-weighted sound power level equal to or less than 1,5 dB (see table 1).

A single value of the sound power level of a noise source determined according to the procedures of this part of ISO 3743 is likely to differ from the true value by an amount within the range of the measurement uncertainty. The uncertainty in determinations of the sound power level arises from several factors which affect the results, some associated with environmental conditions in the measurement laboratory and others with experimental techniques.

If a particular noise source were to be transported to each of a number of different laboratories, and if, at each laboratory, the sound power level of that source were to be determined in accordance with this part of ISO 3743, the results would show a scatter. The standard deviation of the measured levels could be calculated (see examples in ISO 7574-4:1985, annex B) and would vary with frequency. With few exceptions, these standard deviations would not exceed those listed in table 1. The values given in table 1 are standard deviations of reproducibility, σ_R , as defined in ISO 7574-1. The values of table 1 take into account the cumulative effects of measurement uncertainty in applying the procedures of this part of ISO 3743, but exclude variations in the sound power output caused

by changes in operating conditions (e.g. rotational speed, line voltage) or mounting conditions.

The measurement uncertainty depends on the standard deviation of reproducibility tabulated in table 1 and on the degree of confidence that is desired. As examples, for a normal distribution of sound power levels, there is a 90 % confidence that the true value of the sound power level of a source lies within the range $\pm 1,645 \sigma_R$ of the measured value and a 95 % confidence that it lies within the range $\pm 1,96 \sigma_R$ of the measured value. For further examples, reference should be made to the ISO 7574 and ISO 9296 series.

Table 1 — Estimated values of the standard deviation of reproducibility of sound power levels determined in accordance with this part of ISO 3743

Octave-band centre frequency Hz	Standard deviation of reproducibility, σ_R dB
125	3,0
250	2,0
500 to 4 000	1,5
8 000	2,5
A-weighted	1,5*)
*) Applicable to a source which emits noise with a relatively "flat" spectrum in the frequency range 100 Hz to 10 000 Hz.	

NOTES

4 The standard deviations listed in table 1 are associated with the test conditions and procedures defined in this part of ISO 3743, and not with the noise source itself. They arise partly from variations between measurement laboratories in the geometry of the test room, the acoustical properties of the test room boundaries, background noise, the type and calibration of instrumentation, and the reference sound source. They are also due to variations in experimental measurement techniques, including microphone placement and spatial averaging, location of source under test, integration times, and measurement of reverberation time.

5 If several laboratories use similar facilities and instrumentation, the results of sound power determinations on a given source in those laboratories may be in better agreement than would be implied by the standard deviations given in table 1.

6 For a particular family of sound sources, of similar size with similar sound power spectra and similar operating conditions, the standard deviations of reproducibility may be smaller than the values given in table 1. Hence, a noise test code for a particular type of machinery or equipment making reference to this part of ISO 3743 may state standard deviations smaller than those listed in table 1 if substantiation is available from the results of suitable interlaboratory tests.

7 The standard deviation of reproducibility, as tabulated in table 1, includes the uncertainty associated with repeated measurements on the same noise source under the same conditions (for standard deviation of repeatability, see ISO 7574-1). This uncertainty is usually much smaller than the uncertainty associated with interlaboratory variability. However, if it is difficult to maintain stable operating or mounting conditions for a particular source, the standard deviation of repeatability may not be small compared with the values given in table 1. In such cases, the fact that it was difficult to obtain repeatable sound power level data on the source should be recorded and stated in the test report.

8 The procedures of this part of ISO 3743 and the standard deviations given in table 1 are applicable to measurements on an individual machine. Characterization of the sound power levels of batches of machines of the same family or type involves the use of random sampling techniques in which confidence intervals are specified, and the results are expressed in terms of statistical upper limits. In applying these techniques, the total standard deviation must be known or estimated, including the standard deviation of production, as defined in ISO 7574-1, which is a measure of the variation in sound power output between individual machines within the batch. Statistical methods for the characterization of batches of machines are described in ISO 7574-4.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 3743. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 3743 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 2204:1979, *Acoustics — Guide to International Standards on the measurement of airborne acoustical noise and evaluation of its effects on human beings.*

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 6926:1990, *Acoustics — Determination of sound power levels of noise sources — Requirements for the performance and calibration of reference sound sources.*

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 7574-4:1985, *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.*

IEC 225:1966, *Octave, half-octave and third-octave band filters intended for the analysis of sounds and vibrations.*

IEC 651:1979, *Sound level meters.*

IEC 804:1985, *Integrating-averaging sound level meters.*

IEC 942:1988, *Sound calibrators.*

3 Definitions

For the purposes of this part of ISO 3743, the following definitions apply.

3.1 sound pressure, p : A fluctuating pressure superimposed on the static pressure by the presence of sound. It is expressed in pascals.

NOTE 9 The magnitude of the sound pressure can be expressed in several ways, such as instantaneous sound pressure or maximum sound pressure, but, in this part of ISO 3743 the term defines the sound pressure averaged on a mean-square basis (square root of the time average of the squared value) in time, and in space (i.e. over all microphone positions).

3.2 sound pressure level, L_p : Ten times the logarithm to the base 10 of the ratio of the square of the sound pressure to the square of the reference sound pressure. Sound pressure levels are expressed in decibels. The reference sound pressure is 20 μPa (2×10^{-5} Pa).

The frequency weighting or the width of the frequency band used and the time weighting (S, F or I, see IEC 651) shall be indicated.

NOTE 10 For example, the A-weighted sound pressure level with time weighting S is L_{pAS} .

3.3 time-averaged sound pressure level, $L_{peq,T}$: 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.

$$\begin{aligned} L_{peq,T} &= 10 \lg \left[\frac{1}{T} \int_0^T 10^{0,1L_p(t)} dt \right] \text{ dB} \\ &= 10 \lg \left[\frac{1}{T} \int_0^T \frac{p^2(t)}{p_0^2} dt \right] \text{ dB} \quad \dots (1) \end{aligned}$$

Time-averaged sound pressure levels are expressed in decibels and shall be measured with an instrument which complies with the requirements of IEC 804.

NOTES

11 Time-averaged sound pressure levels are usually A-weighted and denoted by $L_{pAeq,T}$ which is usually abbreviated to L_{pA} .

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

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

3.5 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 reference sound power is 1 pW (10^{-12} W).

The frequency weighting or the width of the frequency band used shall be indicated.

NOTE 13 For example, the A-weighted sound power level is L_{WA} .

3.6 reverberant sound field: That portion of the sound field in the test room over which the contribution of the sound received directly from the source is negligible compared to the sound reflected from the boundaries of the room and from objects within the room.

3.7 hard-walled test room: Room in which the acoustical reflectivity of all room surfaces (including floor and ceiling) is high over the frequency range of interest.

3.8 frequency range of interest: For general purposes, the frequency range of interest includes the octave bands with midband frequencies from 125 Hz to 8 000 Hz, i.e. from the lower cut-off of the 125 Hz band (90 Hz) to the upper cut-off of the 8 000 Hz band (11 200 Hz).

NOTE 14 For special purposes, the frequency range of interest may be extended or reduced, but this places additional requirements on the characteristics of the test room which are not described in this part of ISO 3743.

3.9 reference sound source (RSS): Stable sound source emitting steady, broad-band noise with adequate sound power over a wide frequency range, calibrated in accordance with ISO 6926. The sound power levels of the reference sound source are known over the frequency range of interest.

3.10 reference box: Hypothetical surface which is the smallest rectangular parallelepiped that just encloses the source under test and terminates on the floor of the test room.

NOTE 15 Small individual components of the source which do not contribute to its sound radiation may lie outside the reference box.

3.11 comparison method: That method in which the sound power level of a source under test is determined by comparing the averaged value (on a mean-square basis) of the sound pressure levels produced by the source in the test room to the averaged value of the sound pressure levels produced in the same room 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 when conditions are the same for both sets of measurements.

3.12 direct method: That method in which the sound power level of a source under test is determined from the averaged value (on a mean-square basis) of the sound pressure levels produced by the source in the test room, the reverberation time, and the volume of the test room.

3.13 background noise: Noise from all sources other than the source under test.

NOTE 16 Background noise may include contributions from airborne sound, structure-borne vibration, and electrical noise in instrumentation.

3.14 background noise level: Sound pressure level measured in the test room when the source under test is not operating. It is expressed in decibels.

3.15 sound absorption coefficient: In a specified frequency band, a measure of the absorptive property of a material or surface. Ideally, the sound absorption coefficient is the fraction of the randomly incident sound power absorbed or otherwise not reflected.

3.16 highly directional sound source: Sound source with a maximum directivity index measured in accordance with ISO 3745 which exceeds 15 dB.

4 Requirements for hard-walled test room

4.1 Volume of test room

The volume of the test room shall be at least 40 m³, and at least 40 times the volume of the reference box.

In rooms with volumes between 40 m³ and 100 m³, the largest dimension of the source shall not exceed 1,0 m. In rooms with volumes greater than 100 m³, the largest dimension of the source shall not exceed 2,0 m.

4.2 Acoustical properties of test room

A hard-walled room shall be used. This means that the sound absorption coefficient of any portion of any

boundary surface shall not exceed 0,20 at all frequencies within the frequency range of interest. Most ordinary, unfurnished rooms without special acoustical treatment (e.g. acoustical ceilings and/or absorptive wall coverings) will comply with this requirement. Table 2 may be used for guidance.

Table 2 — Acceptable and unacceptable rooms

Acceptable rooms	Unacceptable rooms
Nearly empty rooms with smooth hard walls and ceiling made of concrete, brick, plaster or tile	Rooms with upholstered furniture, machinery or industrial rooms with a small amount of sound absorptive material on ceiling or walls (for example, partially absorptive ceiling)
Partly empty rooms, rooms with smooth hard walls	Rooms with some sound absorptive materials on both ceiling and walls
Rooms without upholstered furniture, rectangular machinery rooms or industrial rooms, no sound absorptive materials on surfaces	Rooms with large amounts of sound absorptive materials on either ceiling or walls
Irregularly shaped rooms without upholstered furniture, irregularly shaped machinery rooms or industrial rooms, no sound absorptive materials on surfaces	

4.3 Test of room suitability

The suitability of a test room may differ from one source to another. The requirements for the room are most critical when a highly directional source is to be evaluated. When testing the general suitability of a test room, the following procedure shall be followed.

A highly directional, broad-band sound source is located in the test room as given in 7.2. Microphone positions are chosen according to 7.4 and the average (energy basis) octave-band sound pressure level, L_{p1} , is determined (see $L_{p(ST)}$ in clause 8). The sound source is then turned 45° to 135° in compliance with the requirement of 7.5 and the corresponding octave-band sound pressure level, L_{p2} , is determined. This procedure is repeated twice more to determine L_{p3} and L_{p4} . The fourth position shall be within 45° to 90° of the first position. If the maximum difference between the octave-band sound pressure levels of any two source positions for the frequency bands with midband frequencies between 125 Hz and 8 000 Hz does not exceed the standard deviations of

table 1, the test room is considered to fulfil the requirements of this part of ISO 3743.

NOTE 17 As an alternative to the highly directional sound source, a sound source of the same type as the source under test may be used. However, if the alternative procedure is used, the qualification is valid for this type of source only.

4.4 Criterion for background noise

At each microphone position, the octave-band sound pressure levels due to background noise shall be at least 6 dB and preferably more than 15 dB below the octave-band sound pressure levels measured with both the reference sound source and the source under test in operation.

4.5 Temperature and humidity

For measurements according to this part of ISO 3743, the temperature and the relative humidity of the test room shall be controlled during the acoustical measurements and maintained at as nearly constant values as practicable. These values shall be reported in the test report.

5 Instrumentation

5.1 Instrumentation system

The instrumentation system, including the microphone and cable, shall meet the requirements for a type 1 instrument specified in IEC 804.

For measurements in octave bands, the instrumentation system shall meet the requirements of IEC 225.

5.2 Calibration

During each series of measurements, a sound calibrator with an accuracy of $\pm 0,3$ dB (class 1 as specified in IEC 942) 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 compliance of the calibrator shall be verified with the requirements of IEC 942 once a year and the compliance of the instrumentation system with the requirements of IEC 804 shall be verified at least every 2 years in a laboratory making calibrations traceable to appropriate standards.

The date of the last verification of compliance with relevant IEC standards shall be recorded.

5.3 Reference sound source

The reference sound source (RSS) shall meet the requirements of ISO 6926 and shall be calibrated annually in accordance with ISO 6926.

6 Installation and operation of source under test

6.1 General

The manner in which the source under test is installed and operated may have a significant influence on the sound power emitted by the source. This clause specifies conditions that minimize variations in the sound power output due to the installation and operating conditions of the source under test. The instructions of a noise test code, if any exists, shall be followed in so far as installation and operation of the source under test are concerned.

6.2 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. Additional requirements for source location are given in 7.2.

The location(s) of the source in the test room shall be described in the test report.

6.3 Source mounting

In many cases, the sound power emitted will depend upon the support or mounting conditions of the source under test. Whenever a typical condition of mounting exists for the equipment under test, that condition shall be used or simulated, if feasible.

If a typical condition of mounting does not exist or cannot be utilized for the test, take care to avoid changes in the sound output of the source caused by the mounting system employed for the test. Take steps to reduce any sound radiation from the structure on which the equipment may be mounted.

Sources normally mounted through a window, wall or ceiling shall be mounted through a wall or the ceiling of the test room.

Other special cases given in ISO 3744:1994, 6.3, are applicable to this part of ISO 3743.

The mounting conditions of the source and its associated equipment shall be described in the test report.

NOTE 18 The use of resilient mounts or vibration-damping material to support the equipment under test may be appropriate.

6.4 Auxiliary equipment

Take care to ensure that any electrical conduits, piping or air ducts connected to the source under test do not radiate significant amounts of sound energy into the test room. If practicable, locate all auxiliary equipment

necessary for the operation of the source under test outside the test room and clear the test room of all objects which may interfere with the measurements.

6.5 Operation of source during the test

During the measurements, use the operating conditions specified in the test code, if any exists for the particular type of machinery or equipment under test. If there is no test code, operate the source, if possible, in a manner which is typical of normal use. In such a case, one or more of the following operating conditions shall be selected:

- a) device under specified load and operating conditions;
- b) device under full load [if different from a) above];
- c) device under no load (idling);
- d) device under operating conditions corresponding to maximum sound generation representative of normal use;
- e) device with simulated load operating under carefully defined conditions;
- f) device under operating condition with characteristic work cycle.

The method given in this part of ISO 3743 is applicable for determining the sound power level of the source under any desired set of operating conditions (i.e. temperature, humidity, device speed, etc.). These test conditions shall be selected beforehand and shall be held constant during the test. The source shall be in the desired operating condition before any acoustical measurements are made.

Other special cases given in ISO 3744:1994, 6.5, are applicable to this part of ISO 3743.

The operating conditions of the source during the acoustical measurements shall be described in the test report.

7 Measurements in test room

7.1 General

Carry out two sets of acoustical measurements, first with the source under test, and then with the reference sound source (RSS). Make these measurements with the sources installed and operated in the test room. Compare the spatial average (octave-band) sound pressure levels produced by the source under test to the spatial average (octave-band) sound pressure levels produced by a reference sound source, of known sound power output, which replaces the source under test and is operated under

the same test conditions. The difference in the sound pressure levels obtained in the two sets of acoustical measurements is equal to the difference in the sound power levels of the two sources.

7.2 Location of source under test

Unless there are contrary requirements in an acoustical test code for the particular type of machinery or equipment under test, install the source such that the distance between any wall or the ceiling of the test room and the reference surface is at least 1 m. The sides of the reference box shall not be parallel to the walls of the room. When installing the source, consider the requirements concerning the placement of the microphones given in 7.4. These usually require that the source be placed near the middle of a large test room so that microphones can be placed on all four sides of the source. In a small test room, place the source at one end so that a reverberant field can be established at the other end of the room.

The source under test shall remain in the test room during all acoustical measurements if its sound absorptivity (when not in operation) affects the sound pressure levels when the RSS is operating.

If the source under test is table-mounted or wall-mounted, the table or wall shall be considered to be part of the test set-up.

7.3 Location of reference sound source (RSS)

When the source under test is placed on the floor more than 1 m from the walls, during the second set of acoustical measurements place the RSS in the same position as that occupied by the source under test during the first set of acoustical measurements. If, however, the source under test is closer than 1 m to a wall, do not place the RSS at the position of the source under test, but at a position on the floor 1 m from the wall.

7.4 Microphone positions

At least three microphone positions shall be used. The same three microphone positions (and orientations) shall be used for measurements on the source under test and on the RSS. If there are discrete frequencies or narrow-band components in the spectrum of the sound emitted by the source under test, follow the procedure given in 7.6.

If practicable, all three microphone positions shall be in the reverberant sound field. This requires that the minimum distance d_{\min} , in metres, between the sound source and the nearest microphone position be not less than

$$d_{\min} = 0,3V^{1/3} \quad \dots (2)$$

where V is the room volume in cubic metres.

No microphone position shall be closer than 0,5 m to the ceiling or to any wall of the test room.

If the room is large enough, and both the conditions for d_{min} and the minimum distance to the ceiling and walls are fulfilled, the number of microphone positions shall be increased to five: one on each side of the reference box and the fifth directly above the reference box.

The microphone positions should be at least a distance of a half-wavelength (i.e. $\lambda/2$) from one another, where λ is the wavelength of the centre frequency of the lowest octave band in the frequency range of interest.

NOTE 19 The use of a moving microphone traversing a path in the test room at constant speed will often be more convenient than the use of a number of fixed microphone positions. The path may be a line, an arc, a circle or some other geometric figure, provided the plane of the path is at least 10° out of parallel with any room surface. Such a sweeping arrangement with a single microphone may be used if the rules for multiple, fixed microphones are complied with. The path length of the sweep should be at least 5 m.

7.5 Special arrangement for directional sources

Before any acoustical measurements are carried out make an aural examination of the noise emitted by the equipment under test. Give special attention to sources which are noticeably directional, i.e. emit more sound energy in one direction than in another. Orient such sources in such a way that the most directional sound energy is reflected at least once from a boundary surface of the room, with a minimum of loss, before reaching any of the microphone positions.

7.6 Special arrangement for sources emitting narrow-band noise

Make an aural examination of the noise emitted by the equipment under test. If discrete tones and/or narrow-band noise are observed, carry out the following procedure to determine if more than one source location in the test room is required. Use fixed microphone positions in accordance with 7.4 and increase the number of such positions to a minimum of six.

Calculate the estimated standard deviation, s_M , in decibels, for each octave band of interest from the following equation:

$$s_M = (n - 1)^{-1/2} \left[\sum_{i=1}^n (L_{pi} - \bar{L}_p)^2 \right]^{1/2} \dots (3)$$

where

L_{pi} is the time-averaged sound pressure level, in decibels, at the i^{th} measurement position;

n is the number of microphone positions ($n = 6$);

and

$$\bar{L}_p = 10 \lg \left[\frac{1}{n} \sum_{i=1}^n 10^{0,1L_{pi}} \right] \text{ dB} \dots (4)$$

Depending on the value of s_M for each frequency band of interest, choose the number of positions for the source, n_s , as given in table 3.

Table 3 — Required number of source locations

s_M dB	n_s
$\leq 2,5$	1
$2,5 < 4,0$	2 in the same room
$> 4,0$	2 in the same room, plus 2 in another test room

For values of s_M greater than 4,0 dB, acoustical measurements are required at two source locations in another test room with different dimensions and which is in accordance with the requirements given in 4.3.

7.7 Acoustical data to be obtained

If a specific noise test code for the source under test has been published, the requirements of that test code shall be followed. In the absence of such a test code, obtain the time-averaged sound pressure level in accordance with IEC 804 for each octave band within the frequency range of interest. A suitable integration time when making measurements in accordance with IEC 804 on a reference sound source (RSS) is 30 s. In the case of a moving microphone, the integration time should include at least one full traverse of the microphone path. When the sound output of the source under test is less stable than that of the reference sound source, a longer integration time is required.

The following acoustical data shall be obtained:

- a) $L'_{pi(ST)}$: time-averaged octave-band sound pressure levels at each microphone position ($i = 1, 2, \dots, n$) when the source under test is operating under prescribed conditions (see 6.5);
- b) $L'_{pi(RSS)}$: time-averaged octave-band sound pressure levels at each microphone position ($i = 1, 2, \dots, n$) when the RSS is operating;

- c) $L''_{pi(B)}$: time-averaged octave-band sound pressure levels at each microphone position ($i = 1, 2, \dots, n$) for the background noise, with neither the RSS nor the source under test in operation.

7.8 Corrections for background noise

If the levels of background noise $L''_{pi(B)}$ at each microphone position and in each frequency band are more than 6 dB below the measured sound pressure levels L'_{pi} , with either one of the sources operating, correct the values of L'_{pi} for the influence of background noise. The corrected value is given by the following equation:

$$L_{pi} = 10 \lg \left[10^{0.1L'_{pi}} - 10^{0.1L''_{pi(B)}} \right] \text{ dB} \quad \dots (5)$$

NOTE 20 When the background noise levels are more than 15 dB below the sound pressure levels with the sources operating, assume L'_{pi} is equal to L_{pi} .

If the 6 dB criterion is not satisfied for one or more octave bands, the accuracy of the measurements is reduced and corrections are not applicable for those levels. The results may, however, be reported and may be useful in determining an upper boundary to the sound power level of the source under test. If such data are reported, it shall be clearly stated in the text of the report, as well as in graphs and tables of results, that the background noise requirements of this part of ISO 3743 have not been fulfilled.

8 Calculation of sound power levels

Calculate the sound power level of the source under test, L_W , in each octave band within the frequency range of interest, using the following equation:

$$L_W = L_{W(RSS)} - \overline{L_{p(RSS)}} + \overline{L_{p(ST)}} \quad \dots (6)$$

where

$L_{W(RSS)}$ is the calibrated sound power level of the RSS;

$\overline{L_{p(RSS)}}$ is the sound pressure level of the reference source averaged (energy basis) over the microphone positions or the microphone path;

$\overline{L_{p(ST)}}$ is the sound pressure level of the source under test averaged (energy basis) over the microphone positions or the microphone path.

Then, calculate the A-weighted sound power level of the source under test from the following equation:

$$L_{WA} = 10 \lg \left[\sum_i 10^{0.1(L_{wi} + A_i)} \right] \text{ dB} \quad \dots (7)$$

where

L_{wi} is the octave-band level, in decibels, in band i ;

A_i is the A-weighting value at the midband frequency of band i , as given in table 4.

Table 4 — A-weighting values, A_i

Frequency Hz	A_i dB
125	-16,1
250	-8,6
500	+3,2
1 000	0
2 000	1,2
4 000	1,0
8 000	-1,1

9 Information to be recorded

The following information, whenever applicable, shall be compiled and recorded for all measurements made in accordance with the requirements of this part of ISO 3743.

9.1 Sound source under test

- a) Description of the sound source under test, including its
 - type,
 - technical data,
 - dimensions,
 - manufacturer,
 - serial number, and
 - year of manufacture.
- b) Operating conditions during test (in accordance with the specific test code for the source, if any, or the manufacturer's instructions).
- c) Mounting conditions.

9.2 Reference sound source

- a) Type, serial number and manufacturer of the reference sound source used for comparison with the source under test.
- b) Calibration values of the sound power level $L_{W(RSS)}$ of the reference sound source in octave bands.

- c) A statement stating whether or not the RSS complies with the requirements of ISO 6926.

9.3 Acoustical environment

- a) Description of the test room, including dimensions, treatment of walls, ceiling and floor.
- b) Sketch of the test room, showing the location of the source and room contents.
- c) Air temperature in degrees Celsius, relative humidity as a percentage, and barometric pressure in pascals.

9.4 Instrumentation

- a) Equipment used for the acoustical measurements, including the name, type, serial number and manufacturer.
- b) Date and place of calibration of the sound calibrator and the instrumentation system (see 5.2).

9.5 Acoustical data

- a) The positions and orientations of the microphones with respect to the source under test; a sketch may be included, if necessary.
- b) The time-averaged sound pressure levels, in octave bands, for the sound source under test, for the RSS, and with neither source in operation, at

all microphone positions, in decibels with reference to 20 μPa ($= 2 \times 10^{-5}$ Pa).

- c) The calculated sound power levels, in octave bands, for the source under test, in decibels with reference 1 pW ($= 10^{-12}$ W).
- d) The calculated A-weighted sound power level for the source under test, in decibels with reference to 1 pW ($= 10^{-12}$ W).

NOTE 21 ISO 9296 requires that the declared A-weighted sound power level, $L_{WA,d}$, of computers and business equipment be expressed in dB, using the identity 1 B = 10 dB.

- e) Remarks on the subjective impression of the noise produced by the source (audible discrete tones, impulsive character, spectral content, temporal characteristics, etc.).
- f) The place where and the date when the measurements were performed, and the person responsible for the test.

10 Information to be reported

Only those recorded data (see clause 9) are to be reported which are required for the purposes of the measurements. The report shall state whether or not the reported sound power levels have been obtained in full conformity with the requirements of this part of ISO 3743.

The A-weighted sound power level of the source under test shall be reported to the nearest 0,5 dB.

Annex A (informative)

Bibliography

- [1] ISO 1996-1:1982, *Acoustics — Description and measurement of environmental noise — Part 1: Basic quantities and procedures.*
- [2] 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.*
- [3] ISO 3741:1988, *Acoustics — Determination of sound power levels of noise sources — Precision methods for broad-band sources in reverberation rooms.*
- [4] ISO 3743-2:—¹⁾, *Acoustics — Determination of sound power levels of noise sources — Engineering methods for small, movable sources in reverberant fields — Part 2: Methods for special reverberation test rooms.*
- [5] ISO 4871:—²⁾, *Acoustics — Declaration and verification of noise emission values of machinery and equipment.*
- [6] 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.*
- [7] ISO 9296:1988, *Acoustics — Declared noise emission values of computer and business equipment.*

1) To be published.

2) To be published. (Revision of ISO 4871:1984)