INTERNATIONAL STANDARD

ISO 3740

Second edition
2000-11-01

Acoustics — Determination of sound power levels of noise sources — Guidelines for the use of basic standards

Acoustique — Détermination des niveaux de puissance acoustique émis par les sources de bruit — Guide pour l'utilisation des normes de base

Reference number
ISO 3740:2000(E)

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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 International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 3740 was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 1, *Noise*.

This second edition cancels and replaces the first edition (ISO 3740:1980), which has been technically revised.

Annex A forms a normative part of this International Standard. Annexes B to D are for information only.

Introduction

0.1 General

The series of International Standards, for which this International Standard serves as a guideline for use, comprises ISO 3741, ISO 3743-1, ISO 3743-2, ISO 3744, ISO 3745, ISO 3746, ISO 3747, ISO 9614-1 and ISO 9614-2. In principle, the methods of determining sound power levels described in ISO 3741 to ISO 3747 and ISO 9614-1 and ISO 9614-2 cover all types of machinery and equipment.

ISO 3741 to ISO 3747, ISO 9614-1 and ISO 9614-2 make up a set of basic International Standards which specify the acoustical conditions and instrumentation to be used, describe the procedures to be followed, and give general information on the mounting and operation of the machine under test in order to determine sound power levels.

The selection of standards for the determination of sound power levels can, for practical reasons, have consequences for the selection of standards for the determination of the emission sound pressure levels (see ISO 11200) and vice versa. It is beneficial to make the choice of standards concurrently with respect to the two noise emission quantities.

0.2 Relationships to other standards

This International Standard is one of a series which specifies various methods for determining the noise emission of a piece of machinery or equipment, or a sub-assembly of such equipment (referred to throughout this International Standard as the "machine under test"). Standards in this series are grouped in three categories.

a) Methods for the determination of sound power levels

This category includes the following standards (see Table 1):

— ISO 3741 to ISO 3747 give methods with precision grade, engineering grade or survey grade of accuracy for determining sound power levels of machinery and equipment using sound pressure level measurements in different types of environments;

— ISO 9614-1 and ISO 9614-2 describe methods for determining the sound power levels of machinery and equipment using sound intensity level measurements.

b) Methods for the determination of emission sound pressure levels at work stations and at other specified positions

This category includes the following standards:

— ISO 11200 gives guidelines for the choice of the method to be used;

— ISO 11201, ISO 11202 and ISO 11204 give methods for determining emission sound pressure levels of machinery and equipment from measured sound pressure levels;

— ISO 11203 gives methods for determining the emission sound pressure levels of machinery and equipment from the sound power levels.

c) Noise test codes

For a particular family of machinery or equipment, a noise test code specifies the following:

— the methods and instruments to be used for the determination of the sound power level;

— the method to be used for the determination of emission sound pressure levels at work stations and/or at other specified positions;

— the positions of the work stations;

— the mounting and operating conditions of the machine under test for the purpose of determining the noise emission quantities;

— the method to be used for verifying declared noise emission quantities.

ISO 12001 gives rules for the drafting and presentation of a noise test code.

Acoustics — Determination of sound power levels of noise sources — Guidelines for the use of basic standards

1 Scope

This International Standard gives guidance for the use of a series of nine International Standards describing various methods for determining the sound power levels from all types of machinery and equipment. It provides:

— brief summaries of these basic International Standards;

— guidance on the selection of one or more of these standards which are appropriate to any particular type (see clause 5 and annex D). The guidance given applies only to airborne sound. It is for use in the preparation of noise test codes (see ISO 12001) and also in noise testing where no specific noise test code exists.

This International Standard is not intended to replace any of the details of, or add any additional requirements to, the individual test methods in the other basic standards referred to.

These basic standards specify the acoustical requirements for measurements appropriate for different test environments and accuracies.

It is important that specific test codes for various types of machinery and equipment be established and used in accordance with the requirements of these basic International Standards. Such standardized noise test codes will recommend the basic International Standard(s) to be used and will give detailed requirements on mounting and operating conditions for a particular family to which the machine under test belongs.

If no specific noise test code exists for a particular type of machinery, this International Standard is of use for the choice of the most suitable of the basic standards. In all cases, the mounting and operating conditions of the machine under test should be in accordance with the general principles given in the basic standards.

NOTE Two quantities which complement each other can be used to describe the sound emission of machinery or equipment. One is the emission sound pressure level at a specified position and the other is the sound power level. The International Standards which describe the basic methods for determining emission sound pressure levels at the work station and at other specified positions are the series ISO 11200 to ISO 11204.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 3741:1999, *Acoustics — Determination of sound power levels of noise sources using sound pressure — Precision methods for reverberation rooms*.

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 1: Comparison method for hard-walled test rooms.*

ISO 3743-2:1994, *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.*

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:—[1)], *Acoustics — Determination of sound power levels of noise sources using sound pressure — Precision methods for anechoic and hemi-anechoic rooms*.

ISO 3746:1995, *Acoustics — Determination of sound power levels of noise sources using sound pressure — Survey method using an enveloping measurement surface over a reflecting plane*.

ISO 3747, *Acoustics — Determination of sound power levels of noise sources using sound pressure — Comparison method* in situ.

ISO 9614-1:1993, *Acoustics — Determination of sound power levels of noise sources using sound intensity — Part 1: Measurement at discrete points*.

ISO 9614-2:1996, *Acoustics — Determination of sound power levels of noise sources using sound intensity — Part 2: Measurement by scanning*.

ISO 12001, *Acoustics — Noise emitted by machinery and equipment — Rules for the drafting and presentation of a noise test code.*

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

3 Terms and definitions

For the purposes of this International Standard, the following terms and definitions apply. More detailed definitions may be found in the ISO 3740 series (which includes ISO 3741 through ISO 3747), in ISO 9614-1 and ISO 9614-2 and in noise test codes for specific types of machinery and equipment.

3.1
emission
airborne sound radiated by a well-defined noise source (e.g. the machine under test) under specified operating and mounting conditions

NOTE Emission values may be incorporated in a product label and/or product specification. The basic noise emission quantities are the sound power level of the source itself and the emission sound pressure levels at the work station and/or at other specified positions (if any) in the vicinity of the source.

[ISO 12001]

3.2
sound power
W
rate per unit time at which airborne sound energy is radiated by a source

NOTE It is expressed in watts.

[ISO 12001]

1) To be published. (Revision of ISO 3745:1977)

3.3
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 [W_0 = 1 pW (10^{-12} W)]

NOTE 1 It is expressed in decibels.

NOTE 2 The frequency weighting or the width of the frequency band used should be indicated; for example A-weighted sound power level (L_{WA}).

NOTE 3 Adapted from ISO 12001.

3.4
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 [p_0 = 20 μPa (2×10^{-5} Pa)]

NOTE 1 It is expressed in decibels.

NOTE 2 The frequency weighting or the width of the frequency band used, and the time weighting (S, F or I, see IEC 61672-1) should be indicated.

NOTE 3 Adapted from ISO 3744.

3.5
time-averaged sound pressure level
$L_{p\mathrm{eq}T}$
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:

$$L_{p\mathrm{eq}T} = 10 \lg \left[\frac{1}{T} \int_0^T \frac{p^2(t)}{p_0^2} \mathrm{d}t \right] \mathrm{dB} \quad (1)$$

NOTE 1 It is expressed in decibels.

NOTE 2 A-weighted time-averaged sound pressure levels are denoted by $L_{p\mathrm{A}\mathrm{eq}T}$, which is usually abbreviated to $L_{p\mathrm{A}}$. $L_{p\mathrm{A}\mathrm{eq}T}$ shall be measured with an instrument which complies with the requirements of IEC 61672-1.

NOTE 3 In general, the subscripts "eq" and "T" are omitted since time-averaged sound pressure levels are necessarily determined over a certain measurement time interval.

NOTE 4 Adapted from ISO 12001.

3.6
sound energy level
L_{J}
ten times the logarithm to the base 10 of the ratio of the sound energy E (in joules) of the single burst of sound or transient sound radiated by the sound source under test to the reference sound energy [E_0 = 1 pJ (10^{-12} J)]:

$$L_{\mathrm{J}} = 10 \lg (E/E_0) \mathrm{dB} \quad (2)$$

NOTE 1 It is expressed in decibels.

NOTE 2 The frequency weighting or the width of the frequency band used should be indicated.

3.7
single-event sound pressure level
$L_{p,1s}$
time-integrated sound pressure level of an isolated single sound event of specified duration T (or specified measurement time T) normalized to T_0 = 1 s:

$$L_{p,1s} = 10 \lg \left[\frac{1}{T_0} \int_0^T \frac{p^2(t)}{p_0^2} \mathrm{d}t \right] \text{ dB}$$

$$= L_{p\mathrm{eq}T} + 10 \lg \left[\frac{T}{T_0} \right] \text{dB} \quad (3)$$

NOTE 1 It is expressed in decibels.

NOTE 2 Adapted from ISO 3744.

3.8
sound intensity
$\vec{I}$
product of the sound pressure at a point and the associated particle velocity

NOTE It is a vectorial quantity.

3.9
background noise
noise from all sources other than the source under test

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

[ISO 3744]

3.10
background noise level
sound pressure level measured when the source under test is not operating

NOTE It is expressed in decibels.

3.11
background noise correction
K_1
correction term to account for the influence of background noise on the surface sound pressure level

NOTE 1 K_1 is frequency dependent and is expressed in decibels.

NOTE 2 The correction in the case of A-weighting is denoted K_{1A}.

[ISO 3744]

3.12
environmental correction
K_2
correction term to account for the influence of reflected or absorbed sound on the surface sound pressure level

NOTE 1 K_2 is frequency dependent and is expressed in decibels.

NOTE 2 The correction in the case of A-weighting is denoted K_{2A}.

[ISO 3744]

NOTE 3 K_2 is used in standards of the ISO 3740 series employing an enveloping measurement surface.

4 Determination of sound power levels

4.1 Reasons for the determination of sound power levels

The effective exchange of acoustical information among the several parties concerned is usually needed to control the noise from machinery and equipment. These include the manufacturer, installer, and user of the machinery or equipment. This acoustical information is obtained from measurements. These measurements are useful only if the conditions under which they are carried out are specified, if they yield defined acoustical quantities, and if they are made using standardized instruments.

Sound power levels may be used for different purposes:

— declaration of the noise emitted under defined conditions (see clause 5);

— verification of declared values;

— comparison of the noise emitted by machinery of various types and sizes;

— comparison with limits specified in a purchasing contract or a regulation;

— engineering work to reduce the noise emission of machinery;

— prediction of noise levels in work places;

— establishment of a list of requirements from the client to the supplier and/or elaboration of a contract with reference to a standardized method;

— characterization and description of the source.

The sound power level data determined according to one of the basic International Standards are essentially independent of the environment in which the data are obtained or in which the machinery or equipment is to be installed. This is one of the reasons for using sound power levels to characterize the noise emitted by various types of machinery and equipment.

4.2 Methodology

The two main principles for the determination of the sound power level of a machine or equipment applied in the ISO 3740 and ISO 9614 series are:

— evaluation of the spatial mean-squared sound pressure built up in a highly reflective environment (measurements in a reverberant field);

— evaluation of the flow of sound energy emitted by the source, with measurements using an enveloping surface (measurements in a free field or in a free field over a reflecting plane or in a more or less free field over a reflecting plane).

Two basic quantities can be measured to determine the sound power level of a machine or equipment, i.e. sound pressure levels or sound intensity levels. Seven International Standards in the ISO 3740 series describe procedures for determining sound power levels from measured sound pressure levels, in different test environments. ISO 9614-1 and ISO 9614-2 give procedures for determining sound power levels from measured values of the sound intensity components in the vicinity of the machine under test.

5 Noise declaration according to ISO 4871

The sound power level determined according to one of the methods described in this International Standard and the related uncertainty are two quantities that are used by manufacturers of machinery and equipment when preparing the noise declaration according to ISO 4871. Values of the uncertainty are normally given in the relevant noise test code. If no specific noise test code exists, values given in annex A of ISO 4871:1996 can be used.

6 Selection of the appropriate International Standard for determination of sound power levels

6.1 Quantities to be measured and determined

Methods are specified in ISO 3741 to ISO 3747 for determining sound power levels by measuring sound pressure levels. Methods are specified in ISO 9614-1 and ISO 9614-2 for determining sound power levels by measuring sound intensity levels.

The levels may be time-averaged, frequency-weighted, in frequency bands, or time-weighted. The preferred frequency weighting is A-weighting.

6.2 Considerations affecting choice of method

Factors to be considered when selecting a standard from this series of International Standards include the following:

a) the grade of accuracy required (see ISO 12001 for the definition);

b) the size and transportability of the machinery or equipment, affecting the practicability of setting it up in an acoustical test laboratory for the purpose of the noise measurements;

c) the test environment available for the measurements;

d) the background noise level;

e) the character of the noise produced by the source (e.g. broad-band, narrow-band, discrete-frequency; steady, non-steady, impulsive);

f) the acoustical instrumentation available;

g) the type of sound power level required (frequency-weighted or in frequency bands, frequency range of interest);

h) other acoustical information desired (e.g. directivity of source, temporal pattern).

NOTE 1 The preferred grade of accuracy for purposes of noise declaration is engineering (grade 2).

NOTE 2 All standards within a specific grade imply the same level of accuracy.

6.3 Synopses

Synopses of ISO 3741 to ISO 3747 and ISO 9614-1 and ISO 9614-2 are given in annex A. Table 1 gives an overview of these International Standards.

6.4 Test environments

Annex B describes the different test environments considered in ISO 3741 to ISO 3747, and ISO 9614-1 and ISO 9614-2.

6.5 Measurement uncertainty

The standard deviations given in Table 2 represent the worst cases of measurement uncertainty for the determination of sound power levels in accordance with these test methods. They reflect the cumulative effects of all causes of measurement uncertainty, excluding those variations in the sound power level from test to test, which may be caused, for example, by changes in the mounting or operating conditions of the machine under test. Furthermore, the standard deviations given in Table 2 cover a great variety of sound source parameters such as very different spectral contents and directional properties. For a well-defined specific machinery family, the range of variation of parameter values may be considerably smaller. Therefore, for measurements on a specific machinery family, standard deviations are smaller.

When preparing a noise test code, an interlaboratory test for the relevant family of machinery is recommended in order to determine the relevant standard deviations (see ISO 5725-2 for details).

6.6 Procedure for selection

Table 1 summarizes the applicability of each of the nine basic International Standards. Table 2 gives the uncertainties involved in the determination of the sound power levels according to these standards.

The purpose(s) for which the noise measurements are to be made determine(s) the grade of accuracy required.

The different factors influencing the selection of an appropriate test method are shown in Table 3. Additional information is given in annex C. Table 3 and annex D give guidance for the selection of the appropriate International Standard.

Table 1 — Overview of International Standards for determination of sound power levels of machines and equipment

Parameter	Using sound pressure							Using sound intensity	
	ISO 3741 Precision [a]	**ISO 3743-1 Engineering** [a]	**ISO 3743-2 Engineering** [a]	**ISO 3744 Engineering** [a]	**ISO 3745 Precision** [a]	**ISO 3746 Survey** [a]	**ISO 3747 Engineering or survey** [a]	**ISO 9614-1 Precision, engineering or survey** [a]	**ISO 9614-2 Engineering or survey** [a]
Test environment	Reverberation room	Hard-walled room	Special reverberation room	Essentially free-field over a reflecting plane	Anechoic or hemi-anechoic room	No special test environment	Essentially reverberant field *in situ*, subject to stated qualification requirements	Any	Any
Criterion for suitability of test environment	Room volume and reverberation time to be qualified	Volume $\geqslant$ 40 m^3 Absorption coef. $\leqslant$ 0,20	70 $m^3 \leqslant$ volume $\leqslant$ 300 m^3 0,5 s $\leqslant T_{nom} \leqslant$ 1 s	$K_2 \leqslant$ 2 dB [b]	Specified requirements	$K_2 \leqslant$ 7 dB [b]	Specified requirements	Specified requirements for: — extraneous intensity — wind, gas flow, vibration, temperature — configuration of surrounding	Specified requirements for: — extraneous intensity — wind, gas flow, vibration, temperature — configuration of surrounding
Volume of sound source	Preferably less than 2 % of test room volume	Preferably less than 1 % of test room volume	Preferably less than 1 % of test room volume	No restrictions; limited only by available test environment	Characteristic dimension less than half measurement radius	No restrictions; limited only by available test environment	No restrictions; limited only by available test environment	No restrictions	No restrictions
Character of noise from the source	Steady, broad-band, narrow-band or discrete frequency	Any, but no isolated bursts	Any, but no isolated bursts	Any	Any	Any	Steady, broad-band, narrow-band or discrete frequency	Broadband, narrow-band or discrete frequency, if stationary in time	Broadband, narrow-band or discrete frequency, if stationary in time
Limitation for background noise	$\Delta L \geqslant$ 10 dB $K_1 \leqslant$ 0,5 dB [c]	$\Delta L \geqslant$ 6 dB $K_1 \leqslant$ 1,3 dB [c]	$\Delta L \geqslant$ 4 dB $K_1 \leqslant$ 2 dB [c]	$\Delta L \geqslant$ 6 dB $K_1 \leqslant$ 1,3 dB [c]	$\Delta L \geqslant$ 10 dB $K_1 \leqslant$ 0,5 dB [c]	$\Delta L \geqslant$ 3 dB $K_1 \leqslant$ 3 dB [c]	$\Delta L \geqslant$ 6 dB $K_1 \leqslant$ 1,3 dB [c]	Level: given by dynamic capability of the instrumentation (typically: $\Delta L \geqslant -10$ dB Variability: specified requirement for field indicator F1	Level: given by dynamic capability of the instrumentation (typically: $\Delta L \geqslant -10$ dB Variability: specified requirement for repeatability check
Instrumentation: [d] a) sound level meter b) integrating sound level meter c) frequency band filter d) calibrator e) sound intensity instrument	a) class 1 b) class 1 c) class 1 d) class 1	a) class 1 b) class 1 c) class 1 d) class 1	a) class 1 b) class 1 c) class 1 d) class 1	a) class 1 b) class 1 c) class 1 d) class 1	a) class 1 b) class 1 c) class 1 d) class 1	a) class 1 b) class 1 c) class 1 d) class 1	a) class 1 b) class 1 c) class 1 d) class 1	e) class 1 or 2 [e]	e) class 1 or 2 [e]
Sound power levels obtainable	A-weighted and in one-third-octave or octave bands	A-weighted and in octave bands	A-weighted and in octave bands	A-weighted and in one-third-octave or octave bands	A-weighted and in one-third-octave or octave bands	A-weighted	A-weighted from octave bands	Band limited (one-third-octave 50 Hz-6 300 Hz) A-weighted and in one-third-octave or octave bands. Grade of accuracy is determined from field indicators	Band limited (one-third-octave 50 Hz-6 300 Hz) A-weighted and in one-third-octave or octave bands. Grade of accuracy is determined from field indicators
Optional information available	Other frequency-weighted sound power levels	Other frequency-weighted sound power levels	Other frequency-weighted sound power levels	Directivity information and sound pressure levels as a function of time; single-event sound pressure levels; other frequency-weighted sound power levels —	Sound energy levels	Sound pressure levels as function of time	Sound pressure levels as a function of time	Positive and/or negative partial sound power concentration	

[a] Grade of accuracy: precision = grade 1; engineering = grade 2; survey = grade 3.

[b] K_2 is the environmental correction (see 3.12)

[c] K_1 is the correction for background noise (see 3.11)

[d] At least complying with class " " of:

a) IEC 61672-1, b) IEC 61672-1, c) IEC 61260, d) IEC 60942, e) IEC 61043.

[e] According to the grade of accuracy of the method (class 1 for precision and engineering and class 2 for survey).

Table 2 — Uncertainty in determining sound power levels, expressed as the largest value of the standard deviation of reproducibility

Values in decibels

Frequency	ISO 3741	ISO 3743-1	ISO 3743-2	ISO 3744	ISO 3745 Anechoic room	ISO 3745 Hemi-anechoic room	ISO 3746	ISO 3747 Engineering	ISO 3747 Survey	ISO 9614-1 Precision	ISO 9614-1 Engineering	ISO 9614-1 Survey	ISO 9614-2 Engineering	ISO 9614-2 Survey
A-weighting	0,5	1,5	2	1,5 [a]	—	—	3 [a] (if $K_2 \leqslant 5$ dB) 4 [a] (if $5 < K_2 \leqslant 7$ dB) 4 [c] (if $K_2 \leqslant 5$ dB) 5 [c] (if $5 < K_2 \leqslant 7$ dB)	1,5	4	—	—	4 [b]	1,5 [b]	4 [b]
Octave bands (Hz)														
63	—	—	—	5 [d]	—	—	—	—		2	3	—	3	—
125	2,5	3	5	3	—	—	—	—		2	3	—	3	—
250	1,5	2	3	2	—	—	—	—		1,5	2	—	2	—
500	1,0	1,5	2	1,5	—	—	—	—		1,5	2	—	1,5	—
1 000 to 4 000	1,0	1,5	2	1,5	—	—	—	—		1	1,5	—	1,5	—
8 000	2	2,5	3	2,5	—	—	—	—		—	—	—	—	—
One-third-octave bands (Hz)														
50 to 80	—	—	—	5[d]	2	2	—	—		2	3	—	3	—
100 to 160	3,0	—	—	3	1	1,5	—	—		2	3	—	3	—
200 to 315	2,0	—	—	2	1	1,5	—	—		1,5	2	—	2	—
400 to 630	1,5	—	—	1,5	1	1,5	—	—		1,5	2	—	1,5	—
800 to 5 000	1,5	—	—	1,5	0,5	1	—	—		1	1,5	—	1,5	—
6 300 to 10 000	3	—	—	2,5	1	1,5	—	—		2 [e]	2,5 [e]	—	2,5 [e]	—

a For a source which emits noise with a relatively "flat" spectrum over the frequency range of interest.
b A-weighted (from octave bands, 63 Hz to 4 000 Hz, or from one-third-octave bands, 50 Hz to 6 300 Hz).
c For a source which emits noise that contains predominant discrete tones.
d Normally for outdoor measurements; many rooms are not qualified for this frequency band.
e One-third-octave band 6 300 Hz only.
— Not stated in the standard.

Table 3 — Factors influencing the choice of the method

		ISO 3741	ISO 3743-1	ISO 3743-2	ISO 3744	ISO 3745	ISO 3746	ISO 3747	ISO 9614-1	ISO 9614-2
Grade of accuracy	Precision (grade 1)	x				x			x	
	Engineering (grade 2)		x	x	x			x	x	x
	Survey (grade 3)						x	x	x	x
Environment specifically designed for the determination of sound power	Reverberation room	x								
	Special reverberation test room			x						
	Anechoic room					x				
	Hemi-anechoic room				x [a]	x				
	Hard-walled test room		x							
***In-situ* environment**	Indoors in a sufficiently reverberant field							x	x	x
	Indoors in an approximate free field over a reflecting plane						x [b]		x	x
	Outdoors and indoors in an essentially free field over a reflecting plane				x				x	x
Background noise level	$\Delta L \geqslant 10$ dB	x	x	x	x	x	x	x	x	x
	$\Delta L \geqslant 6$ dB		x	x	x		x	x	x	x
	$\Delta L \geqslant 3$ dB						x		x	x
	$\Delta L < 3$ dB								x [c]	x [c]
Character of noise	All types as defined in ISO 12001				x	x	x			
	All types, except isolated bursts	x	x	x				x		
	Stationary in time								x	x
Instrumentation (see Table 1)	Sound level meter:									
	class 1	x	x	x	x	x		x		
	class 2						x			
	Integrating sound level meter:									
	class 1	x	x	x	x	x		x		
	class 2						x			
	Frequency band filter class 1	x	x	x	x	x		x		
	Sound intensity instrument								x	x
Sound power levels obtainable	One-third-octave band levels	x			x	x			x	x
	Octave-band levels	x	x	x	x	x		x	x	x
	A-weighted levels	x	x	x	x	x	x	x	x [d]	x [d]
Optional information available	Other frequency weightings	x	x	x	x	x	x	x		
	Directivity information				x	x				
	Temporal pattern				x	x	x			

a Environmental correction $K_2 \leqslant 2$ dB
b Environmental correction $K_2 \leqslant 7$ dB
x Applicable
c Lower limit is approximately –10 dB, but it depends on measurement conditions.
d A-weighted (from octave bands, 63 Hz to 4 000 Hz, or from one-third-octave bands, 50 Hz to 6 300 Hz).

Annex A
(normative)

Synopses of basic International Standards on sound power level determinations

A.1 ISO 3741 — Precision method for reverberation rooms

A.1.1 Applicability

The test environment shall be a reverberation room with a specified shape and a volume less than 300 m^3 and greater than or equal to:

— 70 m^3 for a lowest octave band of interest of 250 Hz (or 200 Hz one-third-octave band);

— 100 m^3 for a lowest one-third-octave band of interest of 160 Hz;

— 150 m^3 for a lowest one-third-octave band of interest of 125 Hz;

— 200 m^3 for a lowest octave band of interest of 125 Hz (or 100 Hz one-third octave band).

For rooms that do not meet the volume requirements, annex E provides a procedure for qualifying the room for the measurement of broad-band sound.

Guidelines for the design of reverberation rooms are given in annexes B and C of ISO 3741:1999.

The type of noise source includes machines, devices, components and sub-assemblies.

The noise source shall have a volume preferably less than 2 % of the volume of the test room.

The character of the noise radiated by the source includes all types of noise as defined in ISO 12001, except impulsive noise. More microphone and source positions may be necessary when noise emission contains discrete-frequency components. Annex A of ISO 3741:1999 provides a procedure for qualifying the room for the measurement of discrete-frequency components.

A.1.2 Measurement uncertainty

The standard deviation of reproducibility is equal to or less than 0,5 dB for A-weighted sound power levels (for sources which emit noise with a relatively "flat" spectrum). In one-third-octave bands, it is equal to or less than 3 dB from 100 Hz to 160 Hz, 2 dB from 200 Hz to 315 Hz, 1,5 dB from 400 Hz to 5 000 Hz and 3 dB from 6 300 Hz to 10 000 Hz. In octave bands, it is equal to or less than 2,5 dB for 125 Hz, 1,5 dB for 250 Hz, 1 dB from 500 Hz to 4 000 Hz and 2 dB for 8 000 Hz.

A.1.3 Quantities to be measured

These are sound pressure levels in one-third-octave-frequency bands at specified fixed microphone positions or along specified paths. Measurements can be made using either the direct method or the comparison method using a reference sound source.

A.1.4 Quantities to be determined

These include:

— sound power levels in frequency bands;

— A-weighted sound power levels calculated from the frequency band sound power levels;

— optionally, sound power levels with other frequency weightings.

A.1.5 Quantities which cannot be determined

These include:

— directivity characteristics of the source;

— time history of noise radiated by sources emitting non-steady noise.

A.2 ISO 3743 — Engineering methods for small, movable sources in reverberant fields

A.2.1 ISO 3743-1 — Comparison method for hard-walled test rooms

A.2.1.1 Applicability

The test environment shall be a test room with a volume greater than 40 m^3 and greater than 40 times the volume of the reference box and with surfaces that are hard and sound-reflective. It shall be ensured that, at all frequencies, the sound absorption coefficient of any boundary surface does not exceed 0,20.

The type of noise source includes small machines, devices, components and sub-assemblies. ISO 3743-1 is particularly suitable for small items of portable equipment and is not intended for larger pieces of stationary equipment.

The size of the noise source shall be such that its largest dimension is not greater than 1,0 m in a test room with a volume less than 100 m^3 and not greater than 2,0 m in larger test rooms.

The character of the noise radiated by the source includes all types of noise as defined in ISO 12001, except isolated bursts of noise.

A.2.1.2 Measurement uncertainty

The standard deviation of reproducibility is equal to or less than 1,5 dB (with few exceptions) for A-weighted sound power levels. In octave frequency bands, it is equal to or less than 3 dB for 125 Hz, 2 dB for 250 Hz, 1,5 dB from 500 Hz to 4 000 Hz, and 2,5 dB for 8 000 Hz.

A.2.1.3 Quantities to be measured

These are sound pressure levels in octave bands at specified fixed microphone positions or along specified paths.

A.2.1.4 Quantities to be determined

These include:

— sound power levels in octave bands;

— A-weighted sound power levels calculated from the octave-band sound power levels.

A.2.1.5 Quantities which cannot be determined

These include:

— directivity characteristics of the source;

— time history of noise radiated by sources emitting non-steady noise.

A.2.2 ISO 3743-2 — Methods for special reverberation test rooms

A.2.2.1 Applicability

The test environment shall be a special reverberation room with specified characteristics. The volume shall be between 70 m^3 and 300 m^3. The reverberation time of the room at low and middle frequencies shall be reduced to the recommended values by installing sound-absorptive materials on the walls and ceiling. Guidelines for the design of special reverberation test rooms are given in annex A of ISO 3743-2:1994.

The type of noise source includes small machines, devices, components and sub-assemblies. ISO 3743-2 is particularly suitable for small items of portable equipment and is not intended for larger pieces of stationary equipment.

The size of the noise source shall preferably be such that its volume is not greater than 1 % of the volume of the test room.

The character of the noise radiated by the source includes all types of noise as defined in ISO 12001, except isolated bursts of noise.

A.2.2.2 Measurement uncertainty

The standard deviation of reproducibility is equal to or less than 2 dB (with few exceptions) for A-weighted sound power levels. In octave frequency bands, it is equal to or less than 5 dB for 125 Hz, 3 dB for 250 Hz, 2 dB from 500 Hz to 4 000 Hz, and 3 dB for 8 000 Hz.

A.2.2.3 Quantities to be measured

These include:

— A-weighted sound pressure levels for the direct method, at specified fixed microphone positions or along specified paths;

— sound pressure levels in octave bands for the comparison method, at specified fixed microphone positions or along specified paths.

A.2.2.4 Quantities to be determined

These include:

— for the direct method, A-weighted sound power levels;

— for the comparison method, sound power levels in octave bands and A-weighted sound power levels calculated from the octave-band sound power levels.

A.2.2.5 Quantities which cannot be determined

These include:

— directivity characteristics of the source;

— time history of noise radiated by sources emitting non-steady noise.

A.3 ISO 3744 — Engineering method employing an enveloping measurement surface in an essentially free field over a reflecting plane

A.3.1 Applicability

The test environment shall be an essentially free field near one or more reflecting planes (indoors or outdoors). The test environment may be a hemi-anechoic room, or a large ordinary test room, if qualified as follows. The adequacy of the test environment shall be checked according to one of the test procedures given in annex A of ISO 3744:1994. The reflecting plane(s) on which the source is located shall extend at least to the measurement surface. The sound absorption coefficient of the reflecting plane(s) should preferably be less than 0,06. The environmental correction K_2 shall not exceed 2 dB (corresponding to a ratio $A/S \geqslant 6$ for rooms where A is the equivalent sound absorption area of the test room and S is the area of the measurement surface).

The type of noise source include any stationary or moving source for indoor or outdoor use.

The size of the noise source is limited only by the available test environment.

The character of the noise radiated by the source includes all types of noise as defined in ISO 12001.

A.3.2 Measurement uncertainty

The standard deviation of reproducibility is equal to or less than 1,5 dB for A-weighted sound power levels (for sources which emit noise with a relatively flat spectrum). In one-third octave bands it is equal to or less than 5 dB from 50 Hz to 80 Hz, 3 dB from 100 Hz to 160 Hz, 2 dB from 200 Hz to 315 Hz, 1,5 dB from 400 Hz to 5 000 Hz and 2,5 dB from 6 300 Hz to 10 000 Hz. In octave bands it is equal to or less than 5 dB for 63 Hz, 3 dB for 125 Hz, 2 dB for 250 Hz, 1,5 dB from 500 Hz to 4 000 Hz and 2,5 dB for 8 000 Hz.

A.3.3 Quantities to be measured

These are sound pressure levels, A-weighted and/or in frequency bands, at specified fixed microphone positions or along specified paths.

A.3.4 Quantities to be determined

These are sound power levels, A-weighted and/or in frequency bands. Other quantities which are optional are sound power levels with other frequency weightings calculated from the results of measurements in frequency bands; surface sound pressure levels; sound pressure levels at single positions; single-event sound pressure levels; a measure of impulsiveness; directivity characteristics and time histories of the sound pressure level and sound power level.

A.4 ISO 3745 — Precision method for anechoic and hemi-anechoic rooms

A.4.1 Applicability

The test environment shall be a free field (anechoic room) or free field over a reflecting plane (hemi-anechoic room). The adequacy of the test environment shall be checked according to procedures given in annexes A or B of

ISO 3745:—. The reflecting plane, on which the source is located, shall extend at least half a wavelength beyond the projection of the measurement surface for the lowest frequency of the frequency range of interest. The sound absorption coefficient of the reflecting plane shall be less than 0,06.

The type of noise source includes primarily small stationary or moving sources for indoor or outdoor use.

The noise source shall have a largest dimension not greater than half the measurement radius.

The character of the noise radiated by the source includes all types of noise as defined in ISO 12001.

A.4.2 Measurement uncertainty

The standard deviation of reproductibility, in one-third-octave frequency bands, is equal to or less than

— 2 dB from 50 Hz to 80 Hz, 1 dB from 100 Hz to 630 Hz, 0,5 dB from 800 Hz to 5 000 Hz, 1 dB from 6 300 Hz to 10 000 Hz for anechoic rooms,

— 2 dB from 50 Hz to 80 Hz, 1,5 dB from 100 Hz to 630 Hz, 1 dB from 800 Hz to 5 000 Hz, 1,5 dB from 6 300 Hz to 10 000 Hz for hemi-anechoic rooms.

A.4.3 Quantities to be measured

These are sound pressure levels in one-third-octave frequency bands, at specified fixed microphone positions or along specified paths.

A.4.4 Quantities to be determined

These are sound power levels, A-weighted and/or in frequency bands, or sound energy levels and single-event sound pressure levels for sources of impulsive noise. Other quantities which are optional are sound power levels with other frequency weightings calculated from the results of measurements in frequency bands; surface sound pressure levels; sound pressure levels at single positions; a measure of impulsiveness; directivity characteristics and time histories of the sound pressure level and sound power level.

A.5 ISO 3746 — Survey method using an enveloping measurement surface over a reflecting plane

A.5.1 Applicability

The test environment shall be an installation (indoors or outdoors) with one or more reflecting planes, meeting specified requirements. The adequacy of the test environment shall be checked according to one of the test procedures given in annex A of ISO 3746:1995.

The type of noise source includes any stationary or moving source for indoor or outdoor use.

The size of the noise source is limited only by the available test environment.

The character of the noise radiated by the source includes all types of noise as defined in ISO 12001.

A.5.2 Measurement uncertainty

For sources which emit steady broad-band noise, the standard deviation of reproducibility is equal to or less than 3 dB or 4 dB, depending on the value of the environmental correction K_2. For sources which emit noise that contains predominant discrete tones, it is equal to or less than 4 dB or 5 dB depending on the value of K_2 (see Table 2).

A.5.3 Quantities to be measured

These are A-weighted sound pressure levels, at specified fixed microphone positions or along specified paths.

A.5.4 Quantities to be determined

These are A-weighted sound power levels. Other quantities which are optional are surface sound pressure levels; sound pressure levels at single positions; a measure of impulsiveness; directivity characteristics and time histories of the sound pressure level and sound power level.

A.6 ISO 3747 — Engineering or survey comparison method for use in an essentially reverberant field *in situ*

A.6.1 Applicability

The test environment may be any kind of indoor environment which is to be found outside of the laboratory environment, provided that the background noise is sufficiently low and the sound field is sufficiently reverberant. The test environment and the actual source are qualified for grade 2 accuracy if specified criteria are fulfilled. The qualification is based on measurements on the reference sound source and the source under test.

The type of noise source includes non-movable sound sources *in situ*.

There is no restriction on the size of the sound source.

The character of the noise radiated by the source includes primarily broad-band noise but also narrow-band noise or discrete tones.

A.6.2 Measurement uncertainty

In a qualified test environment, the standard deviation of reproducibility is equal to or less than 1,5 dB for A-weighted sound power levels which results in grade 2 accuracy. In a non-qualified test environment, the standard deviation of reproducibility is lower than or equal to 4 dB for A-weighted sound power levels, which results in the survey grade of accuracy.

A.6.3 Quantities to be measured

These are sound pressure levels in octave bands at specified microphone positions.

A.6.4 Quantities to be determined

These include:

— sound power levels in octave bands;

— A-weighted sound power levels calculated from the octave-band sound power levels.

A.7 ISO 9614 — Precision, engineering or survey methods using sound intensity

A.7.1 ISO 9614-1: Measurements at discrete points

A.7.1.1 Applicability

The test environment shall be an installation meeting specified requirements (see clause 4 of ISO 9614-1:1993).

The type of noise source includes any stationary or moving source for indoor or outdoor use.

There is no restriction on the size of the sound source.

The character of the noise radiated by the source and of extraneous noise includes noise that is stationary in time during the period of measurement.

The frequency range of interest for the determination of A-weighted levels is limited to

— 63 Hz to 4 000 Hz for octave bands, and

— 50 Hz to 6 300 Hz for one-third-octave bands.

A.7.1.2 Measurement uncertainty

Standard deviations of reproducibility depend on the grade of accuracy of the method, which can be of the precision, engineering or survey grade.

For the precision grade, in octave bands, the standard deviation of reproducibility is equal to or less than 2 dB for 63 Hz and 125 Hz, 1,5 dB for 250 Hz and 500 Hz, 1 dB from 1 000 Hz to 4 000 Hz; for one-third-octave bands, 2 dB from 50 Hz to 160 Hz, 1,5 dB from 200 Hz to 630 Hz, 1 dB from 800 Hz to 5 000 Hz and 2 dB for 6 300 Hz.

For the engineering grade, in octave bands, it is equal to or less than 3 dB for 63 Hz and 125 Hz, 2 dB for 250 Hz and 500 Hz, 1,5 dB from 1 000 Hz to 4 000 Hz; for one-third-octave bands, 3 dB from 50 Hz to 160 Hz, 2 dB from 200 Hz to 630 Hz, 1,5 dB from 800 Hz to 5 000 Hz, and 2,5 dB for 6 300 Hz.

For the survey grade, it is equal to or less than 4 dB for A-weighted sound power levels.

A.7.1.3 Quantities to be measured

These are sound intensity levels and sound pressure levels on a measurement surface enclosing the source.

A.7.1.4 Quantities to be determined

These include:

— sound power levels and field indicators in octave or one-third-octave frequency bands;

— band-limited or frequency-weighted sound power levels.

A.7.2 ISO 9614-2: Measurement by scanning

A.7.2.1 Applicability

The test environment shall be an installation meeting specified requirements (see clause 5 of ISO 9614-2:1996).

The type of noise source includes any stationary or moving source for indoor or outdoor use.

There is no restriction on the size of the sound source.

The character of the noise radiated by the source and of extraneous noise includes noise that is stationary in time during the period of measurement.

The frequency range of interest for the determination of A-weighted levels is limited to

— 63 Hz to 4 000 Hz for octave bands, and

— 50 Hz to 6 300 Hz for one-third-octave bands.

A.7.2.2 Measurement uncertainty

Standard deviations of reproducibility depend of the grade of accuracy of the method, which can be the engineering or survey grade. For the engineering grade, it is equal to or less than:

— 1,5 dB for A-weighted sound power levels;

— in octave bands, 3 dB for 63 Hz and 125 Hz, 2 dB for 250 Hz, 1,5 dB from 500 Hz to 4 000 Hz; for one-third-octave bands, 3 dB from 50 Hz to 160 Hz, 2 dB from 200 Hz to 315 Hz, 1,5 dB from 400 Hz to 5 000 Hz and 2,5 dB for 6 300 Hz.

For the survey grade, it is equal to or less than 4 dB for A-weighted sound power levels.

A.7.2.3 Quantities to be measured

These are sound intensity levels and sound pressure levels on a measurement surface enclosing the source.

A.7.2.4 Quantities to be determined

These include:

— sound power levels in one or one-third-octave-frequency bands;

— band-limited or weighted sound power levels.

Annex B
(informative)

Acoustical test environments

B.1 Environments provided by acoustics laboratories

B.1.1 General

Use of a laboratory room with defined acoustical properties yields the highest accuracy. However, laboratory facilities are costly and only machines which are small compared with the dimensions of the room can be tested. Moreover, the type of room to be used depends on the character of the noise radiated by the machine under test.

B.1.2 Reverberation rooms

Reverberation rooms as described in ISO 3741 are particularly suitable when it is necessary to conduct a large number of tests on comparatively small machines (with volumes less than 2 % of the room volume) and when the sound emitted is predominantly steady in character.

Reverberation rooms do not provide directivity information and are not suitable for measurements on impulsive noise sources. These rooms should be used with caution if the sound emitted by the source contains significant discrete-frequency and/or low-frequency components.

B.1.3 Special reverberation rooms

Special reverberation rooms which are constructed to meet the requirements of ISO 3743-2 are less expensive than the laboratory reverberation rooms described in ISO 3741. The methods described in ISO 3743-2 provide measurements of engineering grade. These special reverberation test rooms are particularly suited for direct measurement of A-weighted sound levels; they are also useful for series measurements on small noise sources (volume less than 1 % of room volume). No information is provided on the directivity characteristics of the sound sources under test.

B.1.4 Anechoic and hemi-anechoic rooms

Anechoic and hemi-anechoic rooms as described in ISO 3745 are useful for measurements on small noise sources (volume less than 0,5 % of room volume) which emit different types of noise. Such rooms are particularly appropriate for measurements on sources which radiate impulsive noise or noise which contains discrete tones (e.g. transformer noise). The directivity characteristics of a source are preferably measured in such rooms.

Measurements which are carried out according to the requirements of ISO 3745 are of precision grade; hemi-anechoic rooms can also be used for measurements of engineering grade, according to the requirements of ISO 3744. In this case, measurements are also possible with considerably larger noise sources.

B.2 Environments *in situ*

B.2.1 Precision method

The method described in ISO 9614-1 can provide, according to the results of specified ancillary tests and calculations performed in association with the measurements, results of precision grade of accuracy in ordinary rooms. This method is particularly suitable in the presence of high background noise generated by sources other than that under test and sound reflections by the environment.

B.2.2 Engineering methods

Essentially free-field conditions over a reflecting plane are to be found when the source is located outdoors or in a large room. The engineering method of measurement is described in ISO 3744. This method is also applicable for many types of machines in their normal environments when operating indoors. The acoustical environment is qualified by following the procedures described in ISO 3744.

Hard-walled test rooms are described in ISO 3743-1. Most ordinary, unfurnished rooms without special acoustical treatment will comply with the requirements of this standard. This method is particularly suitable for small, movable sources.

An essentially reverberant field can be found *in situ*. An engineering comparison method is described in ISO 3747. This method applies to non-movable sound sources *in situ*, preferentially those which radiate broad-band noise.

Methods described in ISO 9614-1 and ISO 9614-2 can provide, according to the results of specified ancillary tests and calculations performed in association with the measurements, results of engineering grade of accuracy in ordinary rooms. These methods are particularly suitable in the presence of high background noise and sound reflections by the environment.

B.2.3 Survey methods

Conditions approximating a free-field over a reflecting plane, i.e. a measuring region with one or more reflecting planes present, are to be found when the source is located outdoors or in a large room. A survey method of measurement is described in ISO 3746, where procedures are indicated to qualify the particular environment.

When specified criteria for grade 2 accuracy are not fulfilled, ISO 3747 yields results of grade 3 accuracy.

These methods place no restriction on the type or size of machine that is operated outdoors and they are many types of machines in their normal environments when operating indoors.

Methods described in ISO 9614-1 and ISO 9614-2 can provide, according to the results of specified ancillary tests and calculations performed in association with the test measurements, results of survey grade of accuracy in ordinary rooms. These methods are particularly suitable in the presence of high background noise.

Annex C
(informative)

Factors affecting the choice of measurement method

C.1 Size of the noise source compared to the size of the test room

Several measurement methods place an upper limit on the volume of the source. The volume of the source should preferably be less than

— 2 % of the test room volume for ISO 3741 (reverberation room),

— 1 % of the test room volume for ISO 3743-1 and ISO 3743-2 (reverberant-field methods).

In ISO 3744, ISO 3746, ISO 3747, ISO 9614-1 and ISO 9614-2, no restriction is placed on the size of the source.

C.2 Test environment available for the measurements

If the source is movable (and small), it can be installed in any available test environment (e.g. semi-anechoic room, outdoors, reverberation room, special reverberation room, hard-walled room, machine test room with good acoustical properties).

If the source is not movable, the noise is measured under *in-situ* conditions. In this case, the measurement methods described in ISO 3744, ISO 3746, ISO 3747 or ISO 9614-1 and ISO 9614-2 may be applicable. Regarding ISO 3744 and ISO 3746, qualification procedures and environmental requirements are given in annex A of these standards; these procedures determine whether ISO 3744 (engineering method) and/or ISO 3746 (survey method) may be used. If the noise is stationary in time, in the case of adverse environmental conditions (high level of background noise), ISO 9614-1 and ISO 9614-2 are recommended.

For machines installed outdoors and for large machines (i.e. with a volume significantly greater than 2 m^3), the methods of ISO 3741, ISO 3743-1 and ISO 3743-2 are not applicable.

Any of the basic International Standards may be used for measurements on small machines (volume preferably less than 1 m^3) which are movable and emit predominantly steady, broad-band noise. For small machines, the available test environment and the desired accuracy determine the method to be selected.

C.3 Character of the noise

All methods apply to sources producing steady, broad-band noise.

If discrete-frequency components or narrow-band noise are present in the spectrum, any method may be used. Impulsive noise consisting of isolated bursts of sound energy cannot be measured according to ISO 3741, ISO 3743-1, ISO 3743-2 or ISO 3747. Sources emitting such noises are measured according to the requirements of ISO 3744, ISO 3745 or ISO 3746. The noise must be stationary in time to be measured according to ISO 9614-1 or ISO 9614-2.

If the frequency range of interest extends below 100 Hz or above 10 000 Hz, larger/smaller room volumes are required (more/less than 200 m^3). Larger measurement distances are required for the lower frequencies under free-field conditions (ISO 3744 and ISO 3746). ISO 9614-1 and ISO 9614-2 cannot be used for sources which emit predominantly in the bands 31,5 Hz to 40 Hz, and/or 8 000 Hz to 10 000 Hz.

C.4 Grade of accuracy required

The basic International Standards offer three grades of accuracy in determining the sound power levels of noise sources, as follows.

a) Precision (laboratory) methods (highest accuracy) are described in ISO 3741 (reverberation room methods), ISO 3745 (free-field method) and ISO 9614-1 (intensity method).

b) Engineering methods (medium accuracy) are described in ISO 3743-1, ISO 3743-2 (reverberant field methods), ISO 3744 (free-field over a reflecting plane method), ISO 3747 (comparison method in an essentially reverberant field *in situ*), and ISO 9614-1 and ISO 9614-2 (intensity methods).

c) Survey methods (lowest accuracy) are described in ISO 3746, ISO 3747, ISO 9614-1 and ISO 9614-2.

In general, the higher the accuracy, the greater the measurement effort required.

C.5 Acoustical data required

C.5.1 General

The data to be obtained depend on the purposes of the noise measurements. The principal areas of application of acoustical data are given in C.5.2 and C.5.3.

C.5.2 Noise control work

In the development of quieter machinery and equipment, quantitative information on the sound power level spectrum (in octave bands or one-third-octave bands) is usually required. Additional measurements on discrete-frequency components, directivity and vibratory characteristics may also be necessary.

The measurement methods should preferably be capable of providing accuracy of the precision grade, but methods giving an engineering grade of accuracy are frequently satisfactory.

C.5.3 Noise testing and noise comparison of machines

For noise testing of machinery and equipment (e.g. in order to declare the noise emission or to determine whether or not there is compliance with an upper limit specified for the total sound emitted by a machine) or for a comparison of machinery of the same type, a simple overall determination of the frequency-weighted sound power level (generally A-weighted) is usually sufficient.

These data become more useful if more detailed information on the characteristics of the noise is obtained (e.g. the sound power level distribution in octave or one-third-octave bands). Information on the sound power level spectrum of the noise radiated by the machines is useful if the comparison is to be made between machines which are different in type or size.

The measurement methods should preferably be capable of providing accuracy of the engineering grade.

Annex D
(informative)

Guidance on the choice of appropriate International Standard for determining the sound power level of a sound source

The flowchart of Figure D.1 gives broad guidance on the choice of appropriate standard(s) in the ISO 3740 and ISO 9614 series. The final choice of the standard to be used in a particular situation always requires careful and detailed consideration of

— the possibility of using an engineering method (a survey method should only be used if it is the only one that is practical),

— the International Standard envisaged in order to make sure that all requirements of this standard can be fulfilled, and

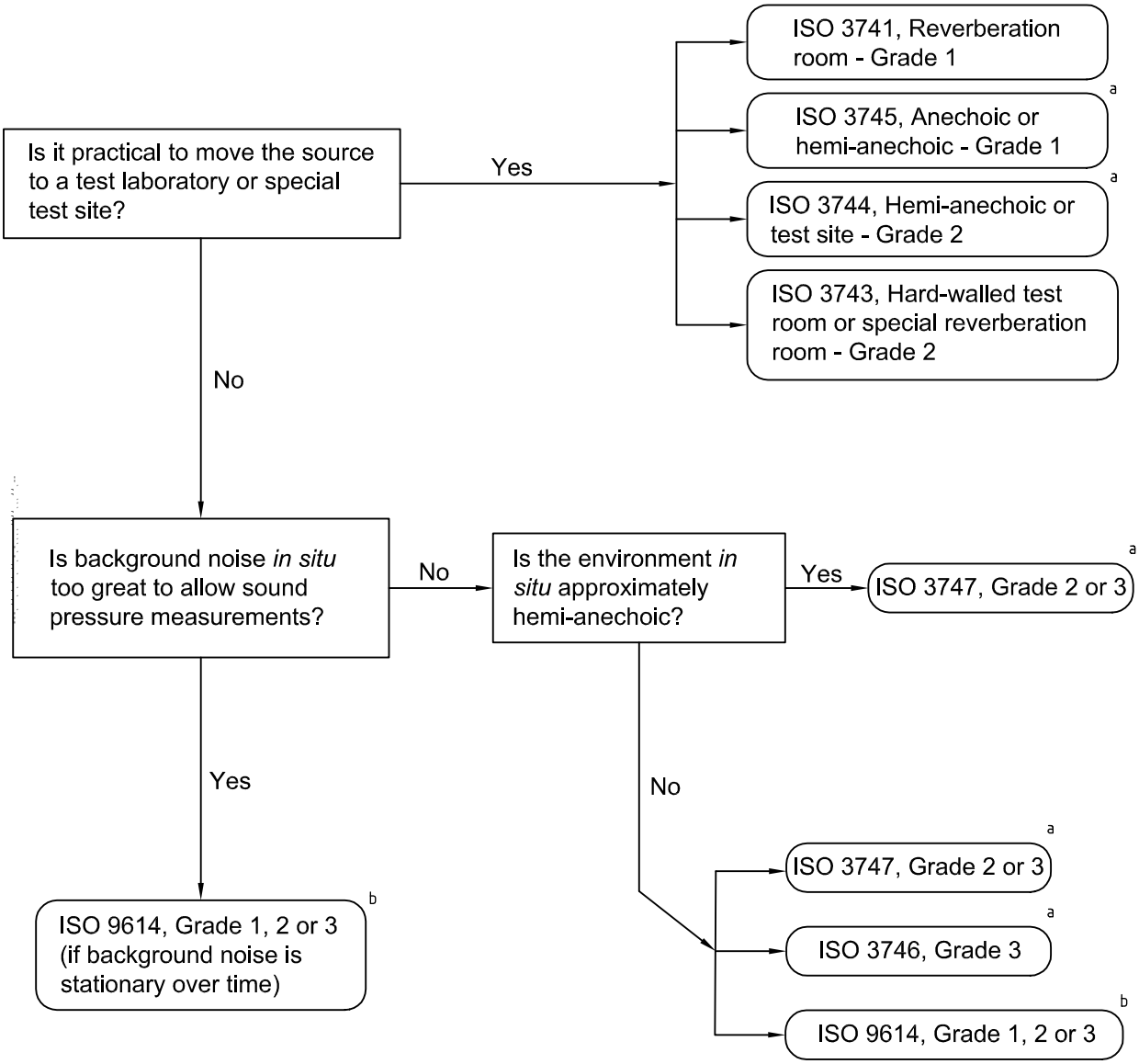
— economic aspects.

A manufacturer who has little or no experience with noise emission measurement should do the following.

a) He should find out whether a noise test code is available for the piece of machinery concerned. If such a code is available, the International Standard retained for the determination of the sound power level should be one of those offered by the code. If no noise test code exists, it is recommended that the manufacturer seeks assistance from persons with knowledge in acoustics and experience with the determination of noise emission from machinery.

b) He should investigate the practicability of a laboratory test site. The use of a laboratory test site may not be expensive.

Noise test code makers should carefully consider this International Standard together with the requirements of ISO 12001 when deciding which standards in the ISO 3740 and ISO 9614 series should appear in the code as the International Standards that can be used for the particular family of machinery concerned.



[a] The emission sound pressure level at work stations or other specified positions (see ISO 11200 series) can be measured in the same test site with the same grade of accuracy.

[b] ISO 9614 can be used in most test environments where the ISO 3740 series apply.

Figure D.1 — Flowchart guiding the choice of appropriate International Standard(s) for determining sound power levels

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[2] ISO 5725-2, *Accuracy (trueness and precision) of measurement methods and results — Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement method*.

[3] ISO 11200, *Acoustics — Noise emitted by machinery and equipment — Guidelines for the use of basic standards for the determination of emission sound pressure levels at a work station and at other specified positions*.

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[8] IEC 60942, *Electroacoustics — Sound calibrators.*

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[10] IEC 61260, *Electroacoustics — Octave-band and fractional-octave-band filters*.

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