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Acoustics — Determination of sound power levels of noise sources — Guidelines for the use of basic standards and for the preparation of noise test codes

MODIFICATION TO FOREWORD *(Inside front cover)*

The following sentence is to be added at the end of the foreword :

"This International Standard cancels and replaces ISO Recommendation R 495-1966, of which it constitutes a technical revision."

International Standard 3740

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INTERNATIONAL ORGANIZATION FOR STANDARDIZATION•МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ•ORGANISATION INTERNATIONALE DE NORMALISATION

Acoustics — Determination of sound power levels of noise sources — Guidelines for the use of basic standards and for the preparation of noise test codes

Acoustique — Détermination des niveaux de puissance acoustique émis par les sources de bruit — Guide pour l'utilisation des normes fondamentales et pour la préparation des codes d'essais relatifs au bruit

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO member bodies). The work of developing International Standards is carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been set up 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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 3740 was developed by Technical Committee ISO/TC 43, *Acoustics*, and was circulated to the member bodies in May 1976.

It has been approved by the member bodies of the following countries :

Australia	India	Poland
Austria	Israel	Romania
Belgium	Italy	South Africa, Rep. of
Canada	Japan	Spain
Czechoslovakia	Korea, Rep. of	Sweden
Denmark	Mexico	Switzerland
Finland	Netherlands	Turkey
France	New Zealand	United Kingdom
Germany, F. R.	Norway	USA
Hungary	Philippines	USSR

No member body expressed disapproval of the document.

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Acoustics — Determination of sound power levels of noise sources — Guidelines for the use of basic standards and for the preparation of noise test codes

Foreword

The most important factor in the selection of a noise measurement method is the ultimate use of the data that are to be obtained. This International Standard introduces a series of six International Standards describing various methods for determining the sound power levels of machines and equipment. Sound power level data are useful for :

a) calculating the approximate sound pressure level at a given distance from a machine operating in a specified environment;

b) comparing the noise radiated by machines of the same type and size;

c) comparing the noise radiated by machines of different types and sizes;

d) determining whether a machine complies with a specified upper limit of sound emission;

e) planning in order to determine the amount of transmission loss or noise control required under certain circumstances;

f) engineering work to assist in developing quiet machinery and equipment.

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. This is one of the reasons for using sound power level to characterize the noise emitted by various types of machines and equipment.

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

When applying these basic standards to sound measurements on specific machines, it is necessary to decide which one of the basic standards is most appropriate for the particular class of machine or equipment and for the purpose of the test. It is also necessary to decide on specific details for mounting and operating the machine to be tested within the general principles stated in the basic documents.

Guidelines for making these decisions are provided in this International Standard. These guidelines are essential for the proper application of the basic acoustical measurement standards and for the preparation of specific sound test codes for various types of machines and equipment.

If no specific sound test code exists for a particular type of machine, the most suitable of the basic documents should be followed and the mounting and operating conditions used should be described in the test report. These conditions should be in accordance with the general principles given in the basic documents.

0 Introduction

Control of noise from machines or equipment requires effective exchange of acoustical information among the several parties concerned. These include the manufacturer, specifier, installer and user of the machine or equipment. This acoustical information is obtained from measurements. These measurements are useful only if they are carried out under specified conditions to obtain defined acoustical quantities using standardized instruments.

The set of basic International Standards for which this International Standard serves as the introduction is :

ISO 3741 — Precision methods for broad-band sources in reverberation rooms.

ISO 3742 — Precision methods for discrete-frequency and narrow-band sources in reverberation rooms.

ISO 3743 — Engineering methods for special reverberation test rooms.

ISO 3744 — Engineering methods for free-field conditions over a reflecting plane.

ISO 3745 — Precision methods for anechoic and semi-anechoic rooms.

ISO 3746 — Survey method.

Additional International Standards may be added to the series in the future.

In principle, the methods of measurement described in ISO 3741 to ISO 3746 cover all types of machines and equipment. For noise measurements on a particular kind and size of machine or equipment, or when only certain kinds of facilities are available for the measurements, only one of these International Standards may be applicable. For type testing, only one method should be prescribed.

The basic International Standards prescribe the acoustical conditions for the noise measurements and the instruments to be

used. Only general information is given on the installation and operation of the sound source during the measurements. Different types of machines and equipment require more detailed instructions concerning the installation and operation of the equipment during the noise tests.

1 Scope and field of application

1.1 Scope

This International Standard provides guidelines comprising :

a) brief explanations of the principles underlying the set of basic International Standards for measuring the noise emitted by machines and equipment;

b) assistance in the selection of the appropriate basic International Standard;

c) general information on supplementing the basic International Standards with instructions concerning the installation and operating conditions for the particular type of machines or equipment; such instructions are usually incorporated in test codes.

1.2 Field of application

These guidelines are applicable to the preparation of all noise test codes for any type of machine or equipment, with the exception of moving vehicles or other non-stationary equipment. These guidelines apply only to airborne sound and are applicable only to test codes requiring the determination of sound power levels of noise sources.

2 References

ISO 2204, *Acoustics — Guide to International Standards on the measurement of airborne acoustical noise and evaluation of its effects on human beings.*

ISO 3741, *Acoustics — Determination of sound power levels of noise sources — Precision methods for broad-band sources in reverberation rooms.*

ISO 3742, *Acoustics — Determination of sound power levels of noise sources — Precision methods for discrete-frequency and narrow-band sources in reverberation rooms.*

ISO 3743, *Acoustics — Determination of sound power levels of noise sources — Engineering methods for reverberation rooms.*

ISO 3744, *Acoustics — Determination of sound power levels of noise sources — Engineering methods for free-field conditions over a reflecting plane.* [1)]

ISO 3745, *Acoustics — Determination of sound power levels of noise sources — Precision methods for anechoic and semi-anechoic rooms.*

ISO 3746, *Acoustics — Determination of sound power levels of noise sources — Survey method.*

IEC Publication 263, *Scales and sizes for plotting frequency characteristics and polar diagrams.*

3 Selection of appropriate International Standard for determination of sound power level

3.1 Quantities to be measured and determined

Methods are prescribed for measuring the sound pressure levels, either A-weighted or in frequency bands, in a specified acoustical environment. From these data, the sound power level of the source is calculated either as an A-weighted value or in frequency bands.

NOTES

1 Other weightings such as C-weighting may give additional information concerning low-frequency components.

2 Other meter characteristics such as "impulse" may give additional information concerning impulsive components.

The sound power levels are mean values obtained by time and space averaging. For certain kinds of noise and under certain measurement conditions, it is useful to supplement the sound power level data with information concerning fluctuations of the values is both space and time.

3.2 Considerations affecting choice of measurement method

The applicability of individual parts of this set of International Standards is determined by

a) the size of the noise source which, for laboratory measurements, is given in terms of the percentage of test room volume;

b) the test environment available for the measurements;

c) the character of the noise produced by the source (for example : broad-band, narrow-band, discrete-frequency; steady, non-steady, impulsive);

1) At present at the stage of draft.

d) frequency range of interest;

e) the highest grade of accuracy required as classified according to ISO 2204;

f) the acoustical data required including the sound power level data and other acoustical information (for example : directivity of source, temporal pattern).

3.3 Synopses

Synopses of ISO 3741 to ISO 3746 are to be found in annex A.

3.4 Test environments

For descriptions of the several test environments described in ISO 3741 to ISO 3746, reference should be made to annex C.

3.5 Procedure for selection

Table 1 summarizes the applicability of each of the series of six basic International Standards. Table 2 gives the uncertainties involved in the determinations of the sound power levels according to the six documents in the series.

Measurements made in conformity with this series of International Standards tend to result in standard deviations which are equal to or less than those given in table 2. The standard deviations of table 2 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 source. The inter-laboratory reproducibility and repeatability of the test results may be considerably better (i.e., smaller standard deviations) than the uncertainties given in table 2 would indicate.

The purpose for which the noise measurements are to be made determines the grade of accuracy required. The several factors influencing the selection of an appropriate test method are shown in table 3. This table gives guidance for the selection of the appropriate International Standard. The left side of the table lists the selection criteria. In the right-hand column, bars along the vertical lines combine the appropriate test conditions according to each of the individual International Standards.

After defining the requirements of the test, the appropriate International Standard can be selected by following the bars along the appropriate vertical line. A solid bar indicates that the corresponding International Standard is fully applicable to the test condition and the sound power levels are within their given ranges of uncertainty. An open bar means that the data obtained are optional.

If the source can be moved and the test environments are available, one of the methods described in ISO 3741 to ISO 3746 should be selected. If the machine or equipment to be tested cannot be moved, only the methods described in ISO 3744 and ISO 3746 are applicable. The method selected will depend upon the factors discussed in 3.2.

Additional information concerning the topics covered in table 1 and 3 is given in annex B.

4 Preparation of noise test codes

4.1 General

Each noise test code requiring the determination of the sound power level of a particular kind of machine or equipment should preferably be based on

a) one of the precision methods (ISO 3741, ISO 3742 or ISO 3745);

b) one of the engineering methods (ISO 3743 or ISO 3744);

c) the survey method (ISO 3746).

For the establishment of noise test codes for particular types of machines and equipment, the most appropriate method of measurement shall be selected from the basic International Standards listed in clause 0 of this International Standard. The decision shall then be made concerning the need for preparing supplementary requirements giving detailed specifications on :

a) operating conditions;

b) installation and mounting conditions;

c) microphone array, microphone traverses and measurement surface.

The decision may be made that supplementary requirements are not necessary and that the basic International Standard is sufficient for the purposes of the noise test code.

If the basic International Standard is to be used in preparing the noise test code for a particular class of machine or equipment, the code should cover the subjects listed in 4.2.

4.2 Use of basic International Standards

4.2.1 Under "Scope", the test code should carefully define the types of machines or equipment for which the test code is applicable. For large machines with many components and sub-assemblies, a clear definition should be made of the noise sources that are to be considered part of the machine under test.

4.2.2 Under "Purpose", the test code should define the specific purpose(s) for which the data are to be obtained (see Foreword). The test code should state whether the noise emission is to be expressed in terms of a weighted sound power level or in terms of the sound power level spectrum (in octave or one-third octave bands).

4.2.3 A "General Statement" should refer specifically to the basic International Standard which is to be used in applying the test code.

4.2.4 The text of the basic International Standard should not be included verbatim in the test code.

Table 1 — International Standards specifying various methods for determining the sound power levels, of machines and equipment

International Standard No.*	Classification of method	Test environment	Volume of source	Character of noise	Sound power levels obtainable	Optional information available
3741	Precision	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	Engineering	Special reverberation test room		Steady, broad-band, narrow-band, discrete-frequency	A-weighted and in octave bands	Other weighted sound power levels
3744	Engineering	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	Anechoic or semi-anechoic room	Preferably less than 0,5 % of test room volume	Any		
3746	Survey	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

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

International Standard No.*	Octave bands (Hz)	125	250	500	1 000 to 4 000	8 000	A-weighting
	1/3 Octave bands (Hz)	100 to 160	200 to 315	400 to 630	800 to 5 000	6 300 to 10 000	
3741 3742		3	2	1,5		3	–
3743		5	3	2		3	2
3744		3	2		1,5	2,5	2
3745	(Anechoic room)	1	1		0,5	1	–
	(Semi-anechoic room)	1,5	1,5		1	1,5	–
3746		–	–	–	–	–	5

* See clause 2.

Table 3 — Factors influencing the choice of the method

■ Information in accordance with International Standards

□ Optional information

		ISO 3741	ISO 3742	ISO 3743	ISO 3744	ISO 3745	ISO 3746
Size of source	Large sources — not movable	■	■	■	■	■	■
	Small sources — movable						
Character of noise	Steady — broad-band	■			■	■	■
	Steady — narrow-band — discrete-frequency		■				
	Non-steady			□			
Classification of method	Precision	■	■			■	
	Engineering			■	■		
	Survey						■
Application of data	Noise control work	■	■	■	■	■	
	Type testing						
	Comparison of machines or equipment : different types						
	same type						■
Information obtained	Octave band levels	■	■	■	■	■	■
	1/3 octave band levels	□	□				
	A-weighted levels			■	■	■	■
	Other weightings			□	□	□	□
	Directivity information				□	□	
	Temporal pattern				□	□	□
Test environment	Laboratory reverberation rooms	■	■				
	Special reverberation test room			■			
	Large rooms, outdoors				■		
	Laboratory anechoic rooms					■	
	In situ, indoors, outdoors				■		■
		ISO 3741	ISO 3742	ISO 3743	ISO 3744	ISO 3745	ISO 3746

4.2.5 Under "Information to be Recorded", the test code should require that the source locations and microphone positions in the test environment be described in detail.

Under "Information to be Reported", the test code should indicate the result of the measurement and the minimum of technical information that will be communicated for general information. Details of measurement procedure, measurement instruments, rooms, etc., need not be reported.

4.2.6 All factors related to the installation, mounting, location and operation of the particular type of machine and equipment covered by the code, which could have an influence on the amount and character of the sound emitted, should be studied. The installation and operating conditions to be specified in the noise test code should be selected. The section of the test code dealing with the installation and operating conditions will generally be the major section of the code.

NOTES

1 Mounting conditions : The equipment to be tested should be installed and mounted in one or more positions that are typical of normal use if practicable.

If the source is placed in close proximity to a wall (or ceiling) during normal usage, its sound radiation is influenced by these surfaces and special precautions should be taken to imitate their effects during measurements. For measurements in reverberation test rooms, the source should be placed with respect to the walls (or ceiling) as for normal use. If the source during normal use is in close proximity to two planes (e.g. wall and floor or wall and ceiling), it should be tested in a similar environment, simulated by erecting an auxiliary wall on the reflecting plane and mounting the source appropriately.

Mounting conditions should be described in detail.

Requirements should be given that all auxiliary equipment necessary for operating the equipment on test that is not a part of the source should be located outside the test environment.

2 Operating conditions : During the acoustical measurements, the source shall be operated in a specified manner. One or more of the following operating conditions should be chosen and described in detail by means of specifically defined parameters for the particular kind of equipment covered by the test code :

a) equipment under load and operating conditions that are typical of normal use;

b) equipment under full load [if different from a)];

c) equipment under no load (idling);

d) equipment under operating condition corresponding to maximum sound generation representative of normal use;

e) equipment with conventional load operating under carefully defined conditions.

4.3 Data presentation

This section of the noise test code should contain sufficient information to assure uniformity in the reporting of the noise data. In particular, the test code should provide a suitable form sheet on which all data pertinent to the particular test are to be presented as octave or one-third octave spectra. A table or graph sheet for reporting the data should be included. The plotting scales should be

20 mm per 10 dB for the ordinate

and 15 mm per octave for the abscissa

as specified in IEC Publication 263.

A sample graph sheet is shown in annex D.

Annex A

Synopses of basic International Standards on sound power level determinations

A.1 ISO 3741 — Precision methods for broad-band sources in reverberation rooms.

A.1.1 Applicability

Noise control work, type testing, comparison of machines or equipment of the same or different types.

A.1.2 Test environment

Reverberation room with prescribed volume and absorption or qualified according to a test procedure given in annex A of ISO 3741. Guidelines for the design of reverberation rooms are given in annex D of ISO 3741. The minimum test room volume depends on lowest frequency band of interest (V_{min} = 200 m^3 corresponds to 100 Hz for the lowest allowable one-third octave band).

A.1.3 Size of noise source

Volume of the source preferably less than 1 % of test room volume.

A.1.4 Character of noise radiated by the source

Steady (as defined in ISO 2204), broad-band.

A.1.5 Accuracy

Precision (standard deviation for determining sound power levels for 1 kHz octave band is less than or equal to 1,5 dB).

A.1.6 Quantities to be measured

Sound pressure levels in frequency bands on a prescribed path or at several discrete microphone positions.

A.1.7 Quantities to be determined

Sound power levels in frequency bands, A-weighted sound power levels (optional).

A.1.8 Quantities which cannot be obtained

Directivity characteristics of the source, temporal pattern of radiated noise for sources emitting non-steady noise.

A.2 ISO 3742 — Precision methods for discrete-frequency and narrow-band sources in reverberation rooms.

A.2.1 Applicability

Noise control work, type testing, comparison of machines or equipment of the same or different types.

A.2.2 Test environment

Prescribed reverberation room which is to be qualified according to a test procedure given in clause 3 of the main part of ISO 3742 and in annex A of ISO 3742. Additional test room requirements as given in ISO 3741.

A.2.3 Size of noise source

Volume of the source preferably less than 1 % of test room volume.

A.2.4 Character of noise radiated by the source

Steady (as defined in ISO 2204), discrete-frequency and/or narrow-band.

A.2.5 Accuracy

Precision (standard deviation for determining sound power levels for the 1 kHz octave band is less than 1,5 dB).

A.2.6 Quantities to be measured

Sound pressure levels in frequency bands on a prescribed path or at several discrete microphone positions.

A.2.7 Quantities to be determined

Sound power level in frequency bands, A-weighted sound power levels (optional).

A.2.8 Quantities which cannot be obtained

Directivity characteristics of the source, temporal pattern of radiated noise for sources emitting non-steady noise.

A.3 ISO 3743 — Engineering methods for special reverberation test rooms.

A.3.1 Applicability

Noise control work, type testing, comparison of machines or equipment of the same or different types.

A.3.2 Test environment

Special reverberation room with prescribed characteristics. The volume is between 70 m^3 and 300 m^3. The reverberation time of the room at low and middle frequencies is 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.

A.3.3 Size of noise source

Volume of the source not greater than 1 % of the volume of the test room.

A.3.4 Character of noise radiated by the source

Steady (as defined in ISO 2204).

A.3.5 Accuracy

Engineering (standard deviation for determining sound power levels for the 1 kHz octave band is about 2,0 dB).

A.3.6 Quantities to be measured

Sound pressure levels (weighted and in octave bands) on prescribed paths or at several fixed microphone positions.

A.3.7 Quantities to be determined

Weighted sound power level (A-weighting is required; other weightings are optional); sound power levels in octave bands.

A.3.8 Quantities which cannot be obtained

Directivity characteristics of the source.

A.4 ISO 3744 — Engineering methods for free-field conditions over a reflecting plane.

A.4.1 Applicability

Noise control work, type testing, comparison of machines or equipment of the same or different types.

A.4.2 Test environment

Free-field over a reflecting plane (indoors or outdoors). The test environment may be a semi-anechoic room, or a large ordinary test room, if qualified as follows. The adequacy of the test environment is to be checked within the measurement space in the presence of the source under test according to one of the test procedures given in annex A of ISO 3744. The reflecting plane on which the source is located shall extend at least to the measurement surface. The sound absorption coefficient of the reflecting plane shall not exceed 0,06. The environmental correction factor K shall not exceed 2 dB (corresponding to a ratio $A/S > 6$ for rooms, where A is the total sound absorption of the test room and S is the area of the measurement surface).

A.4.3 Size of source

Greatest linear dimension less than 15 m.

A.4.4 Character of noise radiated by the source

All types (as defined by ISO 2204 : steady, non-steady, broad-band, discrete-frequency, narrow-band).

A.4.5 Accuracy

Engineering (standard deviation for determining sound power levels for the 1 kHz octave band is about 1,5 dB).

A.4.6 Quantities to be measured

Sound pressure levels (weighted and in frequency bands) at prescribed measurement microphone positions.

A.4.7 Quantities to be determined

Weighted sound power levels (A-weighting is required; other weightings are optional); sound power levels in frequency bands; directivity characteristics of the source (optional).

A.5 ISO 3745 — Precision methods for anechoic and semi-anechoic rooms.

A.5.1 Applicability

Noise control work, type testing, comparison of machines or equipment of the same or different types.

A.5.2 Test environment

Free-field (anechoic room) or free field over a reflecting plane (semi-anechoic room). The adequacy of the test environment is to be checked within the measurement space in the presence of the source under test according to one of the test procedures given in annex A. The reflecting plane on which the source is located shall extend at least to the measurement surface. The sound absorption coefficient of the reflecting plane shall not exceed 0,06.

A.5.3 Size of source

Volume of the source preferably less than 0,5 % of the volume of the test room.

A.5.4 Character of noise radiated by the source

All types (as defined in ISO 2204 : steady, non-steady, broad-band, discrete-frequency, narrow-band).

A.5.5 Accuracy

Precision (standard deviation for determining sound power levels for the 1 kHz octave band is less than or equal to 0,5 dB for anechoic rooms and less than or equal to 1,0 dB for semi-anechoic rooms).

A.5.6 Quantities to be measured

Sound pressure levels (weighted and in frequency bands) at prescribed measurement microphone positions.

A.5.7 Quantities to be determined

Weighted sound power levels (A-weighting is required; other weightings are optional); sound power levels in frequency bands; directivity characteristics of the source (optional).

A.6 ISO 3746 — Survey method

A.6.1 Applicability

Comparison and serial survey of machines or equipment of the same type.

A.6.2 Test environment

Installation (indoors or outdoors) meeting prescribed requirements. The adequacy of the test environment for indoor measurements is to be checked by a simple procedure. Outdoor measurements do not require a special test procedure. The reflecting plane on which the source is located shall extend at least to the measurement surface. The sound absorption coefficient of the reflecting plane shall not exceed 0,1. The environmental correction factor K for indoor measurements shall not exceed 7,0 dB (corresponding to a ratio $A/S > 1$, where A is the total sound absorption of the test room and S is the area of the measurement surface).

A.6.3 Size of noise source

No restrictions.

A.6.4 Character of noise by the source

All types (as defined in ISO 2204 : steady, non-steady, broad-band, discrete-frequency, narrow-band).

A.6.5 Accuracy

Survey (standard deviation for determining A-weighted sound power levels is about 5 dB for discrete-tone sources and about 4 dB for sources which radiate steady, broad-band noise).

A.6.6 Quantities to be measured

Weighted sound pressure levels at prescribed microphone positions.

A.6.7 Quantities to be determined

Weighted sound power level (A-weighting is required; other weightings are optional).

Annex B
Factors affecting choice of measurement method

B.1 The size of the noise source

Several measurement methods place an upper limit on the volume of the source. In ISO 3741, ISO 3742 and ISO 3743 (reverberant-field methods), the volume of the source should preferably be less than 1 % of the test room volume. In ISO 3744 (free-field method), the greatest dimension of the source should be less than 15 m. In ISO 3745 (free-field method), the volume of the source should preferably be less than 0,5 % of the volume of the test room. In ISO 3746 (survey method), no restriction is placed on the size of the source.

B.2 The test environment available for the measurements

If the source is movable (and small), it can be installed in any available test environment (for example : semi-anechoic room, anechoic room, outdoors, reverberation room, machine test room with good acoustical properties). If the chosen test environment and the acoustical characteristics of the source under test meet the qualification requirements described in the individual standards of the series, the measurements can be stated to comply with the requirements of the appropriate International Standards.

If the source is not movable, the noise is measured under *in situ* conditions. In this case, the measurement methods described in ISO 3744 or ISO 3746 may be applicable. Qualification procedures and environmental requirements are given in annex A of ISO 3744 and in the annex of ISO 3746. These procedures determine whether ISO 3744 (engineering method) and/or ISO 3746 (survey method) may be used.

For large machines (i.e., with volumes significantly greater than 2 m^3) and for machines installed outdoors, only the methods of ISO 3744 and ISO 3746 are applicable. On the other hand, any one 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 (the "broad-band" condition may be disregarded in the case of ISO 3746). For small machines, the available test environment and the desired accuracy determine the method to be selected.

B.3 The character of the noise

If discrete-frequency components or narrow-band noises are present in the spectrum of the source, any method except ISO 3741 may be used. Non-steady and impulsive noises cannot be measured under reverberant field conditions. Sources emitting non-steady or impulsive noises are measured according to the requirements of ISO 3744, ISO 3745 or ISO 3746.

If a source produces steady, broad-band noise, the measurement effort is reduced and there is complete freedom in selection of the measurement method (ISO 3741, ISO 3743, ISO 3744, ISO 3745 or ISO 3746).

If the frequency range of interest extends below 100 Hz or above 10 kHz, larger/smaller reverberation 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 3745).

B.4 The highest grade of accuracy required

The set of basic International Standards offers three grades of accuracy in determining the sound power levels of noise sources :

a) Precision (laboratory) methods (highest grade of accuracy) are described in ISO 3741 and ISO 3742 (reverberant-field methods) and ISO 3745 (free-field method).

b) Engineering methods (medium grade of accuracy) are described in ISO 3743 (reverberant-field method) and ISO 3744 (free-field method).

c) Survey method (lowest grade of accuracy) is described in ISO 3746.

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

B.5 Acoustical data required

The data to be obtained depend upon the purposes of the noise measurements. The principal areas of application of acoustical data are the following.

B.5.1 Noise control work

In the development of quieter machines 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 and vibratory characteristics may also be necessary. The methods of measurement should preferably be capable of providing accuracy of the precision grade, but methods giving an engineering grade of accuracy are frequently satisfactory.

B.5.2 Type testing

For production noise testing of machines and equipment, a simple overall determination of the weighted sound power level is usually sufficient. The value of these data is increased if more detailed information on the characteristics of the noise is obtained from a type test. Such a type test should provide information on the sound power level distribution in frequency bands (in octave or one-third octave bands) and the method of measurement should be capable of providing at least an engineering grade of accuracy.

B.5.3 Comparison of machines

If a comparison is to be made between machines which are different in type or size, information on the sound power level spectrum of the noise radiated by the machines is usually required for such comparisons to be meaningful. In most cases, octave or one-third octave band data are sufficient. The measurement should provide an engineering grade of accuracy. When the comparison is between machines of the same type which are built to the same specifications, a determination of the overall weighted sound power level is usually sufficient.

Annex C

Acoustical test environments

C.1 Environments provided by acoustics laboratories

Use of a laboratory room with defined acoustical properties yields the highest grade of 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 equipment under test.

C.1.1 Reverberation rooms

Reverberation rooms as described in ISO 3741 and ISO 3742 are particularly suitable when it is necessary to conduct a large number of tests on comparatively small machines (with volumes less than 1 % of the room volume) and when the sound emitted is predominantly steady in character.

Reverberation rooms do not provide directivity information and are not suited 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.

Measurements made according to these standards are of the precision grade.

C.1.2 Special reverberation test rooms

Special test rooms which are constructed to meet the requirements of ISO 3743 are less expensive than the laboratory reverberation rooms described in ISO 3741 and ISO 3742. The method described in ISO 3743 provides measurements of the engineering grade. These special reverberation test rooms are particularly suited for direct measurement of A-weighted sound levels; they are also useful for series of 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.

C.1.3 Anechoic and semi-anechoic rooms

Anechoic and semi-anechoic rooms as described in ISO 3745 are useful for measurements on small noise sources (volumes 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 (for example : 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 the precision grade.

C.2 Environment *in situ*

C.2.1 Engineering method

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 operated indoors. The acoustical environment in all cases is qualified by following the procedures described in ISO 3744.

If the required qualifications are fulfilled, the measurements in this environment are of the engineering grade.

C.2.2 Survey method

Conditions approximating a free field over a reflecting plane are to be found when the source is located outdoors or in a large room. The survey method of measurement is described in ISO 3746. This method places no restriction on the type or size of machine that is operated outdoors and it applies for many types of machines in their normal environments when operated indoors. The particular environment in all cases is qualified by following the procedures described in ISO 3746.

If the required qualifications are fulfilled, the measurements according to ISO 3746 are of the survey grade.

Annex D

Preferred format for reporting octave and third-octave band sound power levels