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Acoustics — Noise emitted by machinery and equipment — Rules for the drafting and presentation of a noise test code

Acoustique — Bruits émis par les machines et équipements — Règles pour la préparation et la présentation d'un code d'essai acoustique

Reference number
ISO 12001:1996(E)

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 12001 was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 1, *Noise*.

This first edition of ISO 12001 replaces parts of ISO 2204.

Annexes A and B form an integral part of this International Standard. Annexes C and D are for information only.

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Introduction

In the determination, declaration and verification of noise emission values for specific types of machinery and equipment, standardized noise test codes are required for many purposes.

Several basic International Standards dealing with the noise emitted by machinery and equipment exist. In order to prepare a noise test code for a specific family of machinery or equipment, it is necessary to select the most appropriate basic documents and to establish additional requirements for that family (e.g. installation and mounting conditions, operating conditions, measurement positions, noise declarations, information to be recorded and reported, etc.).

A noise test code is a standard for a specific family, sub-family or type of machinery or equipment. Such a code gives all the information necessary to carry out as efficiently as possible the determination, declaration and verification of the noise emission characteristics of the machine under test. This International Standard specifies what information is necessary for the preparation of noise test codes.

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Acoustics — Noise emitted by machinery and equipment — Rules for the drafting and presentation of a noise test code

1 Scope

This International Standard specifies the technical requirements of a noise test code for a specific family of machinery or equipment. It is primarily applicable to stationary machinery and equipment, including hand-held tools, as well as those that present hazards due to mobility or load lifting.

The purpose of a noise test code is to permit comparable test results to be obtained on the noise emissions of machines from the same family, thus enabling users to make comparisons and to check the declared noise emission data. The quantities described in a noise test code are also useful for noise specifications in private contracts, for planning and for noise reduction purposes.

Specific test codes for various types of machinery and equipment are established and used in accordance with the requirements of basic International Standards. Standardized noise test codes give detailed requirements on mounting, loading and operating conditions for the particular family to which the machinery under test belongs, as well as the location of a work station(s) and other specified positions (if any).

The purpose of this International Standard is to assist technical standardization committees responsible for specific families of machinery or equipment in preparing noise test codes to ensure that such noise test codes

- are as homogeneous as possible, with each individual test code having the same basic structure;
- are in full accordance with basic standards on measurement, declaration and verification of noise emissions; and
- reflect the latest technical knowledge of methods of determining the noise emissions from the specific family of machinery or equipment under consideration.

NOTE 1 Annex A lists the basic International Standards to be used in the drafting of a noise test code. An outline of a typical noise test code summarizing the information that is required is given in annex B. Noise emission quantities are described in annex C.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 3740:1980, *Acoustics — Determination of sound power levels of noise sources — Guidelines for the use of basic standards and for the preparation of noise test codes.*

ISO 3741:—[1], *Acoustics — Determination of sound power levels of noise sources using sound pressure — Precision methods for reverberation rooms.*

1) To be published. (Revision of ISO 3741:1988 and ISO 3742:1988)

ISO 3743-1:1994, *Acoustics — Determination of sound power levels of noise sources — Engineering methods for small, movable sources in reverberant fields — Part 1: Comparison method for hard-walled test rooms.*

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 3745:1977, *Acoustics — Determination of sound power levels of noise sources — Precision methods for anechoic and semi-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 3747:1987, *Acoustics — Determination of sound power levels of noise sources — Survey method using a reference sound source.*

ISO 4871:1996, *Acoustics — Declaration and verification of noise emission values of machinery and equipment.*

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 11200:1995, *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.*

ISO 11201:1995, *Acoustics — Noise emitted by machinery and equipment — Measurement of emission sound pressure levels at a work station and at other specified positions — Engineering method in an essentially free field over a reflecting plane.*

ISO 11202:1995, *Acoustics — Noise emitted by machinery and equipment — Measurement of emission sound pressure levels at a work station and at other specified positions — Survey method in situ.*

ISO 11203:1995, *Acoustics — Noise emitted by machinery and equipment — Determination of emission sound pressure levels at a work station and at other specified positions from the sound power level.*

ISO 11204:1995, *Acoustics — Noise emitted by machinery and equipment — Measurement of emission sound pressure levels at a work station and at other specified positions — Method requiring environmental corrections.*

IEC 651:1979, *Sound level meters,* and Amendment 1:1993.

IEC 804:1985, *Integrating-averaging sound level meters,* and Amendment 1:1989 and Amendment 2:1993.

IEC 1043:1993, *Electroacoustics — Instruments for the measurement of sound intensity — Measurement with pairs of pressure sensing microphones.*

IEC 1260:1995, *Electroacoustics — Octave-band and fractional-octave-band filters.*

3 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1 basic noise emission standard (B-type standard): Standard which specifies the procedure for determining the noise emission of machinery and equipment in such a way as to obtain reliable, reproducible results with a specified degree of accuracy.

3.2 noise test code (C-type standard): A standard that is applicable to a particular class, family or type of machinery or equipment, which specifies all the information necessary to carry out efficiently the determination, declaration and verification of the noise emission characteristics under standardized conditions.

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

NOTE 2 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 a work station and/or at other specified positions (if any) in the vicinity of the source.

3.4 emission sound pressure, p**:** The sound pressure, at a specified position near a noise source, when the source is in operation under specified operating and mounting conditions on a reflecting plane surface, excluding the effects of background noise and of reflections other than those from the plane or planes permitted for the purpose of the test. It is expressed in pascals.

3.5 emission sound pressure level, L_p**:** Ten times the logarithm to the base 10 of the ratio of the square of the emission sound pressure, $p^2(t)$, to the square of the reference sound pressure, p_0^2, measured with a particular time weighting and a particular frequency weighting, selected from those defined in IEC 651. It is expressed in decibels. The reference sound pressure is 20 µPa.

NOTE 3 Examples include:

— maximum A-weighted emission sound pressure level with time weighting F: L_{pAFmax};

— C-weighted peak emission sound pressure level: $L_{pC,peak}$.

The emission sound pressure level shall be determined at a specified position and in accordance with either a test code for a specific family of machines or, if no test code exists, a method that complies with the ISO 11200 series.

3.6 time-averaged emission sound pressure level, L_{peqT}**:** Emission 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. It is expressed in decibels.

It is given by the following equation:

$$L_{peqT} = 10 \lg \frac{1}{T} \int_0^T \frac{p^2(t)}{p_0^2} \mathrm{d}t \quad \mathrm{dB} \qquad \ldots (1)$$

A-weighted time-averaged emission sound pressure levels are denoted by L_{pAeqT}, which is usually abbreviated to L_{pA}. L_{pAeqT} shall be measured with an instrument which complies with the requirements of IEC 804.

NOTES

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

5 Equation (1) is identical to that for the familiar ISO environmental noise descriptor "equivalent continuous sound pressure level" defined in ISO 1996-1. However, the emission quantity defined above is used to characterize the noise emitted by a machine under test and assumes that standardized measurement and operating conditions as well as a controlled acoustical environment are used for the measurements.

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

3.8 sound power level, L_W**:** Ten times the logarithm to the base 10 of the ratio of the sound power radiated by the source under test to the reference sound power. It is expressed in decibels.

The frequency weighting or the width of the frequency band used shall be indicated. The reference power is 1 pW (10^{-12} W).

NOTE 6 For example, the A-weighted sound power level is L_{WA}.

The sound power level shall be determined in accordance with either a test code for a specific family of machinery or equipment or, if no test code exists, a method that complies with one of the standards selected from ISO 3741 to ISO 3747, inclusive, or with parts 1 or 2 of ISO 9614.

3.9 noise emission value: A general term by which any one or more of the A-weighted sound power level, L_{WA}, or the A-weighted time-averaged emission sound pressure level, L_{pA}, or the C-weighted peak emission sound pressure level, $L_{pC,peak}$, is inferred.

3.10 measured noise emission value, L**:** The A-weighted sound power level, or the A-weighted time-averaged emission sound pressure level, or the C-weighted peak emission sound pressure level, as determined from measurements. Measured values may be determined either from a single machine or from the average of a number of machines, and are not rounded.

3.11 noise emission declaration: Information on the noise emitted by the machine, given by the manufacturer or supplier in technical documents or other literature concerning noise emission values. The noise emission declaration may take the form of either the declared single-number noise emission value or the declared dual-number noise emission value.

3.12 uncertainty, K**:** Value, in decibels, of the measurement uncertainty associated with a measured noise emission value.

NOTE 7 Guidance on appropriate values for K is given in annex A of ISO 4871:1996.

3.13 declared single-number noise emission value, L_d: The sum of a measured noise emission value and the associated uncertainty factor, rounded to the nearest decibel:

$$L_d = L + K$$

NOTE 8 ISO 9296 requires that the declared A-weighted sound power level, L_{WAd}, of computers and business equipment be expressed in bels using the identity 1 B = 10 dB, rounded to the nearest 0,1 B.

3.14 declared dual-number noise emission value, L and K: A measured noise emission value, L, and its associated uncertainty K, both rounded to the nearest decibel.

NOTE 9 If a specific noise test code requires that the mean emission sound pressure level from a number of specified positions be declared, it is denoted by L_{pAm}.

3.15 work station; operator's position: A position in the vicinity of the machine under test which is intended for the operator.

3.16 operator: An individual whose work station is in the vicinity of a machine and who is performing a work task associated with that machine.

3.17 specified position: A position defined in relation to a machine, including, but not limited to, an operator's position. The position can be a single, fixed point, or a combination of points along a path or on a surface located at a specified distance from the machine, as described in the relevant noise test code, if any.

NOTES

10 Positions located in the vicinity of a work station, or in the vicinity of an unattended machine, may be identified as "bystander positions".

11 The following definitions are of a general nature. Reference should be made to specific standards of the ISO 3740 series and the ISO 11200 series for more detailed definitions.

3.18 steady noise: A noise with negligibly small fluctuations of level within the period of observation. See figure 1 a).

3.19 non-steady noise: A noise whose level shifts significantly during the period of observation.

3.19.1 fluctuating noise: A noise whose level varies continuously and to an appreciable extent during the period of observation. See figure 1 b).

3.19.2 intermittent noise: A noise whose level abruptly drops to the level of the background noise several times during the period of observation. The time during which the level remains at a constant value different from that of the ambient is of the order of 1 s or more. See figure 1 c).

3.19.3 impulsive noise: A noise consisting of a series of bursts of sound energy, each burst having a duration of less than approximately 1 s.

3.19.3.1 isolated burst of sound energy: A single burst of sound energy or a series of bursts with intervals larger than 0,2 s between the individual bursts. See figure 1 d).

3.19.3.2 quasi-impulsive noise: A series of noise bursts of comparable amplitude with intervals shorter than 0,2 s between the individual bursts. See figure 1 e).

3.20 broad-band noise: Noise in which the acoustical energy is distributed over a relatively wide range of frequencies.

NOTES

12 The spectrum is generally smooth and continuous, although it may vary significantly from "flat". If the broad-band sound does not contain any significant discrete tones, the sound will lack a subjective quality of pitch or tonality.

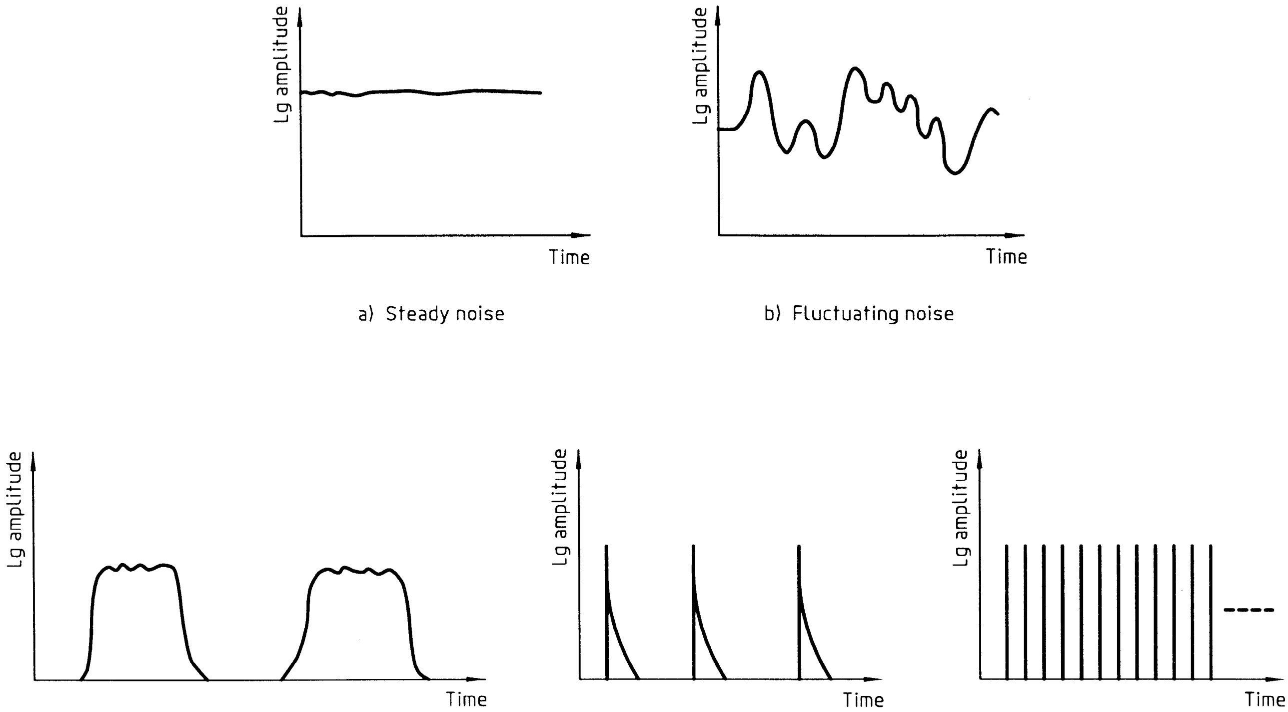
13 Examples of broad-band sounds without discrete tones are the sound of a waterfall, the noise from an air diffuser outlet in a typical room, and the noise from a highway.

3.21 narrow-band noise: Noise in which the acoustical energy is concentrated in a relatively narrow range of frequencies.

NOTES

14 The spectrum will generally show a localized "hump" or peak in amplitude. Narrow-band sound may be superimposed on broad-band sound. If the narrow-band sound does not contain any significant discrete tones, the sound will generally lack a subjective quality of pitch or tonality.

15 Examples of narrow-band sounds without discrete tones are the sound of distant thunder (low frequency), the sound of wind gusting over a prairie or through a canyon (mid frequency), and the sound of an air leak in an automobile tyre (high frequency).



a) Steady noise b) Fluctuating noise

c) Intermittent noise d) Isolated burst of sound energy e) Quasi-impulsive noise

Figure 1 — Pictorial examples of various types of noise

3.22 discrete tone: A periodic sound pressure variation that gives rise to the sensation of pitch.

NOTES

16 A discrete tone can be either a purely sinusoidal variation (sometimes called a "pure tone"), in which case the frequency spectrum would show a single "spike" at the sinusoidal frequency, or, more typically, a non-sinusoidal variation, in which case the spectrum would show a spike at the fundamental frequency and other spikes at harmonics of the fundamental.

17 Examples of discrete tones are the hum of a fan, a beep from a digital gadget, and a note played on a musical instrument.

3.23 free field: A sound field in a homogeneous, isotropic medium free of boundaries. In practice, it is a field in which reflections at the boundaries are negligible over the frequency range of interest.

3.24 free field over a reflecting plane (hemi-free sound field): A sound field in a homogeneous, isotropic medium in the half space above an infinite, rigid plane surface on which the machine under test is located.

3.25 essentially free field over a reflecting plane: A sound field in the half space above a plane surface on which the machine under test is located that is disturbed to only a small degree by reflections.

3.26 *in situ* sound field: A sound field in the half space above a plane surface on which the machine under test is located that may be disturbed by many reflections.

3.27 direct sound field: That portion of the sound field in a test room over which the sound received directly from the source predominates.

3.28 reverberant sound field: That portion of the sound field in a test room over which the influence of sound received directly from the source is negligible.

3.29 semi-reverberant sound field: That portion of the sound field in a test room where neither the sound received directly from the source nor the reverberant sound dominates.

3.30 hemispherically divergent sound field: The sound field of an omnidirectional source which is situated near a hard reflecting plane (usually the ground) but free from other obstructions.

4 Classification of different types of noise

The character of a noise may be described by its frequency spectrum and by variations in the level of the noise with time.

Many noises have a continuous spectrum; i.e. the sound energy is evenly distributed over a major portion of the audible frequency range. In some cases, discrete tones may be clearly audible in the noise.

Noises which display different dependencies upon time include: noise, non-steady noise, fluctuating noise, intermittent noise, impulsive noise, quasi-steady impulsive noise and an isolated burst of sound energy.

5 Classification of the accuracy grade of measurement methods

Each of the basic standards of the ISO 3740 and ISO 9614 series for the determination of sound power levels of noise sources includes a table of standard deviations of reproducibility. A grade 1 method provides the highest precision and a grade 3 method provides the lowest.

The basic standards of the ISO 11200 series, describing methods of measuring the emission sound pressure levels at a work station and at other specified positions (if any), do not include tables of measurement uncertainty values. Where required, such values shall be determined by tests carried out for the specific family of machinery or equipment.

The choice of measurement method depends upon the type of sound source and its environment, the character of the noise it radiates and the degree of thoroughness required for the measurements.

The methods available can be classified according to the requirements they place on the environment in which the measurements are taken, on the instruments available and on the amount of labour involved. Three classes of methods are described in 5.1 to 5.3 which are broadly defined in terms of the facilities, instrumentation and labour required.

NOTE 18 International Standards of the ISO 3740 and ISO 9614 series for the determination of sound power levels of noise sources include methods representing all three classes (grades 1 through 3). International Standards of the ISO 11200 series for the measurement of emission sound pressure levels at a work station and at other specified positions include methods representing two of the three classes (grades 2 and 3). See table A.2.

5.1 Survey grade (grade 3)

This method requires the least amount of time and equipment. It may be used for comparison between noise sources with similar characteristics. The sound field in the vicinity of the source is described by the readings of a sound level meter or sound intensity meter. A limited number of measurement points is used and no detailed analysis of the acoustic environment is made. The measurements are made *in situ* with little effort expended to control the acoustic environment in which the source or sources operate. The time dependence of the noise is noted.

Readings of the sound level or the sound intensity shall be obtained with instrumentation which complies with the requirements of IEC 651, IEC 804 or IEC 1043.

The survey method is generally of limited value if corrective measures to reduce the noise of the source(s) are to be evaluated. The use of class 2 instrumentation in accordance with IEC 651 or IEC 1043 is acceptable.

5.2 Engineering grade (grade 2)

In this method, noise emission determinations are made with a particular time weighting and a particular frequency weighting and/or by noise emission measurements in octave, one-third-octave or narrower frequency bands, from which the A-weighted values may be calculated. The acoustic environment is analysed to determine its effect upon the measurements. The measuring points and the frequency range observed are selected according to the characteristics of the noise source and the environment in which it operates. The time dependence of the level during the period of observation is recorded.

The use of a class 1 sound level meter or a class 1 integrating-averaging sound level meter, in accordance with IEC 651 or IEC 804, is required. Filters complying with the requirements of IEC 1260 shall be used for measurements in octave and fractional octave bands.

The engineering method is the preferred method for noise declaration purposes. This method usually provides information that is sufficient for taking engineering action in many situations, for example, in connection with noise abatement programmes.

NOTES

19 When the environmental requirements for an engineering method cannot be fulfilled, the results of an analysis of band pressure levels may be presented with the disclaimer that they are not grade 2.

20 Fluctuating, intermittent and impulsive noises are frequently described by the time-averaged sound pressure level obtained with an integrating-averaging sound level meter during a stated time interval and/or by the time history of the sound pressure levels.

5.3 Precision grade (grade 1)

This method gives as thorough a description of the noise emitted by a source as possible.

The noise emission determinations are supplemented by determinations of band pressure levels. Measurements are made over an appropriate time interval according to the duration and fluctuations of the noise. The acoustic environment is controlled by carrying out the measurements under laboratory conditions as in an anechoic room, a hemi-anechoic room or a reverberation room.

6 Selection of B-type standards for use in noise test codes

6.1 General

Those responsible for preparing a new noise test code shall select from the several basic measurement methods available (see 6.2 and 6.3), and from the methods for the declaration and verification of noise emission values (see 6.4), those basic standards that are most appropriate for the specific family of machinery or equipment. The requirements of the applicable basic standard(s) are then supplemented with detailed descriptions of mounting and operating conditions as well as the work station position to be used for sound emission determination and declaration for the specific family of machinery or equipment.

The basic standards may be grouped into the three categories given in 6.2 to 6.4.

6.2 Methods for determining sound power levels

This category includes the following International Standards:

— ISO 3740 gives guidance on the choice of the method to be used for determining the sound power levels of machinery and equipment; this standard should always be consulted before choosing the method to be used;

— ISO 3741 to ISO 3747 give methods for determining the sound power levels of machinery and equipment from sound pressure measurements;

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

A list of these standards is given in table A.1.

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

This category includes the following International Standards:

— ISO 11200 gives guidelines for the choice of basic standards for the determination of emission sound pressure levels of machinery and equipment and for the selection of specified positions; this standard should always be consulted before choosing the method to be used;

— ISO 11201 gives an engineering method for measuring emission sound pressure levels of machinery and equipment in an essentially free field over a reflecting plane with no environmental correction;

— ISO 11202 gives a survey method for measuring emission sound pressure levels of machinery and equipment *in situ* with an environmental correction using a simplified method;

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

— ISO 11204 gives a method for measuring the emission sound pressure levels of machinery and equipment yielding engineering grade or survey grade results.

A list of these standards is given in table A.2.

NOTE 21 At any given position in relation to a particular machine, and for given mounting and operating conditions, the emission sound pressure levels determined by the methods of these International Standards will in general be lower than the directly measured sound pressure levels for the same machine in the typical workroom where it is used. This is due to reverberation and the contributions of other