INTERNATIONAL STANDARD

ISO 1680

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Acoustics — Test code for the measurement of airborne noise emitted by rotating electrical machines

Acoustique — Code d'essai pour le mesurage du bruit aérien émis par les machines électriques tournantes

Reference number
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Contents

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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.

International Standard ISO 1680 was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 1, *Noise*.

This first edition of ISO 1680 cancels and replaces ISO 1680-1:1986 and ISO 1680-2:1986, which have been combined and technically revised.

Annexes A and B of this International Standard are for information only.

Introduction

This International Standard is a noise test code giving methods for determining the airborne sound radiation of rotating electrical machines operating under steady-state conditions.

To characterize the airborne sound radiation, procedures are given to determine sound power levels and additionally emission sound pressure levels, if required. Furthermore, requirements are given for the declaration and verification of noise emission values.

Basic standards giving methods for determining sound power levels are as follows:

a) using sound pressure:

- grade 1 (precision): ISO 3741 and ISO 3745;
- grade 2 (engineering): ISO 3743-1, ISO 3743-2, ISO 3744, ISO 3747;
- grade 3 (survey): ISO 3746;

b) using sound intensity:

- all grades: ISO 9614-1;
- grades 2 and 3: ISO 9614-2.

The emission sound pressure level is determined on the basis of ISO 11203. Declaration and verification of noise emission values follow ISO 4871.

This International Standard has been drafted in accordance with ISO 12001.

Acoustics — Test code for the measurement of airborne noise emitted by rotating electrical machines

1 Scope

This International Standard specifies all the information necessary to carry out efficiently and under standardized conditions the determination, declaration and verification of the noise emission characteristics of rotating electrical machines. It specifies noise measurement methods that can be used, and specifies the operating and mounting conditions that shall be used for the test.

Noise emission characteristics include the sound power level and emission sound pressure level. The determination of these quantities is necessary

— for comparing the noise emitted by machines,

— to enable manufacturers to declare the noise emitted, and

— for the purposes of noise control.

The use of this International Standard as a noise test code ensures the reproducibility of the determination of the noise emission characteristics within specified limits determined by the grade of accuracy of the basic noise measurement method used. Noise measurement methods allowed by this International Standard are laboratory methods (grade 1), engineering methods (grade 2) and survey methods (grade 3). Methods of engineering grade (grade 2) are to be preferred.

This International Standard is applicable to rotating electrical machines of any length, width or height.

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

ISO 3743-1, *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, *Acoustics — Determination of sound power levels of noise sources using sound pressure — Engineering methods for small, movable sources in reverberant fields — Part 2: Methods for special reverberation test rooms.*

1) Revision of ISO 3741:1988 and ISO 3742:1988.

ISO 3744, *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, *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 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 for use in situ.*

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

ISO 7574-1, *Acoustics — Statistical methods for determining and verifying stated noise emission values of machinery and equipment — Part 1: General considerations and definitions.*

ISO 7574-4, *Acoustics — Statistical methods for determining and verifying stated noise emission values of machinery and equipment — Part 4: Methods for stated values for batches of machines.*

ISO 7779:1999, *Acoustics — Measurement of airborne noise emitted by information technology and telecommunications equipment.*

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

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

ISO 11203, *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.*

IEC 60034-1, *Rotating electrical machines — Part 1: Rating and performance.*

IEC 60651, *Sound level meters.*

3 Terms and definitions

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

3.1
sound pressure level
L_p
ten times the logarithm to the base 10 of the ratio of the time-averaged square of the sound pressure radiated by the sound source under test to the square of the reference sound pressure

NOTE 1 Sound pressure levels are expressed in decibels.

NOTE 2 The frequency weighting or the width of the frequency band used, and time weighting (S, F or I, see IEC 60651), should be indicated. The reference sound pressure is 20 µPa (2×10^{-5} Pa).

EXAMPLE The A-weighted sound pressure level with time weighting S is L_{pAS}.

3.2
measurement surface
hypothetical surface of area S, enveloping the source on which the measurement points are located

NOTE The measurement surface terminates on one or more reflecting planes.

3.3
surface sound pressure level
$\overline{L_{pf}}$
energy average of the time-averaged sound pressure levels at all the microphone positions on the measurement surface, with the background noise correction K_1 and the environmental correction K_2 applied

NOTE It is expressed in decibels.

3.4
sound intensity
$\vec{I}$
time-averaged value of the product of the instantaneous sound pressure and the associated sound velocity at a point in a temporally stationary sound field

3.5
normal sound intensity level
L_{In}
ten times the logarithm to the base 10 of the ratio of the unsigned value of the normal component of the sound intensity (which is radiated by the sound source under test and determined in a direction perpendicular to the measurement surface) to the reference sound intensity

NOTE 1 It is expressed in decibels.

NOTE 2 The reference sound intensity is 10^{-12} Wm^{-2}.

3.6
sound power level
L_W
ten times the logarithm to the base 10 of the ratio of the sound power radiated by the sound source under test to the reference sound power

NOTE 1 It is expressed in decibels.

NOTE 2 The frequency weighting or the width of the frequency band used should be indicated. The reference sound power is 1 pW (10^{-12} W).

EXAMPLE The A-weighted sound power level is denoted L_{WA}.

3.7
emission sound pressure
p
time-averaged 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 as well as the effects of reflections from room surfaces other than the plane or planes permitted for the purpose of the test

NOTE It is expressed in pascals.

3.8
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 60651

NOTE It is expressed in decibels. The reference sound pressure is 20 µPa.

EXAMPLES The A-weighted emission sound pressure level with time weighting F is denoted L_{pAF}. The C-weighted peak emission sound pressure level is denoted $L_{pC,peak}$.

3.9
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

NOTE 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.

3.10
measured noise emission value
L
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

NOTE 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
declared single-number noise emission value
L_d
sum of the measured noise emission value, L, and the associated uncertainty, K, rounded to the nearest decibel:

$$L_d = L + K$$

3.12
declared dual-number noise emission value
L and K
measured noise emission value L, and its associated uncertainty K, rounded to the nearest decibel

4 Description of machinery family

This International Standard is applicable to self-standing rotating electrical machines, i.e. motors and generators (d.c. and a.c machines), without any limitation on the output or voltage, and with any linear dimensions.

Families of devices covered by this International Standard include rotating electrical machines to be fed by the following possibilities:

— a network (sinusoidal supply) whenever specially designed for that purpose;

— an associated converter.

In the case of supply by an converter, the noise radiated by the converter is excluded from the scope of this International Standard; only the effect of non-sinusoidal voltage and current within the machine is to be taken into account.

Auxiliary components required for the operation of the machine (e.g. oil pumps or cooling ventilators) should be included when integrated with the machine. When these components are separately mounted, they shall not be included as part of the machine under test.

5 Sound power determination

5.1 General

The sound power radiated by rotating electrical machines shall be determined on the basis of one of the following basic standards:

— accuracy grade 1: ISO 3741, ISO 3745, ISO 9614-1;

— accuracy grade 2: ISO 3743-1, ISO 3743-2, ISO 3744, ISO 3747, ISO 9614-1, ISO 9614-2.

Methods of engineering grade (grade 2) are to be preferred.

Furthermore, survey methods may also be used if it has been proved that no method with better accuracy is practical:

— accuracy grade 3: ISO 3746, ISO 9614-1, ISO 9614-2.

5.2 Guidelines for the selection of the most appropriate basic standard

The usable basic standards are mainly distinguished by the following:

— different environmental conditions;

— different requirements with respect to the background noise levels related to the noise level of the machine under test;

— different grades of accuracy;

— different quantities to be measured: sound pressure or sound intensity.

NOTE Detailed guidelines for the selection of the most appropriate basic standards are given in ISO 3740.

The sound intensity measurement method has the following advantages as compared to the sound pressure measurement method.

a) Determination of the correct sound power will be possible regardless of whether the measurement surface lies within or outside the near field.

b) Determination of the correct sound power will be possible in the presence of noise fields where the sound pressure method gives results which are so wrong that they would be no longer conform to sound pressure measurement standards.

c) It allows a better grade of accuracy for the sound power determination especially under the worst environmental conditions (and therefore allows determination of the sound power level of machines in the presence of noisy loading machines).

A description of the fields of application of the main basic standards is given in Table 1, supplemented by Figure 1. A more precise distinction of these standards is shown in annex A.

Table 1 — Sound power determination procedures and relations to their fields of application

International Standard	Environment	Background noise levels	Grade of accuracy	Quantity to be measured
ISO 3741	Special measurement room, "reverberant room"	Very low background noise levels	grade 1	Sound pressure
ISO 3743-1	High reverberant ordinary room	Low background noise level	grade 2	Sound pressure
ISO 3743-2	Special measurement room	Low background noise level	grade 2	Sound pressure
ISO 3744	*In situ*, but with limited environmental reflections	Low background noise levels	grade 2	Sound pressure
ISO 3745	Special measurement room, "anechoic, semi-anechoic room"	Very low back-ground noise levels	grade 1	Sound pressure
ISO 3746	*In situ*, less limited environmental reflections	Less limited back-ground noise levels	grade 3	Sound pressure
ISO 3747	*In situ*, approximately reverberant conditions	Low background noise levels	grade 2	Sound pressure
ISO 9614-1	*In situ*, practically no limitations	Practically no limitation for stationary background noise levels	grades 1, 2 and 3	Normal component of sound intensity
ISO 9614-2	*In situ*, practically no limitations	Practically no limitation for stationary background noise levels	grades 2 and 3	Normal component of sound intensity