INTERNATIONAL STANDARD

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Acoustics — Measurement of airborne noise emitted by information technology and telecommunications equipment

Acoustique — Mesurage du bruit aérien émis par les équipements de technologies de l'information et de télécommunications

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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 7779 was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 1, *Noise*.

This second edition of ISO 7779 cancels and replaces the first edition (ISO 7779:1988), which has been technically revised.

Annexes A, B and C form a normative part of this International Standard. Annexes D and E are for information only.

Introduction

This International Standard specifies methods for the measurement of airborne noise emitted by information technology and telecommunications equipment. Hitherto, a wide variety of methods have been applied by individual manufacturers and users to satisfy particular equipment or application needs. These diverse practices have, in many cases, made comparison of noise emission difficult. This International Standard simplifies such comparisons and is the basis for the declaration of the noise emission levels of information technology and telecommunications equipment.

In order to ensure accuracy, validity and acceptability, this International Standard is based on the basic International Standards for determining the sound power level and for determining the emission sound pressure level at the operator position(s) and bystander position(s). Furthermore, implementation is simplified by conformance with these International Standards.

In many cases free-field conditions over a reflecting plane are realised by hemi-anechoic rooms. These rooms may be particularly useful during product design to locate and to improve individual contributing noise sources. Reverberation rooms may be more economical for production control and for obtaining sound power levels for noise emission declaration purposes.

The method for measuring the emission sound pressure level at the operator or bystander positions (based on ISO 11201) is specified in a separate clause, as this level is not considered to be primary noise emission declaration information. The measurements can, however, be carried out in conjunction with those for sound power determination in a free field over a reflecting plane.

For comparison of similar equipment, it is essential that the installation conditions and mode of operation are the same. In annex C these parameters are standardized for many categories of equipment.

This International Standard is based on ECMA-74. It was circulated for enquiry under the erroneous number ISO/DIS 14605 in 1993.

Acoustics — Measurement of airborne noise emitted by information technology and telecommunications equipment

1 Scope

This International Standard specifies procedures for measuring and reporting the noise emission of information technology and telecommunications equipment. This standard is considered part of a *noise test code* for this type of equipment, and is based on *basic noise emission standards* ISO 3741, ISO 3744, ISO 3745 and ISO 11201. The basic emission quantity is the A-weighted sound power level which may be used for comparing equipment of the same type but from different manufacturers, or for comparing different equipment.

Three basic noise emission standards for determining the sound power levels are specified in this International Standard in order to avoid undue restriction on existing facilities and experience. The first basic standard (ISO 3741) specifies comparison measurements in a reverberation room; the other two (ISO 3744 and ISO 3745) specify measurements in an essentially free field over a reflecting plane. Any one of these three basic noise emission standards may be selected and shall then be used exclusively according to this International Standard when determining sound power levels of a machine.

The A-weighted sound power level is supplemented by the A-weighted sound pressure level measured at the operator position(s) or the bystander positions, based on the *basic noise emission standard* ISO 11201. This sound pressure level is not a worker's immission rating level, but it may assist in identifying any potential problems that could cause annoyance, activity interference, or hearing damage to operators and bystanders.

Methods for determining whether the noise emission includes prominent discrete tones or is impulsive in character are specified in annexes D and E respectively.

This International Standard is suitable for type tests and provides methods for manufacturers and testing laboratories to obtain comparable results.

The methods specified in this International Standard allow the determination of noise emission levels for a unit tested individually.

The procedures may be applied to equipment which emits broad-band noise, narrow-band noise and noise which contains discrete-frequency components, or impulsive noise.

The sound power and sound pressure levels obtained may serve noise emission declaration and comparison purposes (see ISO 9296). They are not to be considered as installation noise immission levels; however they may be used for installation planning (see ECMA TR/27).

If sound power levels obtained are determined for a number of units of the same production series, they can be used to determine a statistical value for that production series (ISO 9296).

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 3744:1994, *Acoustics — Determination of sound power levels of noise sources using sound pressure — Engineering method in an essentially free-field condition over a reflecting plane.*

ISO 3745:1977, *Acoustics — Determination of sound power levels of noise sources — Precision methods for anechoic and semi-anechoic rooms.*

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

ISO 9295, *Acoustics — Measurement of high-frequency noise emitted by computer and business equipment.*

ISO 9296, *Acoustics — Declared noise emission values of computer and business equipment.*

ISO 10302, *Acoustics — Methods for the measurement of airborne noise emitted by small air-moving devices.*

ISO 11201:1995, *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 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 60651, *Sound level meters.*

IEC 60804, *Integrating-averaging sound level meters.*

IEC 60942, *Electroacoustics — Sound calibrators.*

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

ECMA TR/27:1995, *Method for the prediction of installation noise levels.*

3 Terms and definitions

For the purposes of this International Standard, the terms and definitions given in ISO 3744 and ISO 11201 and the following apply.

3.1 General definitions

3.1.1
basic noise emission standard (B-type standard)
procedure for determining the noise emission of machinery and equipment in such a way as to obtain reliable, reproducible results with a degree of accuracy

3.1.2
noise test code (C-type standard)
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

NOTE This International Standard together with ISO 9295 and ISO 9296 comprise the noise test code for Information Technology and Telecommunications Equipment.

3.1.3
information technology and telecommunications equipment
equipment for information processing, and components thereof, used in homes, offices, computer installations, telecommunications installations, or similar environments

3.1.4
functional unit
an entity of physical equipment, which has been allocated an identification number, capable of accomplishing a specified task

NOTE 1 A functional unit may be supported by a frame or frames and may be self-enclosed or designed to be attached to another device.

NOTE 2 An end-use enclosure in the form of a rack, populated with sub-assemblies or other functional units, may be considered a functional unit whether or not it has a separate identification number.

3.1.5
work station
place in the working environment where an operator performs work

NOTE 1 It does not refer to a computer "workstation", which denotes a high-performance, single-user computer.

NOTE 2 See ISO 11201:1995.

3.1.6
operating mode
condition in which the equipment being tested is performing its intended function(s)

3.1.7
idle mode
one or more steady-state conditions in which the equipment being tested is energized but is not operating

3.1.8
floor-standing equipment
functional unit which is intended to be installed on the floor with or without its own stand

3.1.9
table-top equipment
functional unit which has a complete enclosure and which is intended to be installed or used on a table, desk or separate stand

3.1.10
wall-mounted equipment
functional unit which is normally mounted against or in a wall and which does not have a stand of its own

3.1.11
sub-assembly
functional unit intended to be installed in another unit or assembled with other units in a single enclosure

NOTE The unit may or may not have its own enclosure and identification number.

3.1.12
rack-mounted equipment
one or more sub-assemblies installed in an end-use enclosure

3.1.13
standard test table
rigid table having a top surface of at least 0,5 m^2 and length of the top plane not less than 700 mm

NOTE The design for the standard test table is shown in annex A.

3.2 Acoustical definitions

3.2.1
sound pressure
p
square root of the time mean square sound pressure during the measurement duration

NOTE 1 Sound pressure is expressed in pascals.

NOTE 2 See ISO 3744:1994.

3.2.2
time-averaged sound pressure level
L_{pT}
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

NOTE 1 Time averaged sound pressure levels are expressed in decibels.

NOTE 2 See ISO 3744:1994.

3.2.3
emission sound pressure level
L_p
sound pressure level at a specified position near a noise source, measured with a particular time weighting and a particular frequency weighting, when the source is in operation under specified operating and mounting conditions on a reflecting plane surface, excluding the effects of background noise

NOTE Clause 8 specifies the method for measurement of emission sound pressure level.

3.2.4
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

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

NOTE 1 It is expressed in decibels.

NOTE 2 The emission sound pressure level is determined at the specified position(s) required by the test code (i.e. this International Standard, for this specific family of information technology and telecommunications equipment).

NOTE 3 See ISO 11201:1995.

3.2.5
A-weighted impulse sound pressure level
L_{pAI}
A-weighted sound pressure level determined with a sound level meter set for the I time-weighting characteristic (impulse)

NOTE It is expressed in decibels.

3.2.6
C-weighted peak sound pressure level
L_{pCpeak}
highest instantaneous value of the C-weighted sound pressure level determined over an operational cycle

3.2.7
sound power
W
rate per unit time at which airborne sound energy is radiated by a source

NOTE 1 It is expressed in watts.

NOTE 2 In this International Standard, it is the time-averaged value of the sound power during the measurement duration.

3.2.8
reference sound source
device which is intended for use as a stable source of sound, which has a known, calibrated broad-band sound power spectrum over the frequency range of interest and which conforms to ISO 6926

3.2.9
frequency range of interest
octave bands with centre frequencies from 125 Hz to 8 000 Hz

NOTE 1 Under special circumstances the frequency range may have to be extended; see 6.10.2 and Table 4.

NOTE 2 The 16 kHz octave band should be included if a preliminary investigation indicates that it may affect the A-weighted sound pressure or sound power levels. However, if the noise in the 16 kHz octave band contains discrete tones, then the 16 kHz octave band should not be included in the determination of the A-weighted levels. The range and centre frequencies of the octave bands are specified in ISO 266 [6]. See 6.10.2 and Table 4 for additional information.

NOTE 3 If the 16 kHz octave band is included in the measurements, the procedures of this International Standard may yield measurement uncertainties greater than those stated in 6.2, 7.2 and 8.2.

NOTE 4 For equipment which emits sound in the 16 kHz octave band, the procedures specified in ISO 9295 should be used; see 6.10.2 and Table 4.

4 Conformance requirements

Measurements are in conformance with this International Standard if they meet the following requirements.

a) The measurement procedures, the installation and the operating conditions specified by this International Standard are taken fully into account.

b) For the determination of sound power levels, one (and only one) of the methods specified in clause 6 or 7 is used.

c) For measurement of emission sound pressure level at the operator or bystander positions, the method specified in clause 8 is used.

5 Installation and operating conditions

5.1 Equipment installation

5.1.1 General

The equipment shall be installed according to its intended use. Installation conditions for many different categories of information technology and telecommunications equipment are specified in annex C; these shall be followed when noise emission declaration information is to be obtained. If the normal installation is unknown or if several possibilities exist, a representative condition shall be chosen and reported.

Care shall be taken to ensure that any electrical conduits, piping, air ducts or other auxiliary equipment connected to the equipment being tested do not radiate significant amounts of sound energy into the test room. If practicable, all auxiliary equipment necessary for the operation of the equipment shall be located outside the test room and the test room shall be free from all objects which may interfere with the measurements.

NOTE If the equipment is mounted near one or more reflecting planes, the sound power radiated by the equipment may depend upon its position and orientation. It may be of interest to determine the radiated sound power either for one particular equipment position and orientation or from the average value for several positions and orientations.

5.1.2 Floor-standing equipment

5.1.2.1 Requirements for reverberation rooms

Floor-standing equipment shall be located at least 1,5 m from any wall of the room and no major surfaces shall be parallel to a wall of the reverberation room.

5.1.2.2 Requirements for hemi-anechoic rooms

Floor-standing equipment shall be installed on the reflecting (hard) floor at a sufficient distance (more than 2 m, if possible) from the walls, unless otherwise specified in annex C.

The equipment shall be installed in a way which allows access to all sides except the reflecting plane(s). The dimensions of the reflecting plane(s) shall extend beyond the test object by at least the measurement distance. The requirements for reflection are specified in the note to 7.3.1. The plane(s) shall not contribute to the sound radiation due to their own vibrations.

5.1.2.3 Common requirements

If the equipment being tested consists of several frames bolted together in an installation or is too large for testing purposes, the frames may be measured separately. In such circumstances, additional covers may be required for the frames during the acoustical evaluation. These additional covers shall be acoustically comparable with the other covers on the equipment. If a unit is mechanically or acoustically coupled to another unit so that the noise emission levels of one are significantly influenced by the other, the equipment being tested shall, where practicable, include all units coupled together in this way.

Floor-standing equipment which is to be installed only in front of a wall shall be placed on a hard floor in front of a hard wall (see the note in 7.3.1). The distance from the wall shall be in accordance with the manufacturer's instructions or as specified in annex C. If such information is not available, the distance shall be 0,1 m.

5.1.3 Table-top equipment

5.1.3.1 Requirements for reverberation rooms

Table-top equipment shall be placed on the floor at least 1,5 m from any wall of the room unless a table or stand is required for operation according to annex C (e.g. printers which take paper from or stack paper on the floor). Such equipment shall be placed in the centre of the top plane of the standard test table (see annex A).

5.1.3.2 Requirements for hemi-anechoic rooms

Table-top equipment shall be placed on the floor unless a table or stand is required for operation according to annex C (e.g. printers which take paper from or stack paper on the floor). Such equipment shall be placed in the centre of the top plane of the standard test table (see annex A). In any case the measurement surface defined in 7.6 terminates on the floor.

5.1.4 Wall-mounted equipment

Wall mounted equipment shall be mounted on a wall of the reverberation room at least 1,5 m from any other reflecting surface, unless otherwise specified. Alternatively, if operation permits, the equipment may be laid with its mounting surface on the floor at least 1,5 m (more than 2 m, if possible, in hemi-anechoic rooms) from any wall of the room.

If the equipment is usually installed by being recessed into a wall or other structure, a representative structure shall be used for mounting during the measurements and described in the test report.

5.1.5 Rack-mounted equipment

Rack mounted equipment shall be placed in an enclosure which complies with the installation specifications for the equipment. The location of all units within the enclosure shall be described. The enclosure shall be tested as floor-standing or table-top equipment. Rack-mounted equipment which does not include, but requires the use of, air-moving equipment (i.e. cooling-fan assemblies) when in operation shall be tested with such equipment, as supplied or recommended by the manufacturer.

Rack-mounted equipment with more than one end-use enclosure may be tested and reported either as individual functional units or as a complete system.

5.1.6 Hand-held equipment

Hand held equipment shall be supported 0,1 m above the reflecting plane by vibration-isolating elements. The supports shall not interfere with the propagation of airborne sound.

5.1.7 Sub-assemblies

A sub-assembly shall be supported 0,25 m above the reflecting plane by vibration-isolating elements. The supports shall not interfere with the propagation of airborne sound.

5.2 Input voltage and frequency

The equipment shall be operated at its nominal rated voltage and the rated power line frequency.

Phase-to-phase voltage variations shall not exceed 5 %.

5.3 Equipment operation

During the acoustical measurements the equipment shall be operated in a manner typical of normal use.

Annex C specifies such conditions for many categories of equipment and shall be followed. However, if the specified conditions are clearly contrary to the objective of providing uniform conditions closely corresponding to the intended use of the product, then an additional mode or modes closely related to intended use shall be defined, tested and documented. Any subsequent declaration shall either:

— declare both values, indicating that one is based on annex C, and indicating that the other is declared by the manufacturer to be typical use for the intended application; or

— declare only the latter, indicating that it is not based on annex C, but is declared by the manufacturer to be typical use for the intended application.

The equipment shall be operated for a sufficient period of time before proceeding with the acoustical test to allow temperature and other pertinent conditions to stabilize.

The noise shall be measured with the equipment in both idle and the operating modes. If the equipment is designed for performing different functions, such as manually typing and automatic printing of stored information, or for printing in different print qualities, unless otherwise specified in annex C, the noise of each individual mode shall be determined and recorded. For equipment which, in normal functional operation, performs several operating modes, such as document insertion, reading, encoding, printing and document eject, and for which a typical operation cycle has not been defined in annex C, such a typical cycle shall be defined for the measurements and described in the test report.

In the case of rack-mounted equipment or other equipment in which the operation of several functional units is possible, the units intended to operate together shall be operated during the test; all other units shall be in idle mode. In the absence of operational guidelines provided by the manufacturer, the unit producing the highest A-weighted sound power level shall be operated together with those other units required for its operation. All other units shall be in the idle mode. However, if the operation of the unit which has the highest A-weighted sound power level occurs only once and less than 5 % of the time during a typical 8-h working day, the unit producing the next highest A-weighted sound power level shall be operated together with those other units required for its operation; all other units shall be in the idle mode. If none of the operations occurs for more than 5 % of the time of a typical 8-h

working day, then the afore-mentioned conditions with the unit with the highest A-weighted sound power level shall apply.

Some equipment does not operate continuously because of its mechanical design or its mode of operation under program control. Long periods may occur during which the equipment is idle. The operating mode measurements shall not include these idling periods. If it is not possible to operate the equipment continuously during the acoustical evaluation, the time interval during which measurements have to be made shall be described in the test plan, equipment specifications or other documentation.

Some equipment has operational cycles that are too short to allow reliable determination of the noise emissions. In such cases, a typical cycle shall be repeated several times.

If the equipment being tested produces attention signals, such as tones or bells, such intermittent sound shall not be included in an operating mode. During the acoustical evaluation in the operating mode(s), such attention signals shall be inoperative or, if this is not possible, they shall be set to a minimum.

NOTE For certain applications, such signals as well as the maximum response of feedback signals of keyboards may be of interest. Such measurements may be made, but they are not part of the methods specified in this International Standard.

6 Method for determining sound power levels of equipment in reverberation rooms

6.1 General

The method specified in this clause provides a comparison procedure for determining the sound power levels produced by information technology and telecommunications equipment in a reverberation room, according to the comparison method specified in ISO 3741.

It is strongly recommended that the room be qualified in accordance with ISO 3741:1999, annex A. This avoids the need to determine the number of microphone positions and equipment locations each time equipment is measured.

6.2 Measurement uncertainty

Measurements carried out in accordance with this method yield standard deviations which are equal to, or less than, those given in Table 1.

Table 1 — Uncertainty in determining sound power levels in a reverberation room

Octave band centre frequencies Hz	One-third octave band centre frequencies Hz	Standard deviation dB
125	100 to 160	3,0
250	200 to 315	2,0
500 to 4 000	400 to 5 000	1,5
8 000	6 300 to 10 000	3,0

NOTE 1 For most information technology and telecommunications equipment, the A-weighted sound power level is determined by the sound power levels in the 250 Hz to 4 000 Hz octave bands. The A-weighted sound power level is determined with a standard deviation of approximately 1,5 dB. A larger standard deviation may result when the sound power levels in other bands determine the A-weighted level.

NOTE 2 The standard deviations given in Table 1 reflect the cumulative effects of all causes of measurement uncertainty, including variations from laboratory to laboratory, but excluding variations in the sound power level from equipment to equipment or from test to test which may be caused, for example, by changes in the installation or operating conditions of the equipment. The reproducibility and repeatability of the test results for the same piece of equipment and the same measurement conditions may be considerably better (i.e. smaller standard deviations) than the uncertainties given in Table 1 indicate.

NOTE 3 If the method specified in this clause is used to compare the sound power levels of similar equipment that are omnidirectional and radiate broad-band noise, the uncertainty in this comparison yields a standard deviation which is less than that given in Table 1, provided that the measurements are carried out in the same environment.

6.3 Test environment

6.3.1 General

Guidelines specified in ISO 3741 for the design of the reverberation room, as applicable, shall be used. Criteria for room absorption and the procedure for room qualifications, specified in ISO 3741 shall be used.

ISO 3741 shall be followed with regard to the following:

a) test room volume;

b) level of background noise.

6.3.2 Meteorological conditions

The requirements of ISO 3741 shall be followed.

The following conditions are recommended:

a) barometric pressure: 86 kPa to 106 kPa;

b) temperature: within the range defined by the manufacturer for the equipment, if a range is defined; if no range is so defined by the manufacturer, the recommended range is 15 °C to 30 °C;

c) relative humidity: within the range defined by the manufacturer for the equipment, if a range is defined; for processing of paper and card media only, if no range is so defined by the manufacturer, the recommended range is 40 % to 70 %.

In addition, for equipment the sound pressure level of which varies with temperature, the room temperature during the measurement shall be 23 °C ± 2 °C.

6.4 Instrumentation

6.4.1 General

The requirements of 6.4 as well as the instrumentation requirements of ISO 3741 shall be followed.

Digital integration is the preferred method of averaging (see IEC 60804).

6.4.2 The microphone and its associated cable

The requirements of ISO 3741 shall be followed. In addition, the microphone and its associated cable shall be chosen so that their sensitivity does not change by more than 0,2 dB over the temperature range encountered during measurement. If the microphone is moved, care shall be exercised to avoid introducing acoustical or electrical noise (e.g. from gears, flexing cables, or sliding contacts) that could interfere with the measurements.

6.4.3 Frequency response of the instrumentation system

The requirements of ISO 3741 shall be followed.

6.4.4 Reference sound source

The reference sound source shall meet the requirements specified in ISO 6926 over the frequency range of interest.

6.4.5 Filter characteristics

The requirements of a class 1 instrument specified in IEC 61260 shall be followed.