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Acoustics — Measurement of sound pressure level from service equipment or activities in buildings — Engineering method

Acoustique — Mesurage du niveau de pression acoustique des équipements techniques ou activités dans les bâtiments — Méthode d'expertise

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Contents

Page

Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 2, *Building acoustics,* in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 126, *Acoustic properties of building elements and of buildings,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO 16032:2004), which has been technically revised.

The main changes are as follows:

— the terms and definitions have been revised;

— the procedure to detect and average spatial and temporal variations of the sound has been revised;

— measurements can be performed to verify sound levels either from a specific service equipment or an activity in the building, with operating conditions described in Annex B or by national guidelines if such exist for a specific type of service equipment, e.g. lifts;

— the title is updated to reflect that also sound from activities in the building can be measured according to this document, e.g. music sound from a restaurant or sports premises in the same building;

— measurements are performed in one–third–octave–bands;

— octave–band levels, without corrections for reverberation times or background noise may be measured or estimated from the one–third–octave–band levels and reported optionally, but they are not used to calculate the *A*-weighted and *C*-weighted sound pressure levels;

— standardization with respect to reverberation times applies to the 50 Hz to 5 000 Hz one–third–octave–bands;

— the frequency range used to calculate the *A*-weighted and *C*-weighted sound pressure levels can include one–third–octave bands from 25 Hz to 10 000 Hz but shall always include the bands 50 Hz to 5 000 Hz.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Many countries have building regulations intended to protect people from noise in their homes or workplaces. For the purpose of verification of compliance with such regulations, there is a need for a standardized method for the measurement of sound pressure levels from service equipment or activities in this building. This document specifies a procedure for such measurements, under specific operating conditions and operating cycles.

Acoustics — Measurement of sound pressure level from service equipment or activities in buildings — Engineering method

1 Scope

This document specifies an engineering method for the measurement of sound pressure levels in rooms from service equipment installed in the building.

This document covers specifically measurements of sound from sanitary installations, mechanical ventilation, heating and cooling service equipment, lifts, rubbish chutes, heating devices, blowers, pumps and other auxiliary service equipment, and motor driven car park doors. It can also be applied to measurements of sounds from other types of equipment or activities within the building, e.g. noise from sport facilities or restaurants.

The measurement of noise from external sound sources generating air-borne or ground-borne noise in the building are not included in this document.

The methods are suitable for rooms with volumes of approximately 300 m^3 or less for instance, in dwellings, hotels, schools, offices and hospitals.

The methods are not intended for measurements in large auditoria or concert halls.

2 Normative references

The following documents are referred to in the text in such a way that some or all their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 3382-2, *Acoustics — Measurement of room acoustic parameters — Part 2: Reverberation time in ordinary rooms*

IEC 60942, *Electroacoustics — Sound calibrators*

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

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

3 Terms and definitions

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
sound pressure level
L_i
ten times the logarithm to the base 10 of the ratio of the square of the sound pressure $p^2(t)$, to the square of the reference sound pressure p_0^2, measured in a position *i* with a particular time weighting and a particular frequency weighting, selected from those defined in IEC 61672-1

Note 1 to entry: L_i is expressed in decibels.

Note 2 to entry: The reference sound pressure is 20 µPa.

3.2
maximum sound pressure level with time weighting "*S*"
L_Smax
maximum sound pressure level measured in one–third–octave–bands determined with time weighting "*S*"

3.3
maximum sound pressure level with time weighting "*F*"
L_Fmax
maximum sound pressure level measured in one–third–octave–bands determined with time weighting "*F*"

3.4
equivalent continuous sound pressure level
L_eq
sound pressure level measured in one–third–octave–bands determined as a time average of the squared sound pressure during a stated integration time.

Note 1 to entry: The integration time, can be indicated with additional subscripts for the stated time interval or a stated duration, e.g. $L_{22\text{-}06}$ or L_30s or L_1h.

3.5
average sound pressure level *L*

ten times the logarithm to the base 10 of the ratio of the space and time average of the square of the sound pressure $p^2(t)$, to the square of the reference sound pressure p_0^2, the space average being taken over the entire room with the exception of those parts where the direct radiation of a sound source or the near field of the boundaries (walls, etc.) is of significant influence.

Note 1 to entry: L is expressed in decibels.

Note 2 to entry: The space average can be calculated from measurements of the sound pressure level L_i taken in *n* positions, including repetitions in one position, according to the Formula:

$$L = 10\,\lg\left[\frac{1}{n}\sum_{i=1}^{n} 10^{0,1 L_i}\right]\mathrm{dB}$$

Note 3 to entry: The measured sound pressure levels can be maximum time weighted levels L_Smax or L_Fmax, or equivalent continuous sound pressure levels L_eq.

3.6
reverberation time
T
duration required for the space-averaged sound energy density in an enclosure to decrease by 60 dB after the source emission has stopped

Note 1 to entry: The reverberation time is expressed in seconds.

Note 2 to entry: T can be evaluated based on a smaller dynamic range than 60 dB and extrapolated to a decay time of 60 dB. It is then labelled accordingly. Thus, if T is derived from the time at which the decay curve first reaches 5 dB and 25 dB below the initial level, it is labelled T_{20}. If decay values of 5 dB and 35 dB below the initial level are used, it is labelled T_{30}.

Note 3 to entry: T is measured in one–third–octave–bands from 50 Hz to 5 000 Hz.

3.7
standardized average sound pressure level
L_{nT}
average sound pressure level standardized to a reference reverberation time in one–third–octave–bands.

Note 1 to entry: To calculate the standardized quantity, the following formula applies:

$$L_{nT} = L - 10 \lg \left[\frac{T}{T_0} \right] \text{dB}$$

where

T is the measured reverberation time in seconds;

T_0 reference reverberation time 0,5 seconds.

3.8
normalized average sound pressure level
L_n
average sound pressure level normalized to an equivalent sound absorption area of 10 m^2 in one–third–octave–bands.

Note 1 to entry: To calculate the normalized quantity, the following formula applies:

$$L_n = L - 10 \lg \left[\frac{A_0\, T}{0{,}16\, V} \right] \text{dB}$$

where

A_0 is the reference equivalent sound absorption area in square meters; A_0 = 10 m^2;

T is the measured reverberation time in seconds;

V is the room volume in cubic meters;

0,16 has the unit (s/m).

3.9
***A*- weighted average sound pressure level**
L_A

$$L_A = 10 \lg \left[\sum_{k=1}^{m} 10^{0{,}1(L_k + A_k)} \right] \text{dB}$$

where

L_k is the average sound pressure level in each one–third–octave–band k;

A_k is the A-weighting correction of the one–third–octave–band k according to Annex A.

3.10
***C*- weighted average sound pressure level**
L_C

$$L_C = 10 \lg\left[\sum_{k=1}^{m} 10^{0,1(L_k + C_k)}\right] \text{dB}$$

where

L_k is the average sound pressure level in each one–third–octave–band k;

C_k is the C-weighting correction of the one–third–octave–band k according to Annex A.

4 Measurement equipment

Measurement of sound pressure levels according to this document shall be made with a one–third–octave–band analyzer that registers all sound pressure levels simultaneously.

The instrumentation system, including the microphone and cable, shall meet the requirements for a class 1 instrument specified in IEC 61672-1. The one–third–octave–band filters shall meet the requirements for class 1 filters specified in IEC 61260.

The residual noise of the used instrumentation shall be assessed, to be compared with the background levels according to Clause 8.

At the beginning and at the end of the measurements, the sensitivity of the instrumentation shall be verified with a sound calibrator class 1 according to IEC 60942. If the calibration measurement deviates from previous calibrations by more than 0,5 dB, do not use this equipment until the reason for this deviation has been clarified and appropriate actions have been taken to ensure a correct sensitivity within its dynamic range and frequency range.

It is recommended the microphone is mounted on a stable stand, e.g. a tripod, with an adjustable height.

NOTE The stand can be equipped with a resilient mount for the microphone to reduce background noise from vibrations of the floor.

5 Test method — General

The sound pressure level, L_i, from a service equipment or an activity in a building shall be measured in a fixed position i as the linear (unweighted) spectrum in one–third–octave–bands during a specified time period or operating cycle of the service equipment under test.

For the evaluation of a maximum sound pressure level with a time weighting "*S*" or "*F*", register the one–third–octave–band sound pressure levels at that time when the maximum *A*-weighted or *C*-weighted sound pressure level indicated by the instrument occurs in this microphone position.

The equivalent continuous sound pressure level, L_{eq}, shall be determined with an integration time determined according to the guidelines in Annex B.

The sound pressure levels taken in different positions are then used to calculate the average sound pressure levels in one–third–octave–bands.

These average sound pressure levels shall be corrected for background noise measured according to 6.6.

The background noise corrected average sound pressure levels in one–third–octave–bands shall be used to calculate the standardized average sound pressure levels or the normalized average sound pressure levels, unless national requirements only require uncorrected levels to be reported.

Finally, the *A*-weighted average sound pressure level and *C*-weighted average sound pressure level are calculated from the background noise corrected and standardized or normalized or uncorrected one–third–octave–band results.

The average sound pressure levels which can be reported according to this document are given in Table 1.

Table 1 — *A*- and *C*-weighted average sound pressure levels

	***A*-weighted average sound pressure level** (calculated from one–third octave band sound pressure levels)	***C*-weighted average sound pressure level** (calculated from one–third octave band sound pressure levels)
Maximum sound pressure level with time weighting "*S*"	L_{ASmax} $L_{ASmax,nT}$ $L_{ASmax,n}$	L_{CSmax} $L_{CSmax,nT}$ $L_{CSmax,n}$
Maximum sound pressure level with time weighting "*F*"	L_{AFmax} $L_{AFmax,nT}$ $L_{AFmax,n}$	L_{CFmax} $L_{CFmax,nT}$ $L_{CFmax,n}$
Equivalent continuous sound pressure level "eq"	L_{Aeq} $L_{Aeq,nT}$ $L_{Aeq,n}$	L_{Ceq} $L_{Ceq,nT}$ $L_{Ceq,n}$

The different weighted average sound pressure levels given in Table 1 are not comparable. Only measurement results obtained with the same time and frequency weightings shall be compared. When measurement results are compared with legal requirements it shall be ensured that both refer to the same quantity. Thus, the notation in Table 1 shall be used when reporting measurement results.

Sound pressure levels measured in octave–bands or estimated from the one–third–octave–band results can be presented optionally, without correction for background noise and without standardization or normalization.

6 Measurement procedure

6.1 General

The sound pressure level shall be determined for a specified operating condition and operating cycle of a service equipment or a given time frame for an activity in the same building.

NOTE 1 Sounds in a room from external sources of noise can be measured according to ISO 1996–2.

NOTE 2 Background sounds in large spaces or in rooms with highly sound absorbing surfaces, e.g. an office landscape, can be measured according to ISO 3382–3.

Operating conditions and operating cycles are given in Annex B.

Special care shall be taken to ensure that operating conditions of automated service equipment are fulfilled, either by supervised operation of the source or by some kind of additional measurement of the source itself, e.g. with an accelerometer.

Windows and doors shall be closed during the measurements, but air inlets shall be in their normal position.

It is recommended the operator performing the test stays outside the room during the measurement to ensure the background noise is unaffected by the operator. A microphone stand can then be used according to Clause 4.

NOTE 3 It is often efficient to listen to the microphone signal in headphones to ensure no background sound affects the measurement, or to record and playback this signal after the measurement. See Clause 8.

NOTE 4 In some situations, it can be advantageous that the operator is present in the room to listen for intermittent background noise.