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

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

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 16032 was prepared by the European Committee for Standardization (CEN) in collaboration with Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 2, *Building acoustics*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

Throughout the text of this document, read "...this European Standard..." to mean "...this International Standard...".

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Foreword

This document (EN ISO 16032:2004) has been prepared by Technical Committee CEN/TC 126 “Acoustic properties of building products and of buildings”, the secretariat of which is held by AFNOR, in collaboration with Technical Committee ISO/TC 43 “Acoustics”.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by March 2005, and conflicting national standards shall be withdrawn at the latest by March 2005.

This document includes a Bibliography.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

Introduction

This document specifies the engineering method for the measurement of sound pressure level from service equipment in buildings. For use of this document measurements are performed under specified operation conditions and operating cycles. Such conditions are given in Annex B.

The operating conditions and operating cycles given in Annex B are only used if they are not opposed to national requirements and regulations.

1 Scope

This document specifies methods for measuring the sound pressure level from service equipment in buildings installed to building structures. This document covers specifically measurements of sanitary installations, mechanical ventilation, heating and cooling service equipment, lifts, rubbish chutes, boilers, blowers, pumps and other auxiliary service equipment, and motor driven car park doors, but can also be applied to other equipment attached to or installed in buildings.

The methods are suitable for rooms with volumes of approximately 300 m^3 or less in e.g. dwellings, hotels, schools, offices and hospitals. The standard is not in general intended for measurements in large auditoria and concert halls. However, the operating conditions and operating cycles in Annex B can be used in such cases.

The service equipment sound pressure level is determined as the maximum A- weighted and optionally C- weighted sound pressure level occurring during a specified operation cycle of the service equipment under test, or as the equivalent continuous sound pressure level determined with a specified integration time. A-weighted and C- weighted values are calculated from octave-band measurements.

2 Normative references

The following referenced documents are indispensable for the application 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.

EN 60942, *Electroacoustics — Sound calibrators (IEC 60942:2003).*

EN 61260, *Electroacoustics — Octave-band and fractional-octave-band filters (IEC 61260:1995).*

EN 61672-1, *Electroacoustics - Sound level meters - Part 1: Specifications (IEC 61672-1:2002).*

EN 61672-2, *Electroacoustics - Sound level meters - Part 2: Pattern evaluation tests (IEC 61672-2:2003).*

EN ISO 3382, *Acoustics - Measurement of the reverberation time of rooms with reference to other acoustical parameters (ISO 3382:1997).*

3 Terms and definitions

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

3.1
sound pressure level
L
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 with a particular time weighting and a particular frequency weighting, selected from those defined in EN 61672-1. It is expressed in decibels. The reference sound pressure is 20 μPa

3.2
average sound pressure level
$\overline{L}$

$$\overline{L} = 10 \lg \left(\frac{\sum_{i=1}^{n} 10^{0,1 \times L_i}}{n} \right) \text{ dB} \quad (1)$$

where

L_i is the sound pressure level at different microphone positions, in decibels, to be averaged

3.3
***A*- weighted sound pressure level calculated from octave-band values in the frequency range 63 Hz to 8 000 Hz**
L_A

$$L_A = 10 \lg \sum_{i=1}^{n} 10^{0,1(L_i + A_i)} \text{ dB} \quad (2)$$

where

L_i is the sound pressure level in octave-band i, and A_i is the A-weighting correction for octave-band i (see Annex A). The value of L_i depends on the measurements, but can be all the parameters of 3.6

3.4
***C*- weighted sound pressure level calculated from octave-band values in the frequency range 31,5 Hz to 8 000 Hz**
L_C

$$L_C = 10 \lg \sum_{i=1}^{n} 10^{0,1(L_i + C_i)} \text{ dB} \quad (3)$$

where

L_i is the sound pressure level in octave-band i, and C_i is the C-weighting correction for octave-band i (see Annex A). The value of L_i depends on the measurements, but can be all the parameters of 3.6

3.5
sound exposure level
L_E
the sound exposure level of a sound event is given by the formula:

$$L_E = 10 \lg \frac{1}{t_o} \int_{t_1}^{t_2} \frac{p^2(t)}{p_o^2} \mathrm{d}t \quad \mathrm{dB} \tag{4}$$

where

$p(t)$ is the instantaneous sound pressure in Pascals;

$t_2 - t_1$ is a stated time interval long enough to encompass all significant sound of a stated event, in seconds;

p_o is the reference sound pressure (20 μPa);

t_o is the reference duration (t_o = 1 s)

3.6
service equipment sound pressure level in octave-bands in the frequency range 31,5 Hz to 8 000 Hz
in the following subclauses 3.6.1 to 3.6.9 are defined the octave-band values which can be measured according to this document. See also Clause 5, Table 1.

3.6.1
$L_{S\,max}$
maximum sound pressure level in octave-bands determined with time weighting "*S*"

3.6.2
$L_{S\,max,\,nT}$
maximum sound pressure level in octave-bands determined with time weighting "*S*" and standardized to a reverberation time of 0,5 s (3.8, equation (5))

3.6.3
$L_{S\,max,\,n}$
maximum sound pressure level in octave-bands determined with time weighting "*S*" and normalized to an equivalent sound absorption area of 10 m^2 (3.8, equation (6))

3.6.4
$L_{F\,max}$
maximum sound pressure level in octave-bands determined with time weighting "*F*"

3.6.5
$L_{F\,max,\,nT}$
maximum sound pressure level in octave-bands determined with time weighting "*F*" and standardized to a reverberation time of 0,5 s (3.8, equation (5))

3.6.6
$L_{F\,max,\,n}$
maximum sound pressure level in octave-bands determined with time weighting "*F*" and normalized to an equivalent sound absorption area of 10 m^2 (3.8, equation (6))

3.6.7
L_{eq}
equivalent continuous sound pressure level in octave-bands

3.6.8
$L_{eq,\,nT}$
equivalent continuous sound pressure level in octave-bands standardized to a reverberation time of 0,5 s (3.8, equation (5))

3.6.9
$L_{eq,\,n}$
equivalent continuous sound pressure level in octave-bands normalized to an equivalent sound absorption area of 10 m^2 (3.8, equation (6))

3.7
reverberation time
T
time that would be required for the sound pressure level to decrease by 60 dB after the sound source has stopped. It is expressed in seconds

3.8
standardized/normalized sound pressure level
the measured sound pressure levels in octave-bands can be standardized to a reverberation time of 0,5 s or normalized to an equivalent sound absorption area of 10 m^2. The equations (5) and (6), respectively, are used

$$L_{nT} = L - 10 \lg \frac{T}{T_0} \quad \text{dB} \tag{5}$$

where

L can be $L_{S\,max}$, $L_{F\,max}$, L_{eq};

T is the measured reverberation time in seconds;

T_0 = 0,5 s

$$L_n = L - 10 \lg \frac{A_0\, T}{0{,}16 \quad V} \tag{6}$$

where

L can be $L_{S\,max}$, $L_{F\,max}$, L_{eq};

T is the measured reverberation time in seconds;

V is the room volume in cubic metres;

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

0,16 has the unit $\left[\frac{s}{m}\right]$.

4 Instrumentation

Measurement of the maximum sound pressure level according to this document implies the use of an octave-band real-time frequency analyser. The analyser shall be able to read values of all octave-band sound pressure levels at the time when the maximum A-weighted or C-weighted sound pressure level occurs (during a specified operating cycle of the service equipment under test).

NOTE It is important to ensure that the equipment used according to this document fulfils the requirement stated above. The most common analysers used for building acoustic measurements include this feature.

The instrumentation system, including the microphone and cable, shall meet the requirements for a class 1 instrument specified in EN 61672-1.

For measurements in octave-bands, the filters shall meet the requirements for class 1 filters specified in EN 61260.

At the beginning and at the end of the measurements verify the sensitivity of the instrumentation with a sound calibrator class 1 according to EN 60942.

5 Test method – General

The service equipment sound pressure level is measured in octave-bands in the frequency range 31,5 Hz/63 Hz to 8 000 Hz as the linear (unweighted) spectrum corresponding to the maximum A-weighted or C-weighted sound pressure level occurring during a specified operating cycle of the service equipment under test. In order to measure the service equipment sound pressure level a parallel time dependent recording of the A-weighted or C-weighted sound pressure level and the sound pressure levels in octave-bands shall be made (multispectral recording). For evaluation of the equipment sound pressure level take the octave band spectrum at that time when the maximum A-weighted or C-weighted sound pressure level occurs. Time weighting "S" or "F" shall be used. Alternatively or additionally the equivalent continuous sound pressure level can be determined with a specified integration time.

The octave-band results are corrected for background noise and - if required - standardized to a reverberation time of 0,5 s or normalized to an equivalent sound absorption area of 10 m^2. Finally the A-weighted and C-weighted sound pressure levels are calculated from the corrected octave-band results.

A-weighted and C-weighted values shall always be calculated from octave-band results, also in situations where standardization or normalization is not carried out.

The single number quantities which can be determined according to this document are given in Table 1 (calculated from the octave-band values defined in 3.6.1 to 3.6.9). The notation in the table shall be used when reporting measurement results. The different quantities can be combined according to e.g. requirements in national building code regulations.