BRITISH STANDARD

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

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ICS 17.140.20; 91.140.01

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National foreword

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The UK participation in its preparation was entrusted by Technical Committee EH/1, Acoustics, to Subcommittee EH/1/6, Building acoustics, which has the responsibility to:

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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of an identical text or by endorsement, at the latest by March 2005, and conflicting national standards shall be withdrawn at the latest by March 2005.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.

Table 1 — Single number quantities

	***A*-weighted value (calculated from octave-band values in the frequency range 63 Hz to 8 000 Hz)**	***C*-weighted value (calculated from octave-band values in the frequency range 31,5 Hz to 8 000 Hz)**
Maximum sound pressure level, time weighting "*S*"	$L_{\mathrm{AS\ max}}$ $L_{\mathrm{AS\ max,\ nT}}$ $L_{\mathrm{AS\ max,\ n}}$	$L_{\mathrm{CS\ max}}$ $L_{\mathrm{CS\ max,\ nT}}$ [a] $L_{\mathrm{CS\ max,\ n}}$ [a]
Maximum sound pressure level, time weighting "*F*"	$L_{\mathrm{AF\ max}}$ $L_{\mathrm{AF\ max,\ nT}}$ $L_{\mathrm{AF\ max,\ n}}$	$L_{\mathrm{CF\ max}}$ $L_{\mathrm{CF\ max,\ nT}}$ [a] $L_{\mathrm{CF\ max,\ n}}$ [a]
Equivalent continuous sound pressure level	L_{Aeq} $L_{\mathrm{Aeq,\ nT}}$ $L_{\mathrm{Aeq,\ n}}$	L_{ceq} $L_{\mathrm{Ceq,\ nT}}$ [a] $L_{\mathrm{Ceq,\ n}}$ [a]
[a] See 6.7.		

The different single number quantities given in Table 1 are not comparable. Only measurement results obtained with the same method shall be compared. When measurement results are compared with legal requirements it shall be ensured that both refer to the same quantity.

If the sound contains clearly audible tonal components, this shall be stated in the report.

Windows and doors shall be closed during the measurements. The person performing the test should stay outside the room.

6 Measurement procedure

6.1 General

The service equipment sound pressure level is to be determined for a specified operating condition and operating cycle. Operating conditions and operating cycles are given in Annex B. They shall only be used if they are not opposed to national requirements and regulations.

According to this document the sound pressure level is measured in three microphone positions, one position in a corner of the room and two positions in the reverberant sound field.

The service equipment sound pressure level is measured using the following procedure (step 6.2 to 6.9):

6.2 Selection of the corner position for the microphone

To select the corner position (position no. 1), search for the corner of the room with the highest *C*-weighted sound pressure level. The measurement shall be carried out as the maximum sound pressure level with time weighting "*S*" or "*F*", or as the equivalent continuous sound pressure level. The quantity used for selection of the corner position shall be the same as the one chosen to be the final result, but without any corrections. Use the chosen operating condition and operating cycle.

The microphone position shall, preferably, at each corner be 0,5 m from the walls and 0,5 m above the floor. If in a corner this is not feasible due to protruding furniture, obstacles etc., increase the height to 1,0 m or if necessary to

1,5 m above the floor. The measurement height shall be the same for all the corners. Move away small protruding items that do not affect the sound field, if necessary. The microphone position shall be at least 0,2 m away from any obstacle. If the sound pressure level in a corner is dominated by direct sound from a source in the room - e.g. a ventilation outlet - this corner shall be left out when choosing the corner position.

For selection of the corner position, the C-weighted equivalent continuous sound pressure level can be measured directly e.g. by use of a hand held integrating sound level meter. Calculation from octave-bands is not required. The selection procedure for the corner position stated above shall be used prior to all measurements according to this document.

6.3 Selection of the reverberant field positions of the microphone

Choose two additional positions (nos. 2 and 3) in the reverberant field of the room. Whenever practicable, the minimum distance between each of the positions 1 (the corner position), 2 and 3 shall be at least 1,5 m. The distance to any sound source in the room shall be at least 1,5 m. The distance between positions 2 and 3 and any room surface shall be at least 0,75 m. In small rooms where this requirement cannot be fulfilled, the distance can be decreased to 0,5 m. The height above floor level shall be at least 0,5 m and not more than 1,5 m.

6.4 Determination of the number of measurements at each microphone position

6.4.1 For measurement of the equivalent continuous sound pressure level

In the corner position, make two consecutive measurements of the A-weighted equivalent continuous sound pressure level L_{Aeq}. For this purpose the chosen operating conditions and operating cycles shall be used (as for choosing the corner position in 6.2, a hand held integrating sound level meter can be used). If the difference between the results of the two consecutive measurements is equal to or less than 1,0 dB, then one measurement in each of the microphone positions 1, 2 and 3 is sufficient. If the difference exceeds 1,0 dB, the number of measurements at each microphone position shall be equal to the difference in level (rounded up to nearest whole value; a difference of e.g. 3 dB results in three measurements in each position).

6.4.2 For measurement of the maximum sound pressure level

If the maximum sound pressure levels are to be measured, use the A-weighted maximum sound pressure level with a similar procedure to 6.4.1 to determine the number of measurements to be made at each position. The chosen operating conditions and operating cycles shall be used. However, especially for sound events of short duration, it is allowed to use the sound exposure level L_{AE} instead of the maximum sound pressure level when determining the required number of measurements at each microphone position.

6.5 Averaging the sound pressure level

Use the relevant operating conditions and operating cycles as stated in Annex B. Measure the linear (unweighted) octave-band levels at each of the three microphone positions the number of times determined according to 6.4. Calculate for each octave-band the average level of all the measurements (see 3.2). The octave-band levels shall be rounded to one decimal place.

6.6 Correction for background noise

Determine the octave-band background noise level and correct the measured service equipment sound pressure level according to Clause 8.

6.7 Standardization or normalization of octave band results

If required, the octave-band results corrected for background noise can be standardized or normalized to reference absorption properties of the room. Measure the reverberation time according to Clause 7, and make the standardization by use of equation 5 in definition 3.8, and the normalization according to equation 6 in definition 3.8.

Because of severe problems by determining the reverberation time for the 31,5 Hz octave-band, the measured sound pressure level in this band shall not be standardized or normalized. If the 31,5 Hz octave-band contributes to the C-weighted sound pressure level, this shall be mentioned in the report.

Background noise problems may be present when measuring the reverberation time in the 8 000 Hz octave-band. If this problem occurs it is allowed not to correct the 8 000 Hz octave-band sound pressure level of the service equipment, if this level is at least 15 dB below the octave-band in the spectrum with the highest level.

6.8 Calculation of A- and C-weighted values

Using either the results achieved in 6.6, or alternatively 6.7, determine the A-weighted level from the octave-band levels in the frequency range 63 Hz to 8 000 Hz according to definition 3.3. Determine the C-weighted level from the octave-band levels in the frequency range 31,5 Hz to 8 000 Hz according to definition 3.4. The A-weighted and C-weighted results shall be rounded to an integer.

6.9 Sound sources present in the room (additional measurements)

In situations where sound sources are present in the room - e.g. a ventilation outlet in the wall or in the ceiling - an additional measurement position shall be used for each source. For noise sources in the wall a position is chosen 1 m in front of the source and 1,5 m above floor level. For a noise source in the ceiling, the position shall be 1,5 m above floor level, directly below the source. Additional measurement result(s) shall not be standardized or normalized. They shall be reported separately and shall not be included in the average of the microphone positions 1, 2 and 3.

7 Measurement of reverberation time

The reverberation time is measured in octave-bands in the frequency range 63 Hz to 8 000 Hz according to EN ISO 3382.

8 Correction for background noise

The background noise measurement shall be made just before or after the service equipment sound pressure level measurement.

The background noise shall be determined in octave-bands as the equivalent continuous sound pressure level over a period of approximately 30 s. The same microphone positions as used for the service equipment sound pressure level measurements shall be used. Calculate the energetic average of the background sound pressure level in the three positions before correction of the service equipment sound pressure level. This method is only suitable provided that the background noise is approximately constant in time.

If the background noise level is 10 dB or more below the sound pressure level of the service equipment, no correction shall be made.

If the background noise level is 4 dB to 10 dB below the sound pressure level of the service equipment, the measured sound pressure level shall be corrected using the following equations (7) to (9):

$$L = L_1 - K \text{ dB} \tag{7}$$

$$K = -10 \lg \left(1 - 10^{-0,1 \times \Delta L}\right) \text{ dB} \tag{8}$$

$$\Delta L = L_1 - L_2 \text{ dB} \tag{9}$$

where

L is the corrected sound pressure level, in decibels;

L_1 is the measured octave-band sound pressure level from the service equipment including background noise, in decibels;

L_2 is the octave-band background sound pressure level, in decibels;

K is the octave-band correction value, in decibels.

A difference of 4 dB corresponds to a correction value of 2,2 dB. If the difference is less than 4 dB the correction value shall be limited to 2,2 dB, and in the report it shall be stated that the measurement result is influenced by background noise. For comparison with noise limits, the measuring result can be considered as the upper limit of the service equipment sound pressure level. It shall be stated whether or not the background noise is influencing the A-weighted and C-weighted service equipment sound pressure level.

NOTE If the background noise is varying with time - e.g. caused by road traffic - a reliable correction cannot be made. However, the maximum sound pressure levels of the background noise could be determined over a period of 10 min to 15 min in one of the microphone positions. If the maximum level is 10 dB or more below the service equipment sound pressure level the result can be regarded valid without correction. It could also be helpful to monitor the time signal to select the appropriate time slot for measurements and check the validity in all relevant octave-bands.

9 Precision

In Table 2 are given estimates of the standard deviation associated with reproducibility. The values are estimated based on a limited number of measurements on sound sources constant in time [1]. Fluctuations of the sound pressure level of the source will increase the measurement uncertainty, particularly for maximum sound pressure levels.

Table 2 — Estimated standard deviation associated with reproducibility

Octave-band centre frequencies Hz	Standard deviation of reproducibility dB
31,5	1,5
63	1,5
125	1,5
250	1,5
500	1,2
1 000 to 8 000	1,0
A-weighted	0,8[a]
C-weighted	1,1[a]
[a] Valid for a constant sound with a relatively flat sound spectrum in the frequency range 100 Hz to 8 000 Hz and with a difference between service equipment sound pressure level and background noise level of at least 10 dB.	

Fluctuations of the sound pressure level of the source will increase the measurement uncertainty, particularly for maximum sound pressure levels.

10 Test report

The test report shall include the following information:

a) the name and address of the test laboratory;

b) the name and address of the organization or the person who ordered the test;

c) the date of the test;

d) a reference to this document;

e) an identification of the room where the service equipment sound pressure level has been measured;

f) a description of relevant building constructions;

g) an exact description of the equipment tested;

h) detailed information about operating conditions and operating cycles (e.g. period of a cycle) if they deviate from Annex B;

i) for water installations:

   1) normative:

      — the position of stop cocks;

      — a description of all relevant aspects of the water installation and the operating conditions;

   2) optional:

      — the flow pressure (cold and warm water system);

      — the flow rate/refilling time for cisterns;

      — the manufacture and destination of the valve or device;

      — the sound class and flow rate for valves or devices classified according to EN ISO 3822-1;

      — the flow rate, static pressure and flow pressure of the valves during the test;

      — the volume and filling time of the flush tank (if possible);

j) the positions of the microphones;

k) the time constant for L_{pmax};

l) the test result (the notation stated in Table 1 shall be used). For A-weighted and/or C-weighted values the corresponding weighted octave-band spectrum shall always be given (corrected values). For A-weighted values the spectrum shall be given in the frequency range 63 Hz to 8 000 Hz, and for C-weighted values the spectrum shall be given for the frequency range 31,5 Hz to 8 000 Hz. If the sound contains clearly audible tonal components this shall be stated in the report;

m) the reverberation time in octave-bands if determined;

n) background noise in octave-bands;

o) instrumentation used, with the date of the latest verification by certified laboratory;

p) any deviation from the test method.

q) the date of the last verification of the compliance with the relevant European Standards shall be recorded.

Annex A
(normative)

A-weighting and *C*-weighting correction value

Table A.1 — *A*- weighting and *C*-weighting correction values

	31,5 (Hz)	63 (Hz)	125 (Hz)	250 (Hz)	500 (Hz)	1 000 (Hz)	2 000 (Hz)	4 000 (Hz)	8 000 (Hz)
A **(dB)**	-	- 26,2	- 16,1	- 8,6	- 3,2	0	+ 1,2	+ 1,0	- 1,1
C **(dB)**	- 3,0	- 0,8	- 0,2	0	0	0	- 0,2	- 0,8	- 3,0

Annex B
(normative)

Operating conditions and operating cycles for measuring the maximum sound pressure level and the equivalent continuous sound pressure level

B.1 General principles

B.1.1 General

In the following, operating conditions and operating cycles are given for the most common service equipment in buildings. They shall only be used if they are not opposed to national requirements and regulations. However, service equipment not mentioned in the following can be measured according to the principles stated in this document. The chosen operating conditions and operating cycle shall then be reported in detail.

B.1.2 Maximum sound pressure level (L_{max})

In this Annex L_{max} is used as a general symbol for the respective quantities given in Table 1. The basic principle for measuring the maximum sound pressure level is that the service equipment under test during the measurement is operated - automatically or manually - within the limits of normal practical use. For service equipment with a constant sound level the maximum sound pressure level is determined during a measurement period of approximately 30 s. For service equipment with sound varying with time the maximum sound pressure level is determined for a typical operation, e.g. during the period of opening and closing a water tap.

B.1.3 Equivalent continuous sound pressure level (L_{eq})

In this Annex L_{eq} is used as a general symbol for the respective quantities given in Table 1. The basic principle for measuring the equivalent continuous sound pressure level is that the integration time corresponds to a typical operating cycle of the service equipment under test.

For water taps the equivalent continuous sound pressure level is measured with the tap fixed at the position causing the highest sound pressure level.

B.2 Water installations

B.2.1 General operating conditions

For sound measurements on water taps, normally the water shall be drained off the sink, shower cabin or tub during the measurement.

It shall be ensured that all functions are in normal operation (water pressure, flow rate etc.). For water installations the stop cocks shall be completely open, or when this is not the case the position shall be reported. Measurement and reporting of the flow pressure and the flow rate of the valve are optional.

Normally the sound pressure level from sanitary installations is not measured in the room where the installation is mounted, but exclusively in surrounding rooms (e.g. neighbouring dwellings).

L_{max}:

The maximum sound pressure level at each microphone position is determined for a specified operating condition and operating cycle of the installation under test as prescribed in B.2.2 to B.2.6.

Measurement on water installations starts before the installation is operated and stops after the operating cycle has ended.

L_{eq}:

Concerning water taps the measurement is carried out with the tap fixed in the position causing the highest sound pressure level (see B.2.2, operating cycle for the equivalent continuous sound pressure level).

B.2.2 Water tap

a) Operating conditions:

L_{max} and L_{eq}:

If the outlet of the tap or valve is movable, it shall be placed in the position closest to the middle of the sink (for further operating conditions, see B.2.1).

b) Operating cycles:

L_{max}:

Taps with one inlet: Open the tap completely, wait a few seconds and then turn off the tap.

Mixing valves with similar independent controls for hot and cold water: Open the hot tap completely, open the cold tap, wait a few seconds, close the hot tap and then close the cold tap.

Mixing valves with one dual function control for flow and temperature: Open the control completely at average temperature setting, decrease the temperature to the minimum, and then increase the temperature to the maximum, wait until the maximum temperature has been reached and close the control.

Mixing valves with independent controls for flow and temperature: Open the flow control completely at average temperature setting, decrease the temperature to the minimum and then increase the temperature to the maximum, wait until the maximum temperature has been reached and close the control.

Thermostatic mixing valves: Open the tap completely at average temperature setting, decrease the temperature to the minimum and then increase the temperature to the maximum and close the tap.

L_{eq}:

The integration time is approximately 30 s.

Taps with one inlet: open the tap and find the position causing the highest sound pressure level. The taps shall be fixed in this position during the measurement.

Mixing valves with similar independent controls for hot and cold water: open both the hot tap and the cold tap and find the position causing the highest sound pressure level. The taps shall be fixed in this position during the measurement.

Mixing valves with one dual function control for flow and temperature: open the tap and find the position causing the highest sound pressure level at average temperature setting. The taps shall be fixed in this position during the measurement. The sound pressure level with the taps in hot-water position and cold-water position, respectively, shall be checked. The highest of the three levels is the measurement result.

Mixing valves with independent controls for flow and temperature, and thermostatic valves: open the tap and find the position causing the highest sound pressure level at average temperature setting. The taps shall be fixed in this position during the measurement. The sound pressure level with the tap in hot-water position and cold-water position respectively, shall be checked. The highest of the three levels is the measurement result.

B.2.3 Shower cabin

a) Operating conditions

L_{max} and L_{eq}:

The shower shall be placed in the wall fixture at its highest position above floor level and the shower shall be directed towards the floor of the cabin (for further operation conditions, see B.2.1).

b) Operating cycle

The measurement is performed according to B.2.2.

If a distinction is needed between the sound pressure level originating by the impact sound excitation from the water bouncing on the floor of the cabin and the sound pressure level originating by using the valves, the water shall be drained off soundlessly (measurement of the valves alone).

B.2.4 Bath (tub)

a) Operating conditions

L_{max} and L_{eq}:

If the tap of the bath is a combination of a nozzle exclusively for filling the bath and a separate shower, the two functions shall be regarded separately. If there is no fixture on the wall, the shower shall be held at a height above the bottom of the tub of approximately 1,5 m. Emptying the bath shall take place simultaneously with the measurement (for further operating conditions see B.2.1).

b) Operating cycle

L_{max} and L_{eq}:

The measurement is performed according to B.2.2 and, if the bath is fitted with a shower, according to B.2.3.

If a distinction is needed between the sound pressure level originating by the impact sound excitation from the water bouncing on the bottom of the tub and the sound pressure level originating by using the valves, the water shall be drained off soundlessly (measurement of the valves alone).

B.2.5 Filling and emptying sinks and baths

a) Operating conditions

L_{max} and L_{eq}:

If the sound pressure level from filling and emptying sinks and baths is to be measured separately, the plug is closed and the sink/bath is filled to half of the maximum level during the measurement. Hot and cold water is mixed equally with the tap(s) in fully opened position(s) (for further operating conditions see B.2.1).

The plug is opened and a new measurement is carried out during the emptying period.

b) Operating cycle

L_{max}:

The measurement is carried out first during the filling and then during the emptying period.

L_{eq}:

Integration time is equal to the filling period and emptying period.

B.2.6 Water closet

a) Operating conditions

L_{max} and L_{eq}:

The sound from a water closet consists partly of the sound from flushing the water and partly of sound generated when the cistern is refilled. Flushing valves and flushing cisterns shall be operated to the end stop. In case of a flushing cistern the sound pressure level is measured when the supply valve is fully opened and until the supply valve has closed (for further operating conditions see B.2.1).

b) Operating cycle

L_{max}:

The measurement is carried out during a full flushing/refilling cycle.

NOTE 1 The maximum sound pressure level exclusively generated by flushing the water closet can be determined by refilling seven litres of water from a bucket directly into the w.c pan within about 3 s.

L_{eq}:

The integration time shall correspond to a full flushing/refilling cycle.

NOTE 2 For a water closet the equivalent continuous sound pressure level should be supplemented by the maximum A-weighted sound pressure level measured according to B.2.6.

B.3 Mechanical ventilation

a) Operating conditions

L_{max} and L_{eq}:

The part of a ventilation system placed in a dwelling normally consists of vents in living rooms and toilets for comfort ventilation, and cooker hoods in kitchens.

Generally, manually operated systems shall be set to the position with the highest sound pressure level, normally the maximum speed and/or the fully opened position of the vent. Before taking measurements it shall be checked that the system has been adjusted to the correct air-flow.

NOTE 1 In building Code regulations it might be stated that manually operated ventilation systems should be measured at a lower setting than maximum for measurement in the dwelling to which the system belongs.

NOTE 2 Cooker hoods connected to a ventilation system common to the whole building can generate a considerable sound when the vent is fully closed. A measurement with the hood in this operating condition might be appropriate.

b) Operating cycle

L_{max}:

Continuous operating. The measurement time is approximately 30 s.

L_{eq}:

The integration time is approximately 30 s.

B.4 Heating and cooling service equipment

a) Operating conditions

L_{max} and L_{eq}:

For individual heating systems the measurement has to be carried out during simultaneous working of the burner under full load, circulation pump, fan and fuel delivery pump (maximum normal water flow; maximum normal airflow).

Cooling systems shall be set to the position with the highest sound pressure level.

b) Operating cycle

L_{max}:

For heating systems, start-up from cold conditions. Operate at full load. Open and close slowly each appliance (taps for heating elements; regulators of air devices) and stop.

For cooling systems the measurement time shall be approximately 30 s.

L_{eq}:

The integration time is approximately 30 s.

NOTE For heating systems the equivalent continuous sound pressure level should be supplemented by the maximum A- weighted sound pressure level measured when operating each appliance (taps for heating elements; regulators of air devices) according to B.4.

L_{max} and L_{eq}:

For measurements of sound pressure levels from radiators the water flow shall be stabilized in the thermostat position for the highest possible room temperature. After that search for the thermostat position which causes the maximum constant noise level.

B.5 Lift

a) Operating conditions

L_{max} and L_{eq}:

The lift shall be loaded with 1 or 2 persons. The load and the number of persons in the lift during the measurement shall be reported.

b) Operating cycle

L_{max} and L_{eq}:

Start the lift from the lowest possible level. Stop at each intermediate level. Open and close the door (if by hand without force). When the lift has arrived at the highest level of its shaft, call it back directly to the lowest possible level and then open and close the door.

NOTE For measurements on lifts the equivalent continuous sound pressure level should preferably be supplemented by at least the maximum A-weighted sound pressure level.

B.6 Rubbish chute

a) Operating conditions

The chute shall be clear of waste.

b) Operating cycle

L_{max}:

From the top storey two objects are dispatched simultaneously.

The objects shall consist of a tube with open ends and a length of 0,1 m made of unplasticized polyvinyl chloride or a material with similar characteristics. The nominal external diameter shall be 50 mm, and the wall thickness 3 mm. The mass per metre length shall be 0,7 kg/m.

Sound from rubbish chutes shall exclusively be determined as the maximum sound pressure level.

B.7 Boilers, blowers, pumps and other auxiliary service equipment

a) Operating conditions

Continuously operating under normal (loaded) conditions.

b) Operating cycle

L_{max} and L_{eq}:

For manually, electrically controlled appliances a cycle of start - operate - stop shall be used.

For automatically controlled service equipment a full cycle shall be used (including start/stop if relevant).

The integration time for measurement of the equivalent continuous sound pressure level shall correspond to the duration of the operating cycle.

B.8 Motor driven car park door

a) Operating conditions

L_{max} and L_{eq}:

The car park door shall be in normal operation.

b) Operating cycle

L_{max}:

Opening and closing the door.

L_{eq}:

The integration time shall correspond to a full cycle of opening and closing the door.

B.9 Other types of building service equipment

a) Operating conditions

For other types of service equipment that are not mentioned here, the operating conditions for normal use shall be selected for the measurement.

b) Operating cycle

For other types of service equipment that are not mentioned here, the operating cycle for normal use shall be selected for the measurement.

The integration time for measurement of the equivalent continuous sound pressure level shall correspond to the duration of the operating cycle.

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