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Acoustics — Determination and application of measurement uncertainties in building acoustics —

Part 2: Sound absorption

Acoustique — Détermination et application des incertitudes de mesure dans l'acoustique des bâtiments —

Partie 2: Absorption acoustique

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Contents

Page

Foreword ..... **iv**
Introduction ..... **v**
1 Scope **1**
2 Normative references **1**
3 Terms and definitions **1**
4 General approach **3**
5 Standard uncertainties in one-third octave bands **3**
6 Standard uncertainties for the practical sound absorption coefficient **4**
7 Standard uncertainties of single number values **5**
8 Reporting uncertainties **5**
Bibliography **8**

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Foreword

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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).

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Introduction

An assessment of uncertainties that is comprehensible and close to reality is indispensable for reporting and applying measured sound absorption. Uncertainties should preferably be determined following the principles of ISO/IEC Guide 98-3.

ISO/IEC Guide 98-3 specifies a detailed procedure for the uncertainty evaluation that is based upon a complete mathematical model of the measurement procedure. At the current knowledge, it is impossible to formulate these models for sound absorption measurements according to ISO 354 and evaluations according to ISO 11654 or similar. To come to uncertainties all the same, the concept of reproducibility and repeatability is applied in this document. This concept offers the possibility to state the uncertainty of a method and of measurements carried out according to the method, based on the results of inter-laboratory measurements.

Observed uncertainties are probably caused by different laboratory designs. When the method of ISO 354 for measuring sound absorption is modified, other uncertainties than the ones given in this document can be applicable.

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Acoustics — Determination and application of measurement uncertainties in building acoustics —

Part 2: Sound absorption

1 Scope

This document specifies how to calculate:

— the uncertainty of sound absorption coefficients and equivalent sound absorption areas measured according to ISO 354;

— the uncertainty of the practical and weighted sound absorption coefficients determined according to ISO 11654;

— the uncertainty of the object sound absorption coefficient according to ISO 20189; and

— the uncertainty of the single number rating determined according to EN 1793-1.

Furthermore, the use of uncertainties in reporting measured or weighted sound absorption coefficients is explained.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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

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

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

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

3.1
measurand
quantity intended to be measured

EXAMPLE The sound absorption coefficient of a particular test specimen measured according to ISO 354.

[SOURCE: ISO/IEC Guide 99:2007, 2.3, modified — The Notes to entry have been deleted and the example has been added.]

3.2
measurement result
value attributed to a *measurand* (3.1), obtained by following the complete set of instructions given in a measurement procedure

Note 1 to entry: The measurement result is the sound absorption coefficient in one-third octave bands according to the procedure of ISO 354 or a (single number) value according to a rating procedure of EN 1793-1 or ISO 11654.

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[SOURCE: ISO 12999-1:2014, 3.2, modified — Note 1 to entry has been changed.]

3.3
uncertainty
parameter, associated with the result of a measurement, that characterizes the dispersion of the values that can reasonably be attributed to the *measurand* (3.1)

[SOURCE: ISO/IEC Guide 98-3:2008, 2.2.3, modified — In the term, "(of measurement)" has been removed, and the Notes have been deleted.]

3.4
standard uncertainty
u
uncertainty (3.3) of the result of a measurement expressed as a standard deviation

Note 1 to entry: The standard uncertainty, *u*, is the *reproducibility standard deviation* (3.8), σ_R, when evaluating the uncertainty of a measurement under *reproducibility conditions* (3.7).

Note 2 to entry: The standard uncertainty, *u*, is the *repeatability standard deviation* (3.10), σ_r, when evaluating the uncertainty of a measurement under *repeatability conditions* (3.9).

[SOURCE: ISO/IEC Guide 98-3:2008, 2.3.1, modified — The symbol "*u*" and the Notes to entry have been added.]

3.5
expanded uncertainty
U
quantity defining an interval about the result of a measurement that may be expected to encompass a large fraction of the distribution of values that can reasonably be attributed to the *measurand* (3.1)

[SOURCE: ISO/IEC Guide 98-3:2008, 2.3.5, modified — The symbol "*U*" has been added and the Notes have been deleted.]

3.6
coverage factor
k
numerical factor used as a multiplier of the combined *standard uncertainty* (3.4) in order to obtain an *expanded uncertainty* (3.5)

[SOURCE: ISO/IEC Guide 98-3:2008, 2.3.6, modified — The symbol "*k*" has been added and the Note has been deleted.]

3.7
reproducibility condition of measurement
reproducibility condition
condition of measurement that includes different laboratories, operators, measuring systems, and replicate measurements on the same or similar objects

[SOURCE: ISO/IEC Guide 99:2007, 2.24, modified — The Notes have been deleted. In the definition, “out of a set of conditions” has been removed and “locations” has been replaced by “laboratories”.]

3.8
reproducibility standard deviation
σ_R
standard deviation of *measurement results* (3.2) obtained under *reproducibility conditions* (3.7)

[SOURCE: ISO 5725-1:1994, 3.19, modified — The Notes have been deleted. In the definition, “test” has been replaced by “measurement”.]

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3.9
repeatability condition of measurement
repeatability condition
condition of measurement that includes the same measurement procedure, same operators, same measuring system, same location (laboratory or usual building), and replicate measurements on the same object over a short period of time

[SOURCE: ISO/IEC Guide 99:2007, 2.20, modified — The Notes have been deleted. In the definition, "out of a set of conditions" and "same operating conditions" have been removed and "(laboratory or usual building)" has been added after "location".]

3.10
repeatability standard deviation
σ_r
standard deviation of *measurement results* (3.2) obtained under *repeatability conditions* (3.9)

[SOURCE: ISO 5725-1:1994, 3.15, modified — The Notes have been deleted. In the definition, "test" has been replaced by "measurement".]

4 General approach

If uncertainty data are available for specific specimens, test setups or measurement/evaluation standards, e.g. from an inter-laboratory test, these data shall be used. If no such data are available, the uncertainties given in Clauses 5, 6 and 7 shall be used. In Clauses 5, 6 and 7, standard uncertainties, u, are estimated by reproducibility standard deviations, σ_R, or by repeatability standard deviations, σ_r. The numbers given are derived from inter-laboratory measurements according to ISO 5725-1 and ISO 5725-2 with different types of test specimens including suspended ceilings, mineral wool, foams[1][2][3].

5 Standard uncertainties in one-third octave bands

The reproducibility standard deviation of sound absorption coefficients measured according to ISO 354 in one-third octave bands shall be calculated using Formula (1):

$$\sigma_R = m\,\alpha_s + n \tag{1}$$

where

α_s is the sound absorption coefficient measured in accordance with ISO 354;

m, n are frequency-dependent numerical constants given in Table 1.

Table 1 — Values *m* and *n* to be used in Formula (1)

One-third octave midband frequency Hz	*m*	*n*
63	0,450	0,015
80	0,330	0,015
100	0,240	0,015
125	0,180	0,015
160	0,140	0,015
200	0,110	0,015
250	0,090	0,015
315	0,075	0,015
400	0,060	0,015

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