BRITISH STANDARD

BS EN ISO
11654:1997

Acoustics — Sound absorbers for use in buildings — Rating of sound absorption

The European Standard EN ISO 11654:1997 has the status of a British Standard

ICS 91.120.20

National foreword

This British Standard is the English language version of EN ISO 11654:1997. It is identical with ISO 11654:1997.

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:

— aid enquirers to understand the text;

— present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

Cross-references

Attention is drawn to the fact that CEN and CENELEC Standards normally include an annex which lists normative references to international publications with their corresponding European publications. The British Standards which implement these international European publications may be found in the BSI Standards Catalogue under the section entitled "International Standards Correspondence Index", or by using the "Find" facility of the BSI Standards Electronic Catalogue.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the EN ISO title page, page 2, the ISO title page, pages ii to iv, pages 1 to 6, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

This British Standard, having been prepared under the direction of the Health and Environment Sector Board, was published under the authority of the Standards Board and comes into effect on 15 November 1997

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Amendments issued since publication

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Contents

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN ISO 11654

April 1997

ICS 91.120.20

Descriptors: See ISO document

English version

Acoustics — Sound absorbers for use in buildings — Rating of sound absorption

(ISO 11654:1997)

Acoustique — Absorbants pour l'utilisation dans les bâtiments — Evaluation de l'absorption acoustique
(ISO 11654:1997)

Akustik — Schallabsorber für die Anwendung in Gebäuden — Bewertung der Schallabsorption
(ISO 11654:1997)

This European Standard was approved by CEN on 1997-03-19. CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

The European Standards exist in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

Central Secretariat: rue de Stassart 36, B-1050 Brussels

Ref. No. EN ISO 11654:1997 E

Foreword

The text of the International Standard ISO 11654:1997 has been prepared by Technical Committee ISO/TC 43 "Acoustics" in collaboration with Technical Committee CEN/TC 126 "Acoustic properties of building products and of buildings", the secretariat of which is held by AFNOR.

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 October 1997, and conflicting national standards shall be withdrawn at the latest by October 1997.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Endorsement notice

The text of the International Standard ISO 11654:1997 was approved by CEN as a European Standard without any modification.

NOTE Normative references to International Standards are listed in Annex ZA (normative).

INTERNATIONAL STANDARD

ISO 11654

First edition
1997-04-01

Acoustics — Sound absorbers for use in buildings — Rating of sound absorption

Acoustique — Absorbants pour l'utilisation dans les bâtiments — Évaluation de l'absorption acoustique

Reference number
ISO 11654:1997(E)

Contents

Descriptors: Acoustics, acoustic absorption, buildings, sound absorbers, tests, estimation, sound absorption coefficient, rules of calculation, acoustic measurements.

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.

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 11654 was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 2, *Building acoustics*.

Annex A, Annex B and Annex C of this International Standard are for information only.

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1 Scope

1.1 This International Standard specifies a method by which the frequency-dependent values of the sound absorption coefficient can be converted into a single number. Before this is done, the one-third-octave band values of the sound absorption coefficient measured in accordance with ISO 354 are converted into octave bands.

In Annex B a classification method, based on these single numbers, is given for information.

1.2 The single-number rating specified in this International Standard can be used to formulate requirements and to describe acoustical properties of sound-absorbing products to be used for routine applications in normal offices, corridors, class rooms, hospitals, etc. The rating is not appropriate when the products are to be used in qualified environments requiring careful acoustical design by expertise. In such cases, only complete sound absorption data as a function of frequency are satisfactory.

This International Standard is not applicable unless the applications cover the whole frequency range of the reference curve. If only a part of this range is of interest, it may be more appropriate to look for products with a good sound absorption within this range only. The shape indicators described in this International Standard give some guidance in identifying such products which may have a relatively low single number but a much higher potential if a more restricted frequency range is considered. Such products should be judged from the complete sound absorption curve.

As the rating curve in this International Standard has as a lower limit the 250 Hz octave band, the rating is not appropriate below this frequency. If such low frequencies are of interest, reference must be made to the complete sound absorption curve.

This International Standard is, in principle, applicable to all building products for which the sound absorption coefficient has been determined in accordance with ISO 354. It is, however, often not suitable for application to single items, such as chairs, baffles, etc., nor is it applicable to road barriers and road surfaces.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 354:1985, *Acoustics — Measurement of sound absorption in a reverberation room.*

ISO 354:1985/Amd. 1:—, *Annex D: Test specimen mountings for sound absorption tests*[1)].

3 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1
practical sound absorption coefficient, α_p

frequency-dependent value of the sound absorption coefficient which is based on measurements on one-third-octave bands in accordance with ISO 354 and which is calculated in octave bands in accordance with this International Standard

NOTE For the value in the i^{th} octave band, the notation α_{pi} is used.

3.2
weighted sound absorption coefficient, α_w

single-number frequency-independent value which equals the value of the reference curve at 500 Hz after shifting it as specified in this International Standard

3.3
shape indicators, L, M, H

indication showing practical sound absorption coefficients exceeding those of the shifted reference curve by 0,25 or more in different frequency ranges as specified in this International Standard

NOTE Negative deviations (values under the reference curve) are not considered as they are already maximized to 0,1 in the curve-shifting procedure.

[1)] To be published.

4 Calculation

4.1 Practical sound absorption coefficient

Calculate the practical sound absorption coefficient, α_{pi}, for each octave band i from the arithmetic mean value of the three one-third-octave sound absorption coefficients, α_{i1}, α_{i2}, and α_{i3} within the octave:

$$\alpha_{pi} = \frac{(\alpha_{i1} + \alpha_{i2} + \alpha_{i3})}{3}$$

The mean value is calculated to the second decimal and rounded in steps of 0,05 and maximized to $\alpha_{pi} = 1{,}00$ for rounded mean values > 1,00.

NOTE $x,y2$ is rounded to $x,y0$ and $x,y3$ is rounded to $x,y5$. $x,y7$ is rounded to $x,y5$ and $x,y8$ is rounded to $x,y + 0{,}1$.

EXAMPLE

0,92 is rounded to 0,90.

4.2 Weighted sound absorption coefficient

Use the α_{pi} values to calculate the weighted sound absorption coefficient α_w from the reference curve shown in Figure 1. Shift the reference curve in steps of 0,05 towards the measured value until the sum of the unfavourable deviations is less than or equal to 0,10. An unfavourable deviation occurs at a particular frequency when the measured value is less than the value of the reference curve. Only deviations in the unfavourable direction shall be counted. The weighted sound absorption α_w is defined as the value of the shifted reference curve at 500 Hz.

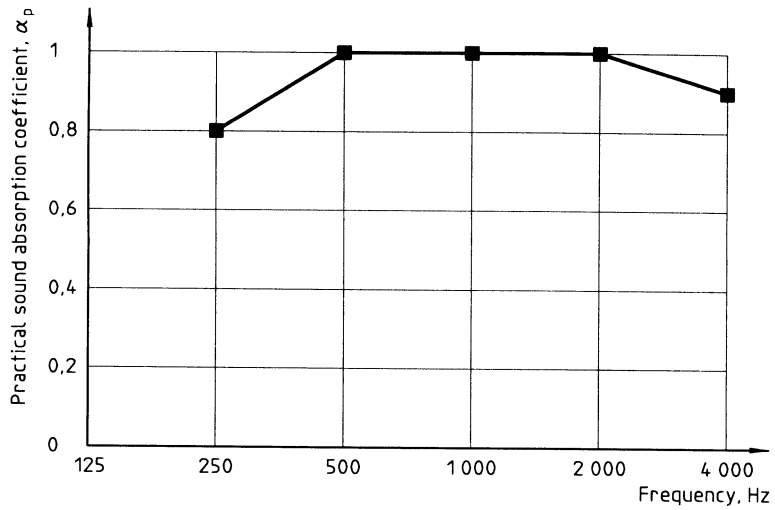
Examples of calculations of α_w are given in Annex A.

4.3 Shape indicators

Whenever a practical sound absorption coefficient α_{pi} exceeds the value of the shifted reference curve by 0,25 or more, one or more shape indicators shall be added, in parentheses, to the α_w value.

If the excess absorption occurs at 250 Hz, use the notation L. If the excess absorption occurs at 500 Hz or 1 000 Hz, use the notation M. If the excess absorption occurs at 2 000 Hz or 4 000 Hz, use the notation H.

NOTE A shape indicator means that the sound absorption coefficient at one or more frequencies is considerably higher than the values of the shifted reference curve and that the interested parties are encouraged to look at the complete sound absorption coefficient curve.



Frequency	250 Hz	500 Hz	1 000 Hz	2 000 Hz	4 000 Hz
Value	0,80	1,00	1,00	1,00	0,90

Figure 1 — Reference curve for evaluation of weighted sound absorption coefficient, α_w

5 Presentation of results

Results shall be given in the formats specified in **5.1** to **5.3**. Depending on the purpose of the presentation, one or more of the descriptors can be omitted, unless otherwise specified.

5.1 α_s values

Plot the values of the one-third-octave band sound absorption coefficients α_s, measured in accordance with ISO 354, on a diagram. Set out the frequency along the *x*-axis to a logarithmic scale and the values of α_s along the *y*-axis to a linear scale. The distance for an octave on the frequency scale shall be 15 mm; the distance for a range of 0,30 in absorption coefficient shall also be 15 mm. (See Annex C.)

Optionally, the diagram may be replaced or supplemented by a table. In that case, the values shall be given to two decimal places.

5.2 α_p values

Plot the values of the practical sound absorption coefficient α_p on a diagram. Set out the frequency along the *x*-axis to a logarithmic scale and the values of α_p along the *y*-axis to a linear scale. The distance for an octave on the frequency scale shall be 15 mm; the distance for a range of 0,30 in absorption coefficient shall also be 15 mm. Scale the *y*-axis from $\alpha_p = 0$ to $\alpha_p = 1{,}0$ and the *x*-axis in octave bands from 125 Hz to 4 000 Hz. (See Annex A.)

Optionally, the diagram may be replaced or supplemented by a table. In that case, the values shall be given to two decimal places.

5.3 α_w values and shape indicators

Express the weighted sound absorption coefficient α_w to two decimal places. Express the shape indicators, without commas, in parentheses, after the α_w value.

EXAMPLE

$\alpha_w = 0{,}70(MH)$

NOTE Whenever a shape indicator is given, the following sentence should be added: "It is strongly recommended to use this single-number rating in combination with the complete sound absorption coefficient curve that can be obtained on request."

5.4 Other information

For each α_p curve and α_w value, specify the following.

For all products for which the test specimen was mounted with an air space behind it, specify the depth of construction. (See Figure 2.)

NOTE In Europe it is recommended to use at least a construction depth of 200 mm. In Japan it is recommended to use at least a construction depth of 300 mm. In North America it is recommended to use at least a construction depth of 400 mm.

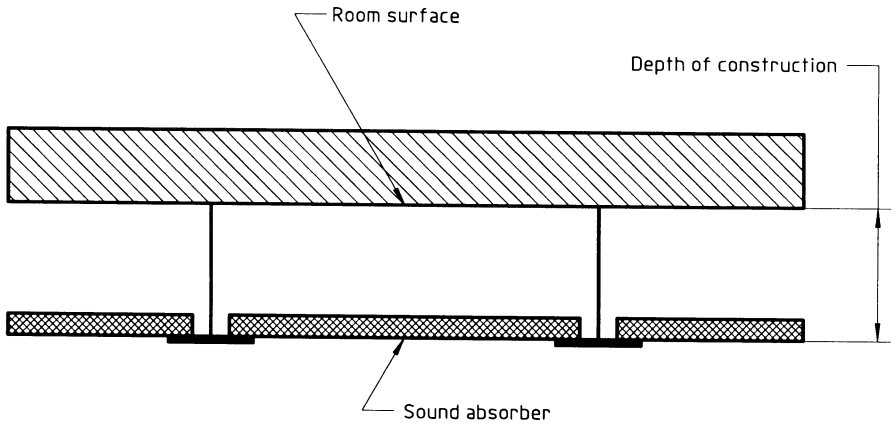
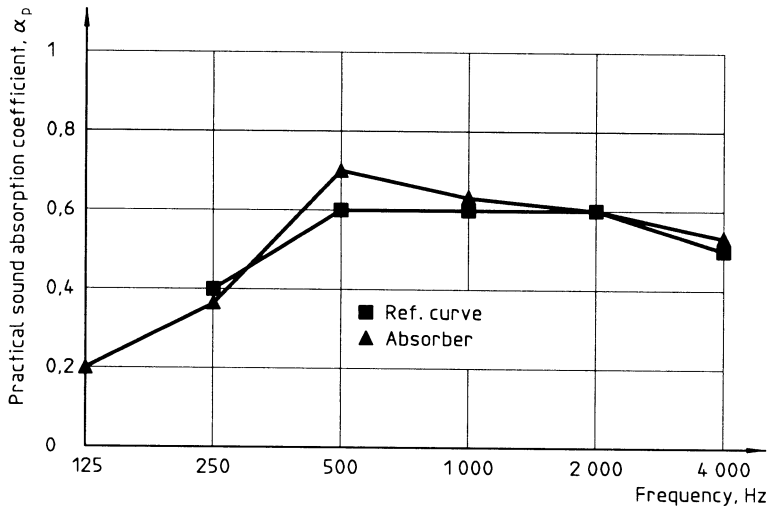


Figure 2 — Specification of depth of construction

Annex A (informative)
Examples of calculations of α_w, with and without a shape indicator

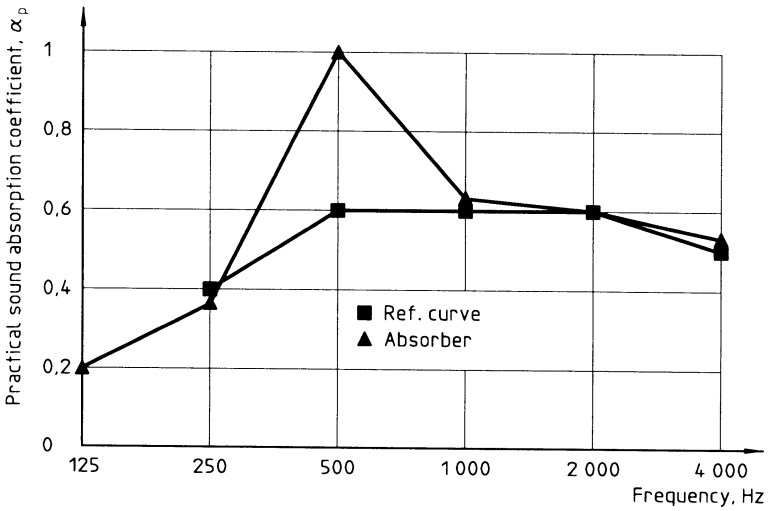
Figure A.1 shows an example of how to calculate α_w. Shift the reference curve in steps of 0,05 towards the measured value until the sum of the unfavourable deviations $\leqslant$ 0,10. In the example, an unfavourable deviation occurs at 250 Hz and the result is α_w = 0,60. No shape indicators need be given.

Figure A.2 gives an example with a shape indicator. The unfavourable deviation is equal to that of Figure A.1 and thus the same α_w value is obtained. However, as the practical sound absorption coefficient of the absorber exceeds that of the shifted reference curve by more than 0,25 at 500 Hz, the mid-frequency (M) shape indicator is added.



Freq.	Ref. curve	Absorber
125		0,20
250	0,40	0,35
500	0,60	0,70
1 000	0,60	0,65
2 000	0,60	0,60
4 000	0,50	0,55

Figure A.1 — Example of a calculation of α_w (α_w = 0,60)



Freq.	Ref. curve	Absorber
125		0,20
250	0,40	0,35
500	0,60	1,00
1 000	0,60	0,65
2 000	0,60	0,60
4 000	0,50	0,55

Figure A.2 — Example of a calculation of α_w [α_w = 0,60(M)]

Annex B (informative)
Classification of sound absorbers

The classification system of this annex is primarily intended to be used for broad-band applications. The single-number value, α_w, is used to calculate the sound absorption class according to Table B.1. The different classes are illustrated in Figure B.1.

Table B.1 — Sound absorption classes

Sound absorption class	α_w
A	0,90; 0,95; 1,00
B	0,80; 0,85
C	0,60; 0,65; 0,70; 0,75
D	0,30; 0,35; 0,40; 0,45; 0,50; 0,55
E	0,25; 0,20; 0,15
Not classified	0,10; 0,05; 0,00

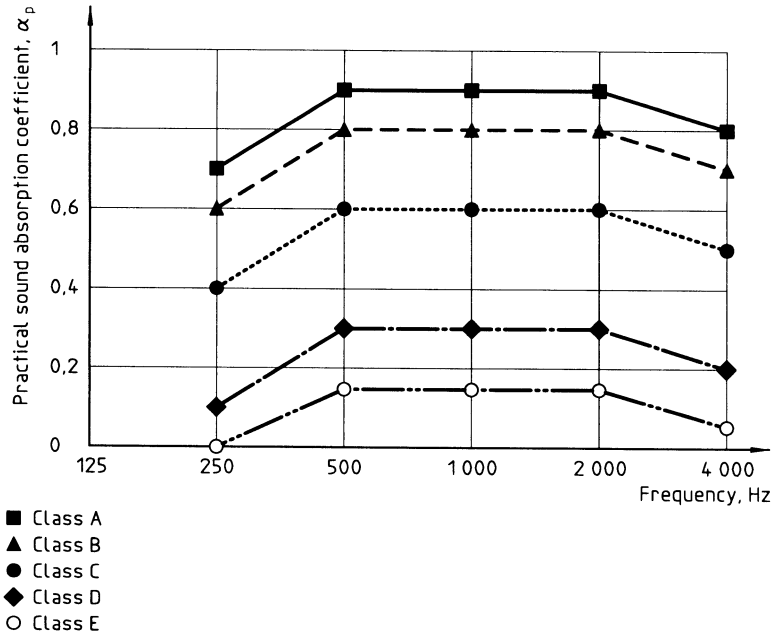
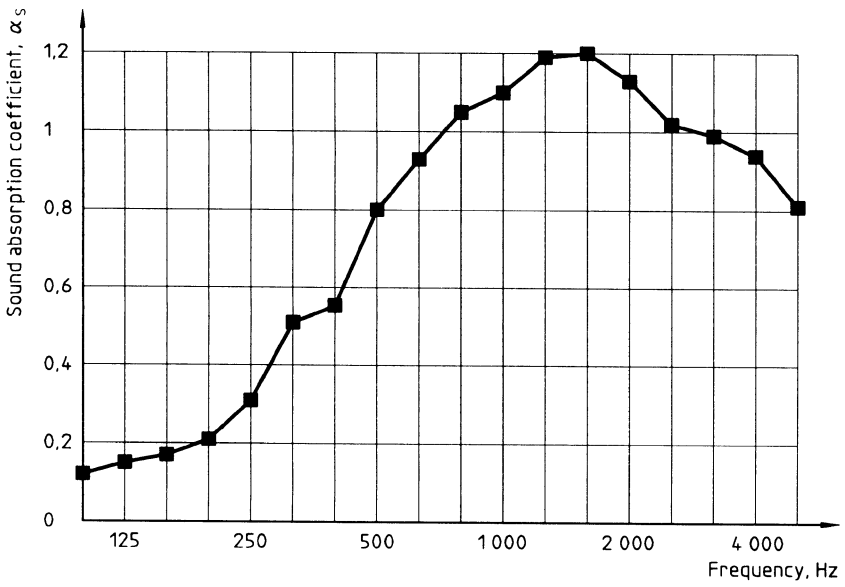


Figure B.1 — Illustration of the reference curve limiting the different sound absorption classes

Annex C (informative)
Example of a standardized diagram for α_s values



Frequency, Hz	α_s
100	0,12
125	0,15
160	0,17
200	0,21
250	0,31
315	0,51
400	0,54
500	0,80
630	0,93
800	1,05
1 000	1,10
1 250	1,19
1 600	1,20
2 000	1,13
2 500	1,02
3 150	0,99
4 000	0,94
5 000	0,81

NOTE This is just an example and has no connection with the other examples in this International Standard.

Annex ZA (normative)
Normative references to international publications with their relevant European publications

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

Publication	Year	Title	EN	Year
ISO 354	1985	*Acoustics — Measurement of sound absorption in a reverberation room*	EN ISO 354	1993

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