INTERNATIONAL STANDARD

ISO 717-1

Second edition
1996-12-15

Acoustics — Rating of sound insulation in buildings and of building elements —

Part 1:
Airborne sound insulation

Acoustique — Évaluation de l'isolement acoustique des immeubles et des éléments de construction —

Partie 1: Isolement aux bruits aériens

Reference number
ISO 717-1:1996(E)

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 717-1 was prepared by Technical Commitee ISO/TC 43, *Acoustics*, Subcommittee SC 2, *Building acoustics*.

This second edition of ISO 717-1 cancels and replaces ISO 717-1:1982 and ISO 717-3:1982, which have been technically revised.

ISO 717 consists of the following parts, under the general title

Acoustics — Rating of sound insulation in buildings and of building elements

— *Part 1: Airborne sound insulation*

— *Part 2: Impact sound insulation*

Annexes A, B and C of this part of ISO 717 are for information only.

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Introduction

Methods of measurement of airborne sound insulation of building elements and in buildings have been standardized in ISO 140-3, ISO 140-4, ISO 140-5, ISO 140-9 and ISO 140-10. The purpose of this part of ISO 717 is to standardize a method whereby the frequency-dependent values of airborne sound insulation can be converted into a single number characterizing the acoustical performance.

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Acoustics — Rating of sound insulation in buildings and of building elements —

Part 1: Airborne sound insulation

1 Scope

This part of ISO 717

a) defines single-number quantities for airborne sound insulation in buildings and of building elements such as walls, floors, doors and windows;

b) takes into consideration the different sound level spectra of various noise sources such as noise sources inside a building and traffic outside a building; and

c) gives rules for determining these quantities from the results of measurements carried out in one-third-octave or octave bands in accordance with ISO 140-3, ISO 140-4, ISO 140-5, ISO 140-9 and ISO 140-10.

The single-number quantities in accordance with this part of ISO 717 are intended for rating the airborne sound insulation and for simplifying the formulation of acoustical requirements in building codes. The required numerical values of the single-number quantities are specified according to varying needs. The single-number quantities are based on results of measurements in one-third-octave bands or octave bands.

For laboratory measurements made in accordance with ISO 140-3, ISO 140-9 and ISO 140-10, single-number quantities should be calculated using one-third-octave bands only.

The rating of results of measurements carried out over an enlarged frequency range is dealt with in annex B.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 717. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 717 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 140-3:1995, *Acoustics — Measurement of sound insulation in buildings and of building elements — Part 3: Laboratory measurements of airborne sound insulation of building elements.*

ISO 140-4:—[1], *Acoustics — Measurement of sound insulation in buildings and of building elements — Part 4: Field measurements of airborne sound insulation between rooms.*

ISO 140-5:—[2], *Acoustics — Measurement of sound insulation in buildings and of building elements — Part 5: Field measurements of airborne sound insulation of façade elements and façades.*

ISO 140-9:1985, *Acoustics — Measurement of sound insulation in buildings and of building elements — Part 9: Laboratory measurement of room-to-room airborne sound insulation of a suspended ceiling with a plenum above it.*

1) To be published. (Revision of ISO 140-4:1978)

2) To be published. (Revision of ISO 140-5:1978)

ISO 140-10:1991, *Acoustics — Measurement of sound insulation in buildings and of building elements — Part 10: Laboratory measurement of airborne sound insulation of small building elements.*

3 Definitions

For the purposes of this part of ISO 717, the following definitions apply.

3.1 single-number quantity for airborne sound insulation rating: Value, in decibels, of the reference curve at 500 Hz after shifting it in accordance with the method specified in this part of ISO 717.

NOTE 1 Terms and symbols for the single-number quantity used depend on the type of measurement. They are listed in table 1 for airborne sound insulation properties of building elements and in table 2 for airborne sound insulation in buildings. In general, new single-number quantities are derived in a similar way.

3.2 spectrum adaptation term: Value, in decibels, to be added to the single-number rating (e.g. R_w) to take account of the characteristics of particular sound spectra.

NOTES

2 Two sound spectra are defined (in one-third-octave bands and in octave bands) in this part of ISO 717.

3 Annex A gives information on the purpose of introducing these two spectrum adaptation terms.

Table 1 — Single-number quantities of airborne sound insulation properties of building elements

Derived from one-third-octave band values		Defined in	
Single-number quantity	**Term and symbol**		
Weighted sound reduction index, R_w	Sound reduction index, R	ISO 140-3:1995	equation (4)
Weighted suspended-ceiling normalized level difference, $D_{n,c,w}$	Suspended-ceiling normalized level difference, $D_{n,c}$	ISO 140-9:1985	equation (3)
Weighted element-normalized level difference, $D_{n,e,w}$	Element-normalized level difference, $D_{n,e}$	ISO 140-10:1991	equation (1)

Table 2 — Single-number quantities of airborne sound insulation in buildings

Derived from one-third-octave or octave-band values		Defined in	
Single-number quantity	**Term and symbol**		
Weighted apparent sound reduction index, R'_w	Apparent sound reduction index, R'	ISO 140-4:—	equation (5)
Weighted apparent sound reduction index, $R'_{45°,w}$	Apparent sound reduction index, $R'_{45°}$	ISO 140-5:—	equation (3)
Weighted apparent sound reduction index, $R'_{tr,s,w}$	Apparent sound reduction index, $R'_{tr,s}$	ISO 140-5:—	equation (4)
Weighted normalized level difference, $D_{n,w}$	Normalized level difference, D_n	ISO 140-4:—	equation (3)
Weighted standardized level difference, $D_{nT,w}$	Standardized level difference, D_{nT}	ISO 140-4:—	equation (4)
Weighted standardized level difference, $D_{ls,2m,nT,w}$ or $D_{tr,2m,nT,w}$	Standardized level difference, $D_{ls,2m,nT}$ or $D_{tr,2m,nT}$	ISO 140-5:—	equation (7)

4 Procedure for evaluating single-number quantities

4.1 General

The values obtained in accordance with ISO 140-3, ISO 140-4, ISO 140-5, ISO 140-9 and ISO 140-10 are compared with reference values (see 4.2) at the frequencies of measurement within the range 100 Hz to 3 150 Hz for one-third-octave bands and 125 Hz to 2 000 Hz for octave bands.

The comparison shall be carried out as specified in 4.4

Furthermore, two spectrum adaptation terms shall be calculated (see 4.5) based on two typical spectra within the frequency range as quoted above. These two terms may optionally be supplemented by additional spectrum adaptation terms covering (if need be and if measured data are available) a wider frequency range between 50 Hz and 5 000 Hz.

4.2 Reference values

The set of reference values used for comparison with measurement results shall be as given in table 3. The reference curves are shown in figures 1 and 2.

4.3 Sound spectra

The set of sound spectra in one-third-octave bands and octave bands to calculate the spectrum adaptation terms shall be as given in table 4 and shown in figures 3 and 4. The spectra are A-weighted and the overall spectrum level is normalized to 0 dB.

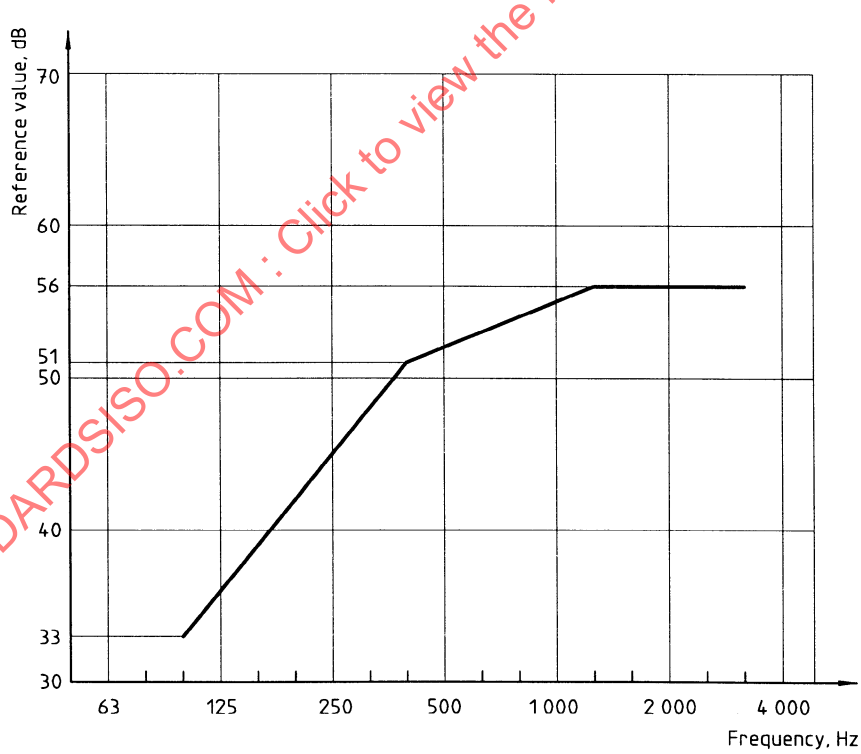


Figure 1 — Curve of reference values for airborne sound, one-third-octave bands

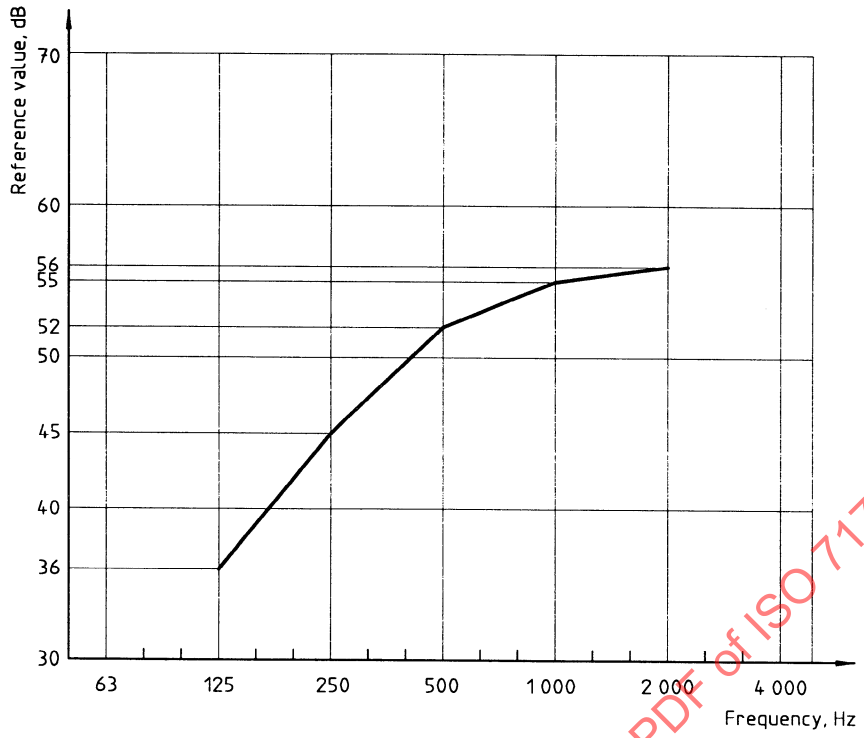
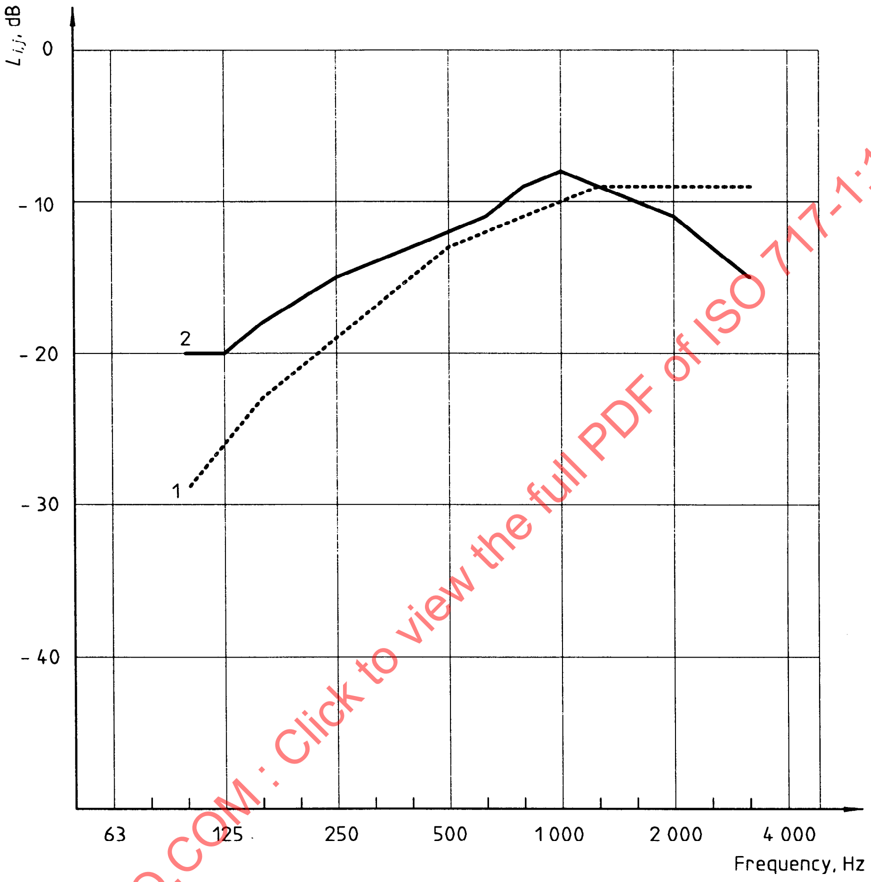


Figure 2 — Curve of reference values for airborne sound, octave bands

Table 3 — Reference values for airborne sound

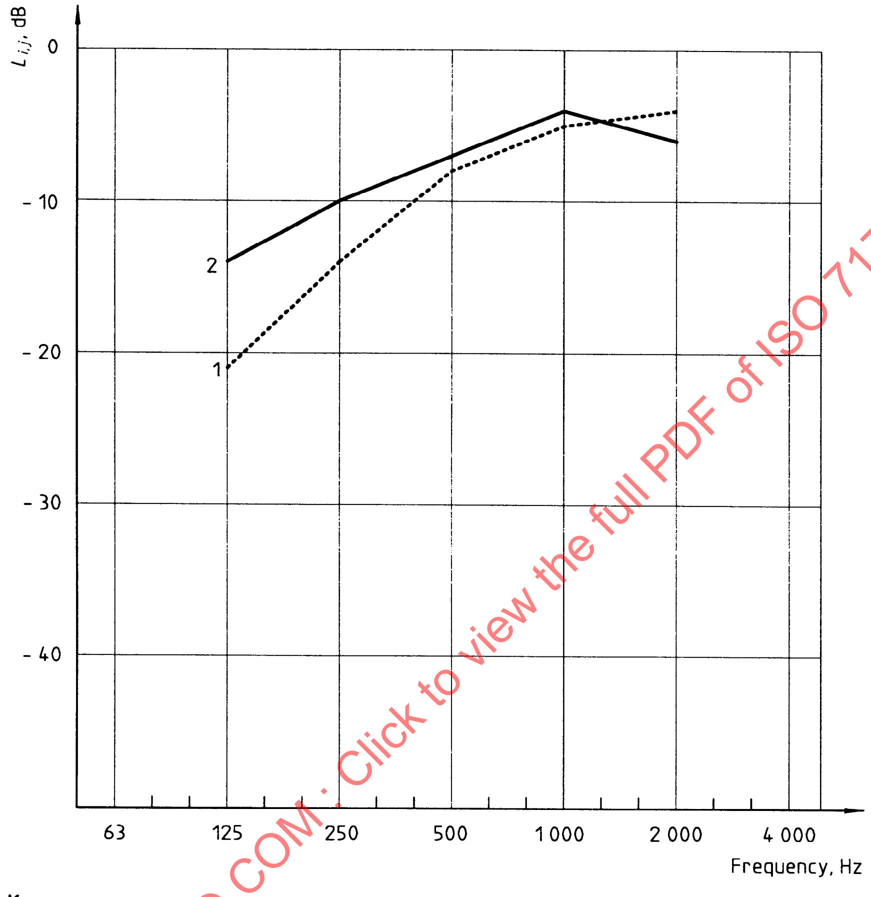
Frequency Hz	**Reference values**, dB One-third-octave bands	 Octave bands
100	33	
125	36	36
160	39	
200	42	
250	45	45
315	48	
400	51	
500	52	52
630	53	
800	54	
1 000	55	55
1 250	56	
1 600	56	
2 000	56	56
2 500	56	
3 150	56	



Key

- .... Spectrum No. 1 to calculate C
- ——— Spectrum No. 2 to calculate C_{tr}

Figure 3 — Sound level spectra to calculate the spectrum adaptation terms for one-third-octave band measurements



Key

-------- Spectrum No. 1 to calculate C

———— Spectrum No. 2 to calculate C_{tr}

Figure 4 — Sound level spectra to calculate the spectrum adaptation terms for octave-band measurements

Table 4 — Sound level spectra to calculate the adaptation terms

Frequency Hz	Sound levels, L_{ij}, dB			
	Spectrum No. 1 to calculate C		Spectrum No. 2 to calculate C_{tr}	
	One-third octave	Octave	One-third octave	Octave
100	– 29		– 20	
125	– 26	– 21	– 20	– 14
160	– 23		– 18	
200	– 21		– 16	
250	– 19	– 14	– 15	– 10
315	– 17		– 14	
400	– 15		– 13	
500	– 13	– 8	– 12	– 7
630	– 12		– 11	
800	– 11		– 9	
1 000	– 10	– 5	– 8	– 4
1 250	– 9		– 9	
1 600	– 9		– 10	
2 000	– 9	– 4	– 11	– 6
2 500	– 9		– 13	
3 150	– 9		– 15	

NOTE — All levels are A-weighted and the overall spectrum level is normalized to 0 dB.

4.4 Method of comparison

To evaluate the results of a measurement made in accordance with ISO 140-3, ISO 140-4, ISO 140-5, ISO 140-9 and ISO 140-10 in one-third-octave bands (or octave bands), given to 0,1 dB, shift the relevant reference curve in steps of 1 dB towards the measured curve until the sum of unfavourable deviations is as large as possible but not more than 32,0 dB (measurement in 16 one-third-octave bands) or 10,0 dB (measurement in 5 octave bands).

An unfavourable deviation at a particular frequency occurs when the result of measurements is less than the reference value. Only the unfavourable deviations shall be taken into account.

The value, in decibels, of the reference curve at 500 Hz, after shifting it in accordance with this procedure, is R_w, R'_w, $D_{n,w}$ or $D_{nT,w}$, etc. (see tables 1 and 2).

Only use reference values in octave bands for comparison with results of measurements in octave bands in the field.

4.5 Calculation of spectrum adaptation terms

The spectrum adaptation terms, C_j, in decibels, shall be calculated with the sound spectra given in 4.3 from the following equation:

$$C_j = X_{Aj} - X_w$$

where

j is the index for the sound spectra Nos. 1 and 2;

X_w is the single-number quantity calculated according to 4.4 from R, R', D_n or D_{nT} values;

X_{Aj} is calculated from

$$X_{Aji} = -10 \lg \sum 10^{(L_{ij} - X_i)/10} \text{ dB}$$

where

i is the index for the one-third-octave bands 100 Hz to 3 150 Hz or the octave bands 125 Hz to 2 000 Hz;

L_{ij} are the levels as given in 4.3 at the frequency i for the spectrum j;

X_i is the sound reduction index R_i, or apparent sound reduction index R'_i, or normalized sound level difference $D_{n,i}$, or standardized sound level difference $D_{nT,i}$, at the measuring frequency i given to the nearest 0,1 dB.

Calculate the spectrum adaptation term according to 0,1 dB and rounded to an integer[3]. It shall be identified according to the spectrum used, as follows:

- C when calculated with spectrum No. 1 (A-weighted pink noise);
- C_{tr} when calculated with spectrum No. 2 (A-weighted urban traffic noise).

NOTES

4 The spectra of most of the usual prevailing indoor and outdoor noise sources lie in the range of spectra Nos.1 and 2; the spectrum adaptation terms C and C_{tr} may therefore be used to characterize the sound insulation with respect to many types of noise. Guidelines for the relevant spectrum adaptation terms are given in annex A.

5 Supplementary calculations of the spectrum adaptation terms may also be carried out for the enlarged frequency range (including 50 Hz + 63 Hz + 80 Hz and/or 4 000 Hz + 5 000 Hz one-third-octave bands or 63 Hz and/or 4 000 Hz octave bands). The relevant terms and spectra are given in annex B. An example of the calculation of the single-number quantity and the adaptation terms is given in annex C.

5 Statement of results

The appropriate single-number quantity R_w, R'_w, $D_{n,w}$, or $D_{nT,w}$ and both adaptation terms shall be given with reference to this part of ISO 717.

5.1 Statement of performance of building elements

Calculate the single-number quantity from one-third-octave bands only. State the two spectrum adaptation terms in parentheses after the single-number quantity, separated by a semicolon.

EXAMPLE

$R_w\ (C;\ C_{tr}) = 41\ (0;\ -5)$ dB

5.2 Statement of requirements and of performance of buildings

Requirements shall be given with the single-number quantity according to 4.2 and 4.4 or be based on the sum of this value and the relevant spectrum adaptation term.

EXAMPLES

$R'_w + C_{tr} \geqslant 45$ dB (e.g. for façades)

or

$D_{nT,w} + C \geqslant 54$ dB (e.g. between dwellings)

The acoustic performance of buildings shall be given in the relevant terms according to the requirements (see annex A).

For field measurements in accordance with ISO 140-4 or ISO 140-5, it shall be stated whether the single-number quantity is calculated from measuring results in one-third-octave bands or octave bands. In general, there may be differences between single-number quantities calculated from one-third-octave- or octave-band measurements of about ± 1 dB.

3) $+xy$,5 is rounded to $xy + 1$ and $-xy$,5 is rounded to $-xy$. For further details see ISO 31-0:1992, *Quantities and units — Part 0: General principles.*

Annex A
(informative)

Use of spectrum adaptation terms

NOTE 6 The spectrum adaptation terms C and C_{tr} have been introduced in this second edition of ISO 717-1 (which now includes the former ISO 717-3) to take into account different spectra of noise sources (such as pink noise and road traffic noise) and to assess sound insulation curves with very low values in a single frequency band. (The validity of the rating obtained with the reference curve alone is limited for such cases.) The spectrum adaptation term in this sense replaces the 8 dB rule used in the first edition of ISO 717-1. C and C_{tr} have not been included as one single-number quantity but have been included as separate numbers. This is to ensure continuity with the reference curve system and to avoid the danger of confusion of different single-number quantities of about the same magnitude. Furthermore, interlaboratory tests have shown that the reproducibility of the single-number quantity based on the reference curve is somewhat better.

A.1 Spectrum adaptation term C

The spectrum adaptation term C is defined in 4.5 as

$$C = X_{A,1} - X_w$$

where

$X_{A,1}$ characterizes the difference between the A-weighted sound levels in the source room and the receiving room, for pink noise (spectrum No.1) in the source room;

X_w is the relevant single-number quantity based on the reference curve.

NOTE 7 In several countries, when using pink noise as a sound source,

$$R_{A,1} = R_w + C$$

is used as R_A (the sound reduction index) and

$$D_{nT,A,1} = D_{nT,w} + C$$

is used as $D_{nT,A}$ (the standardized level difference).

Generally, C is approximately -1, however, when there is a dip in the sound insulation curve in a single frequency band, C will become < -1. When comparing constructions, it may therefore be appropriate to consider both R_w and C.

In setting requirements, it may be appropriate to base these on the sum of X_w and C, as stated in 5.2.

A.2 Spectrum adaptation term C_{tr}

The spectrum adaptation term C_{tr} is defined in 4.5 as

$$C_{tr} = X_{A,2} - X_w$$

where

$X_{A,2}$ characterizes the difference between the A-weighted levels in the source room (or open air in front of the façade) and in the receiving room, for road traffic noise (spectrum No.2);

X_w is the relevant single-number quantity based on the reference curve.

NOTE 8 In several countries, when using traffic noise as a source signal,

$$R_{A,2} = R_w + C_{tr}$$

is used instead of $R_{A,tr}$ (the sound reduction index) and

$$D_{nT,A,2} = D_{nT,w} + C_{tr}$$

is used instead of $D_{nT,A,tr}$ (the sound insulation).

Generally, for different makes of window having the same basic construction, the numerical value of the term C_{tr} will be almost the same; in such cases it may be appropriate to use R_w for rating purposes. However, when comparing very different types of constructions, both R_w and C_{tr} should be considered.

Requirements may be based on the sum of X_w and C_{tr} as stated in 5.2. An estimation of the A-weighted indoor level from the known A-weighted traffic noise level in front of the façade should be based on $X_w + C_{tr}$.

A.3 Application of the spectrum adaptation terms to additional types of noise

In table 1, a number of different noise sources is attached to the spectrum adaptation terms C and C_{tr}.

This may be used as guidelines for the application of the spectrum adaptation terms to assess the sound insulation with respect to these noise sources. If the A-weighted spectrum of a certain type of noise is known, it can be compared with the data in table 4 and figures 3 and 4 and the relevant adaptation term may be chosen.

Table A.1 — Relevant spectrum adaptation term for different types of noise source

Type of noise source	Relevant spectrum adaptation term
Living activities (talking, music, radio, tv) Children playing Railway traffic at medium and high speed[1)] Highway road traffic > 80 km/h[1)] Jet aircraft, short distance Factories emitting mainly medium and high frequency noise	C (spectrum No. 1)
Urban road traffic Railway traffic at low speeds[1)] Aircraft, propeller driven Jet aircraft, large distance Disco music Factories emitting mainly low and medium frequency noise	C_{tr} (spectrum No. 2)

1) In several European countries, calculation models for highway road traffic noise and railway noise exist, which define octave band levels; these could be used for comparison with spectra Nos.1 and 2.

Annex B
(informative)

Terms and spectra for an enlarged frequency range

When measurements have been carried out for an enlarged frequency range, additional spectrum adaptation terms may be calculated and stated for this frequency range. The frequency range has to be stated in the index of C or C_{tr}.

EXAMPLES

$C_{50\text{-}3150}$ or $C_{50\text{-}5000}$ or $C_{100\text{-}5000}$
$C_{tr,50\text{-}3150}$ or $C_{tr,50\text{-}5000}$ or $C_{tr,100\text{-}5000}$

In the statement of results, these additional adaptation terms may be given as follows:

$$R_w(C;C_{tr};C_{50\text{-}3150};C_{tr,50\text{-}3150}) = 41\ (0; -5; -1; -4)\ \text{dB}$$

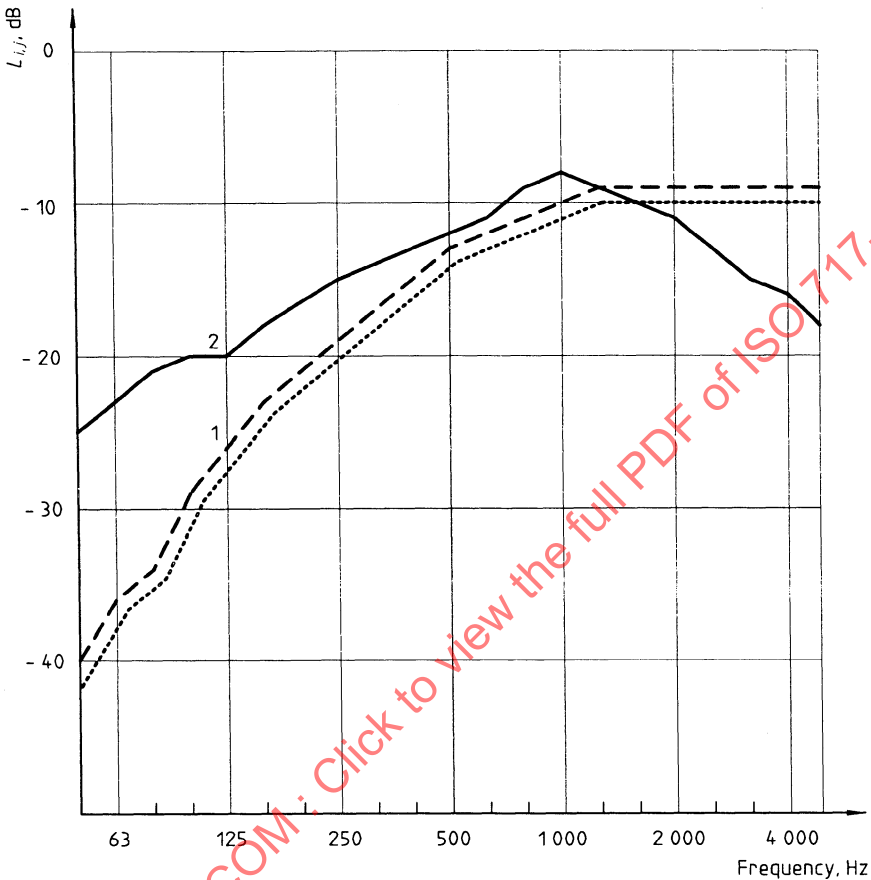
The sound spectra in one-third-octave bands and in octave bands for the enlarged frequency range are specified in table B.1 and shown in figures B.1 and B.2. The spectra, like those in table 4, are A-weighted and the overall spectrum level is normalized to 0 dB.

NOTE 9 Because of the normalization to 0 dB, the absolute values for the enlarged frequency ranges 50 Hz to 5 000 Hz and 100 Hz to 5 000 Hz for spectrum No.1 differ by 1 dB from those given for the frequency range 100 Hz to 3 150 Hz in table 4.

Table B.1 — Sound level spectra to calculate the adaptation terms for enlarged frequency range

Frequency Hz	**Sound levels, L_{ij}, dB**					
	Spectrum No.1 to calculate				**Spectrum No.2 to calculate C_{tr} for any frequency range**	
	$C_{50\text{-}3150}$		$C_{50\text{-}5000}$ and $C_{100\text{-}5000}$			
	One-third octave	Octave	One-third octave	Octave	One-third octave	Octave
50	– 40		– 41		– 25	
63	– 36	– 31	– 37	– 32	– 23	– 18
80	– 33		– 34		– 21	
100	– 29		– 30		– 20	
125	– 26	– 21	– 27	– 22	– 20	– 14
160	– 23		– 24		– 18	
200	– 21		– 22		– 16	
250	– 19	– 14	– 20	– 15	– 15	– 10
315	– 17		– 18		– 14	
400	– 15		– 16		– 13	
500	– 13	– 8	– 14	– 9	– 12	– 7
630	– 12		– 13		– 11	
800	– 11		– 12		– 9	
1 000	– 10	– 5	– 11	– 6	– 8	– 4
1 250	– 9		– 10		– 9	
1 600	– 9		– 10		– 10	
2 000	– 9	– 4	– 10	– 5	– 11	– 6
2 500	– 9		– 10		– 13	
3 150	– 9		– 10		– 15	
4 000			– 10	– 5	– 16	– 11
5 000			– 10		– 18	

NOTE — All levels are A-weighted and the overall spectrum level is normalized to 0 dB.



Key

Spectrum No. 1 to calculate C:

·········· 50 Hz to 5 000 Hz and 100 Hz to 5 000 Hz

— — — 50 Hz to 3 150 Hz

——— Spectrum No. 2 to calculate C_{tr}

Figure B.1 — Sound level spectra to calculate the spectrum adaptation terms for measurements using one-third-octave bands