



DPC: 23/30468479 DC

BSI Group Headquarters

389 Chiswick High Road London W4 4AL

Tel: +44 (0)20 8996 9000

Fax: +44 (0)20 8996 7400

www.bsigroup.com

Date: 24 August 2023

Origin: European

Latest date for receipt of comments: 17 October 2023

Project No. 2023/00105

Responsible committee: B/509/6 Fences for the attenuation of noise

Interested committees:

Title: Draft BS EN 1793-4 Road traffic noise reducing devices - Test method for determining the acoustic performance. Part 4: Intrinsic characteristics. In situ values of sound diffraction.

Please notify the secretary if you are aware of any keywords that might assist in classifying or identifying the standard or if the content of this standard

- i) has any issues related to 3rd party IPR, patent or copyright
- ii) affects other national standard(s)
- iii) requires additional national guidance or information

WARNING: THIS IS A DRAFT AND MUST NOT BE REGARDED OR USED AS A BRITISH STANDARD. THIS DRAFT IS NOT CURRENT BEYOND 17 October 2023

This draft is issued to allow comments from interested parties; all comments will be given consideration prior to publication. No acknowledgement will normally be sent. **See overleaf for information on the submission of comments.**

No copying is allowed, in any form, without prior written permission from BSI except as permitted under the Copyright, Designs and Patent Act 1988 or for circulation within a nominating organization for briefing purposes. Electronic circulation is limited to dissemination by e-mail within such an organization by committee members.

Further copies of this draft may be purchased from BSI Shop <http://shop.bsigroup.com> or from BSI Customer Services, Tel: +44(0) 20 8996 9001 or email cservices@bsigroup.com. British, International and foreign standards are also available from BSI Customer Services.

Information on the co-operating organizations represented on the committees referenced above may be obtained from <https://standardsdevelopment.bsigroup.com/>.

Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

For national standards, comments will be reviewed by the relevant UK national committee and the resulting standards published as a British Standard.

UK Vote

Please indicate whether you consider the UK should submit a negative (with supporting technical reasons) or positive vote on this draft. Please indicate if you are aware of any reason why this draft standard should not be published as a British Standard.

Submission of Comments

- **Annotated drafts are not acceptable and will be rejected.**
- All comments should be submitted online at <https://standardsdevelopment.bsigroup.com/>. You will need to register in order to comment.

Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
------------------	------------------------

1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/ Figure/Table/Note	Type of comment	Comment (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	

English Version

Road traffic noise reducing devices - Test method for
determining the acoustic performance - Part 4: Intrinsic
characteristics - In situ values of sound diffraction

Dispositifs de réduction du bruit du trafic routier -
Méthode d'essai pour la détermination de la
performance acoustique - Partie 4 : caractéristiques
intrinsèques - Valeurs in-situ de la diffraction
acoustique

Lärmschutzvorrichtungen an Straßen - Prüfverfahren
zur Bestimmung der akustischen Eigenschaften - Teil
4: Produktspezifische Merkmale - In-situ-Werte der
Schallbeugung

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 226.

If this draft becomes a European Standard, 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.

This draft European Standard was established by CEN 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 CEN-CENELEC Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and United Kingdom.

Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

Warning : This document is not a European Standard. It is distributed for review and comments. It is subject to change without notice and shall not be referred to as a European Standard.



EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

Contents

Page

European foreword	4
Introduction.....	5
1 Scope	6
2 Normative references	6
3 Terms and definitions.....	7
4 Symbols and abbreviations.....	9
5 Sound diffraction index difference measurements.....	11
5.1 General principle.....	11
5.2 Dimensions and specifications.....	11
5.2.1 Added devices.....	11
5.2.2 Reference walls.....	12
5.2.3 In-situ tests.....	12
5.3 Positions of the sound source.....	12
5.4 Position of the microphone(s).....	13
5.5 Free-field measurements.....	14
5.6 Measured quantity.....	19
5.7 Measuring equipment.....	19
5.7.1 Components of the measuring system.....	19
5.7.2 Sound source.....	20
5.7.3 Test signal.....	21
5.8 Data processing.....	21
5.8.1 Calibration.....	21
5.8.2 Sample rate	21
5.8.3 Background noise.....	22
5.8.4 Measurement points.....	22
5.8.5 Adrienne temporal window	22
5.8.6 Placement of the Adrienne temporal window.....	24
5.8.7 Low frequency limit and sample size.....	25
5.9 Positioning of the measuring equipment.....	26
5.9.1 Selection of the measurement positions.....	26
5.9.2 Reflecting objects.....	27
5.9.3 Safety considerations.....	27
5.10 Sample surface and meteorological conditions.....	27
5.10.1 Condition of the sample surface.....	27
5.10.2 Wind	27
5.10.3 Air temperature.....	27
5.11 Sound diffraction index difference.....	27
5.12 Single-number rating of sound diffraction index difference	28
6 Measurement uncertainty.....	29
7 Measuring procedure.....	29
7.1 Test report.....	30
Annex A (informative) Low-frequency limit and window width.....	31
A.1 General.....	31

Annex B (informative) Measurement uncertainty.....	35
B.1 General.....	35
B.2 Expression for the calculation of sound diffraction index.....	35
B.3 Contributions to measurement uncertainty.....	36
B.4 Expanded uncertainty of measurement.....	37
B.5 Measurement uncertainty based upon reproducibility data	37
Annex C (normative) Template of test report on sound diffraction index difference of added devices	38
C.1 General.....	38
Annex D (informative) Indoor measurements for product qualification	41
D.1 Parasitic reflections	41
D.2 Reverberation time of the room.....	41
Bibliography.....	42

European foreword

This document (prEN 1793-4:2023) has been prepared by Technical Committee CEN/TC 226 “Road equipment”, the secretariat of which is held by AFNOR.

This document is currently submitted to the CEN Enquiry.

This document will supersede EN 1793-4:2015.

With respect to the superseded document, the following changes have been made:

- The title has been improved.
- The ‘References’ clause has been updated.
- The ‘Terms, definitions and symbols and abbreviations’ clause has been updated.
- The single-number rating DL_{ADI} is now reported with one decimal digit.
- Annex A “Low-frequency limit and window width” has been added.
- Annex C with a template of the test report has been added.
- Previous Annex A has been shifted to Annex D.
- The ‘Bibliography’ clause has been updated.

EN 1793-4 is part of a series and should be read in conjunction with the other parts. All parts are listed in the following:

- EN 1793-1:2023, *Road traffic noise reducing devices - Test method for determining the acoustic performance – Part 1: Intrinsic characteristics – Sound absorption under diffuse sound field conditions*;
- EN 1793-2:2023, *Road traffic noise reducing devices - Test method for determining the acoustic performance – Part 2: Intrinsic characteristics – Airborne sound insulation under diffuse sound field conditions*;
- EN 1793-3:2023, *Road traffic noise reducing devices - Test method for determining the acoustic performance – Part 3: Normalized traffic noise spectrum*;
- EN 1793-4:2023, *Road traffic noise reducing devices — Test method for determining the acoustic performance — Part 4: Intrinsic characteristics — Intrinsic sound diffraction*;
- EN 1793-5:2023, *Road traffic noise reducing devices - Test method for determining the acoustic performance – Part 5: Intrinsic characteristics - Sound absorption under direct sound field conditions*;
- EN 1793-6:20223 *Road traffic noise reducing devices - Test method for determining the acoustic performance – Part 6: Intrinsic characteristics - Airborne sound insulation under direct sound field conditions*.

Introduction

Part of the market of road traffic noise reducing devices is constituted of products to be added on the top of road traffic noise reducing devices and intended to contribute to sound attenuation acting primarily on the diffracted sound field. These products will be called added devices. This document has been developed to specify a test method for determining the acoustic performance of added devices.

The test method can be applied in situ, i.e., where the road traffic noise reducing devices and the added devices are installed. The method can be applied without damaging the road traffic noise reducing devices or the added devices.

The method can be used to qualify products before the installation along roads as well as to verify the compliance of installed added devices to design specifications. Repeated application of the method can be used to verify the long-term performance of added devices.

No other national or international standard exists about the subject of this document.

This method can be used to qualify noise reducing devices for other applications, e.g., to be installed nearby industrial sites. In this case, the single-number ratings can preferably be calculated using an appropriate spectrum.

1 Scope

This document describes a test method for determining the intrinsic characteristics of sound diffraction of added devices installed on the top of road traffic noise reducing devices. The test method prescribes measurements of the sound pressure level at several reference points near the top edge of a road traffic noise reducing device with and without the added device installed on its top. The effectiveness of the added device is calculated as the difference between the measured values with and without the added devices, correcting for any change in height (the method described gives the acoustic benefit over a simple barrier of the same height; however, in practice the added device can raise the height and this could provide additional screening depending on the source and receiver positions).

The test method is intended for the following applications:

- preliminary qualification, outdoors or indoors, of added devices to be installed on road traffic noise reducing devices;
- determination of sound diffraction index difference of added devices in actual use;
- comparison of design specifications with actual performance data after the completion of the construction work;
- verification of the long-term performance of added devices (with a repeated application of the method);
- interactive design process of new products, including the formulation of installation manuals.

The test method can be applied both in situ and on samples purposely built to be tested using the method described here.

Results are expressed as a function of frequency, in one-third octave bands between 100 Hz and 5 kHz. If it is not possible to get valid measurements results over the whole frequency range indicated, the results shall be given in the restricted frequency range and the reasons of the restriction(s) shall be clearly reported. A single-number rating is calculated from frequency data.

For indoors measurements see Annex A.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 ISO 354:2003, *Acoustics - Measurement of sound absorption in a reverberation room (ISO 354:2003)*

EN 1793-1:2022, *Road traffic noise reducing devices — Test method for determining the acoustic performance — Part 1: Intrinsic characteristics — Sound absorption under diffuse sound field conditions;*

EN 1793-3:2022, *Road traffic noise reducing devices - Test method for determining the acoustic performance – Part 3: Normalized traffic noise spectrum*

EN 1793-5:2022, *Road traffic noise reducing devices — Test method for determining the acoustic performance — Part 5: Intrinsic characteristics — Sound absorption under direct sound field conditions;*

EN 1793-6:2022, *Road traffic noise reducing devices — Test method for determining the acoustic performance — Part 6: Intrinsic characteristics — Airborne sound insulation under direct sound field conditions.*

EN 61672-1:2013, *Electroacoustics – Sound level meters – Part 1: Specifications (IEC 61672-1:2013)*

ISO/IEC Guide 98-3:2008, *Uncertainty of measurement – Guide to the expression of uncertainty in measurement (GUM:1995)*

3 Terms and definitions

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

3.1

road traffic noise reducing device

RTNRD

device designed to reduce the propagation of traffic noise away from the road environment

Note 1 to entry: The RTNRD may comprise acoustic elements (3.2) only or both structural (3.3) and acoustic elements.

Note 2 to entry: Applications of RTNRD include noise barriers (3.5), claddings (3.6), covers (3.7) and added devices (3.8).

3.2

acoustic element

element whose primary function is to provide the acoustic performance of the device

3.3

structural element

element whose primary function is to support or hold in place acoustic elements

3.4

self-supporting acoustic element

acoustic element including its own structural element to support itself

3.5

noise barrier

road traffic noise reducing device which obstructs the direct transmission of airborne sound emanating from road traffic

3.6

cladding

road traffic noise reducing device which is attached to a wall or other structure and reduces the amount of sound reflected

3.7

cover

road traffic noise reducing device which either spans or overhangs the road

3.8

added device

additional component that influences the acoustic performance of the original road traffic noise reducing device

Note 1 to entry: The added device is acting primarily on the diffracted energy.

3.9

roadside exposure

use of the product as a noise reducing device installed alongside roads

3.10

sound diffraction index

quantity representing the amount of sound diffracted by the device under test

Note 1 to entry: This is the result of a sound diffraction test according to the present document

Note 2 to entry: The symbol for the sound diffraction index includes information on the setup used during the test: $DI_{x,refl}$ refers to measurements on a reflective reference wall. $DI_{x,abs}$ refers to measurements on an absorptive reference wall. $DI_{x,situ}$ refers to in situ measurements; where x is "0" when the added device is not on the top of the test construction and "ad" when the added device is on the top of the test construction (see Table 1).

Note 3 to entry: The test is specified by Formula (1)

3.11

sound diffraction index difference

difference between the results of sound diffraction tests on the same reference wall with and without an added device on the top

Note 1 to entry: This is described by the formulae (5a), (5b), (5c)

3.12

test construction

construction on which the added device is placed

Note to entry: For in situ measurements the test construction is an installed road traffic noise reducing device; for qualification tests it is a reference wall (see 5.2).

3.13

reference plane of the test construction

the vertical plane passing through the midpoint of the top edge of the construction (reference wall or installed road traffic noise reducing device) on which the added device has to be placed

Note 1 to entry: See figures 1, 2, 4, 5, 8.

3.14

reference height of the test construction without the added device

height of the highest point of the test construction in relation to the surrounding ground surface

Note 1 to entry: This highest point is not necessarily lying in the plane of longitudinal symmetry of the reference test construction, if this symmetry exists (Figure 1).

3.15

reference height of the test construction with the added device on the top

height of the highest point of the added device installed on the test construction in relation to the surrounding ground surface

Note 1 to entry: This highest point is not necessarily lying in the plane of longitudinal symmetry of the reference test construction, if this symmetry exists (Figure 4).

3.16**free-field measurement for sound diffraction index measurements**

measurement carried out placing the loudspeaker and the microphone without any obstacle, including the test construction with or without added device, between them

Note 1 to entry: For example, see Figure 7.

Note 2 to entry: Microphone and loudspeaker placement is as specified in 5.3, 5.4 and 5.5.

3.17**Adrienne temporal window**

composite temporal window

Note 1 to entry: As described in 5.8.5.

3.18**background noise**

noise coming from sources other than the source emitting the test signal

3.19**signal-to-noise ratio**

difference in decibels between the level of the test signal and the level of the background noise at the moment of detection of the useful event (within the Adrienne temporal window)

3.20**impulse response**

time signal at the output of a system when a Dirac function is applied to the input

Note 1 to entry: The Dirac function, also called δ function, is the mathematical idealisation of a signal infinitely short in time that carries a unit amount of energy

Note 2 to entry: It is impossible in practice to create and radiate true Dirac delta functions. Short transient sounds can offer close enough approximations but are not very repeatable. An alternative measurement technique, generally more accurate, is to use a period of deterministic, flat-spectrum signal, like maximum-length sequence (MLS) or exponential sine sweep (ESS), and transform the measured response back to an impulse response.

4 Symbols and abbreviations

For the purposes of this document, the following symbols apply.

Table 1 — Symbols and abbreviations

Symbol or abbreviation	Designation	Unit
α	Sound absorption coefficient measured according to EN ISO 354	-
DI_j	Sound diffraction index in the j -th one-third octave frequency band	dB
$DI_{0,refl}$	Sound diffraction index for the reflective reference wall without the added device	dB
$DI_{ad,refl}$	Sound diffraction index for the reflective reference wall with the added device	dB
$DI_{0,abs}$	Sound diffraction index for the absorptive reference wall without the added device	dB

Symbol or abbreviation	Designation	Unit
$DI_{ad,abs}$	Sound diffraction index for the absorptive reference wall with the added device	dB
$DI_{0,situ}$	Sound diffraction index for the in-situ test construction without the added device	dB
$DI_{ad,situ}$	Sound diffraction index for the in-situ test construction with the added device	dB
δ_i	Any input quantity to allow for uncertainty estimates	-
Δf_j	Width of the j -th one-third octave frequency band	Hz
f	Frequency	Hz
F	Symbol of the Fourier transform	-
f_{min}	Low frequency limit of sound diffraction index measurements	Hz
f_s	Sample rate	Hz
f_{co}	Cut-off frequency of the anti-aliasing filter	Hz
h_B	Noise barrier height	m
h_{ref}	Reference height of the test construction	m
$h_{ref,0}$	Reference height of the test construction without the added device	m
$h_{ref,ad}$	Reference height of the test construction with the added device	m
$h_{i,k}(t)$	Incident reference component of the free-field impulse response at the k -th measurement point	-
$h_{d,k}(t)$	Diffracted component of the impulse response at the k -th measurement point	-
j	Index of the j -th one-third octave frequency band (between 100 Hz and 5 kHz)	-
k	Index of the k -th measurement point ($k = 1 \dots n$)	-
k_p	Coverage factor	-
k_f	Constant used for the anti-aliasing filter	-
L_b	Minimum length of the reference wall	m
L_d	Minimum length of the added device under test	m
n	Number of measurement points	-
SI	Sound Insulation Index measured according to EN 16272-6	dB
t	Time	s or ms
t_C	Air temperature	°C
$T_{W,BH}$	Length of the Blackman-Harris trailing edge of the Adrienne temporal window	ms
u	Standard uncertainty	-

Symbol or abbreviation	Designation	Unit
U	Expanded uncertainty	-
$w_{i,k}(t)$	Width of the time window (Adrienne temporal window) for the component of the free-field impulse response received at the k -th measurement point	ms
$w_{d,k}(t)$	Width of the time window (Adrienne temporal window) for the component of the impulse response diffracted by the top edge of the test construction and received at the k -th measurement point	ms

5 Sound diffraction index difference measurements

5.1 General principle

The sound source emits a transient sound wave that travels toward the noise reducing device under test and is partly reflected, partly transmitted and partly diffracted by it. The microphone placed on the other side of the noise reducing device receives both the transmitted sound pressure wave travelling from the sound source through the road traffic noise reducing device and the sound pressure wave diffracted by the top edge of the road traffic noise reducing device under test (for the test to be meaningful the diffraction from the vertical edges of the test construction shall be sufficiently delayed in order to be outside the Adrienne temporal window). If the measurement is repeated without the added device and the test construction between the loudspeaker and the microphone, the direct free-field wave can be acquired. The power spectra of the direct and the top-edge diffracted components, corrected to take into account the path length difference of the two components, give the basis for calculating the sound diffraction index.

The final sound diffraction index shall be a weighted average of the diffraction indices measured at different points (see figures 1-6).

When the test method is applied in situ, the measurement procedure and sound diffraction index calculation shall be carried out two times, with and without the added device placed on the test construction.

When the test method is applied on samples purposely built to be tested according to the present standard, the added device shall be subsequently placed on the top of two reference walls (reflective and absorptive), or of the same reference wall in two different configurations, (see 5.2) and the measurement procedure and sound diffraction index calculation shall be carried out for both walls, with and without the added device on the top.

The measurement must take place in an essentially free field in the direct surroundings of the device, i.e., a field free from reflections coming from surfaces other than the surface of the device under test. For this reason, the acquisition of an impulse response having peaks as sharp as possible is recommended: in this way, the reflections coming from other surfaces than the tested device can be identified from their delay time and rejected.

5.2 Dimensions and specifications

5.2.1 Added devices

The added device shall have a minimum length L_d of 10 m. The reference wall shall have a minimum length L_b of 10 m and a minimum height of 4 m. The reference wall shall be vertical, flat and fixed firmly and without any air gaps on a supporting construction (foundation, floor etc.). The top surface of the supporting construction shall be level with the surrounding ground surface.

The maximum size of the added device measured perpendicularly from the reference plane either in the direction of the source or in the direction of the microphones shall not exceed a value of 1,0 m (see Figure 8).

5.2.2 Reference walls

Two versions of the reference wall shall be used in the tests:

- A A reflective reference wall, constructed of homogeneous panels with a smooth surface finish. The wall shall be free of air leaks and shall have a thickness not greater than 0,20 m. The reference wall shall have the minimum values of Sound Insulation Index measured according to EN 1793-6 specified in table 2, in order that the sound transmission through the reference wall is negligible.

Table 2 – Minimum values of the Sound Insulation Index of the reference wall, measured according to EN 1793-6. Tolerance $\pm 0,5$ dB.

Octave centre frequency (Hz)	125	250	500	1000	2000	4000
SI (dB)	21,0	22,0	24,0	26,0	29,0	32,0

- B An absorptive reference wall, constructed as mentioned under A, lined on the source side with an absorptive flat layer of a single porous material having the minimum values of sound absorption coefficient measured according to EN ISO 354 specified in table 3.

Table 3 – Minimum values of the sound absorption coefficient for the absorptive treatment of the reference wall, measured in reverberation room. Tolerance $\pm 0,05$.

Octave centre frequency (Hz)	125	250	500	1000	2000	4000
α	0,20	0,50	0,85	0,95	0,95	0,95

5.2.3 In-situ tests

When applying the test method in situ on existing noise reducing devices, with the intention of obtaining results valid over the entire frequency range specified in 5.6, the test construction shall satisfy the requirements in 5.2.2.

If these requirements cannot be fulfilled by the existing noise reducing device, the obtained results shall only be valid over a restricted frequency range (see 5.8.7) and for the type of noise reducing device being tested.

5.3 Positions of the sound source

Two angles of incidence, 90° and 45° , shall be used (see Figures 2 and 5).

For execution of the diffraction test at a right angle to the test construction the sound source shall be placed as follows (see figures 1, 2, 4 and 5):

- in the vertical plane containing the perpendicular bisector plane to the reference plane;
- horizontally: at 2 m distance from the reference plane of the test construction;
- vertically: in relation to the reference height h_{ref} of the test construction,
 - for the obligatory source position S1: centre of the source 0,50 m lower than h_{ref}
 - for the obligatory source position S2: centre of the source 0,15 m lower than h_{ref} ;