SLOVENSKI STANDARD
SIST EN 16272-5:2024

01-februar-2024

Železniške naprave - Infrastruktura - Protihrupne ovire in pripadajoče naprave, ki vplivajo na širjenje zvoka v zraku - Preskusna metoda za ugotavljanje akustičnih lastnosti - 5. del: Posebne karakteristike - Absorpcija zvoka pri usmerjenem zvočnem polju

Railway applications - Infrastructure - Noise barriers and related devices acting on airborne sound propagation - Test method for determining the acoustic performance - Part 5: Intrinsic characteristics - Sound absorption under direct sound field conditions

Bahnanwendungen - Oberbau - Lärmschutzwände und verwandte Vorrichtungen zur Beeinflussung der Luftschallausbreitung - Prüfverfahren zur Bestimmung der akustischen Eigenschaften - Teil 5: Intrinsische Merkmale - In-situ-Werte zur Schallreflexion in gerichteten Schallfeldern

Applications ferroviaires - Voie - Dispositifs de réduction du bruit - Méthode d'essai pour la détermination des performances acoustiques - Partie 5 : Caractéristiques intrinsèques - Absorption acoustique dans des conditions de champ acoustique direct

Ta slovenski standard je istoveten z: **EN 16272-5:2023**

ICS:

17.140.30	Emisija hrupa transportnih sredstev	Noise emitted by means of transport
93.100	Gradnja železnic	Construction of railways

SIST EN 16272-5:2024 **en,fr,de**

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 16272-5

November 2023

ICS 93.100

Supersedes CEN/TS 16272-5:2014

English Version

Railway applications - Infrastructure - Noise barriers and related devices acting on airborne sound propagation - Test method for determining the acoustic performance - Part 5: Intrinsic characteristics - Sound absorption under direct sound field conditions

Applications ferroviaires - Infrastructure - Dispositifs de réduction du bruit - Méthode d'essai pour la détermination de la performance acoustique - Partie 5 : Caractéristique intrinsèques - Absorption acoustique dans des conditions de champ acoustique direct

Bahnanwendungen - Oberbau - Lärmschutzwände und verwandte Vorrichtungen zur Beeinflussung der Luftschallausbreitung - Prüfverfahren zur Bestimmung der akustischen Eigenschaften - Teil 5: Produktspezifische Merkmale - In-situ-Werte zur Schallreflexion in gerichteten Schallfeldern

This European Standard was approved by CEN on 8 October 2023.

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Contents

European foreword

This document (EN 16272-5:2023) has been prepared by Technical Committee CEN/TC 256 “Railway applications”, the secretariat of which is held by DIN.

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 May 2024 and conflicting national standards shall be withdrawn at the latest by May 2024.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes CEN/TS 16272-5:2014.

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

- the references have been updated;
- the rotating loudspeaker/microphone assembly has been replaced by a loudspeaker and a 9-microphone square array (the measurement grid);
- the definition of RI has been changed;
- the geometrical divergence correction factor has been changed;
- a new correction factor for sound source directivity has been introduced;
- a new correction factor for gain mismatch has been introduced;
- the impulse response alignment for signal subtraction has been specified in more detail;
- the lowest reliable one-third frequency band has been better defined (Annex A);
- the single number rating DL_{RI} is now reported with one decimal digit;
- the way to evaluate the uncertainty of the measurement method from reproducibility data has been introduced (Annex B);
- a detailed example is given, including the evaluation of measurement uncertainty (Annex C);
- a new annex on indoor measurements has been added (Annex D).

EN 16272-5 is part of a series and should be read in conjunction with the other parts. All parts are listed below:

EN 16272-1, *Railway applications — Infrastructure — Noise barriers and related devices acting on airborne sound propagation — Test method for determining the acoustic performance — Part 1: Intrinsic characteristics - Sound absorption under diffuse sound field conditions*

EN 16272-2, *Railway applications — Infrastructure — Noise barriers and related devices acting on airborne sound propagation — Test method for determining the acoustic performance — Part 2: Intrinsic characteristics - Airborne sound insulation under diffuse sound field conditions* (the present document)

EN 16272-3-1, *Railway applications — Infrastructure — Noise barriers and related devices acting on airborne sound propagation — Test method for determining the acoustic performance — Part 3-1: Normalized railway noise spectrum and single number ratings for diffuse sound field applications*

EN 16272-3-2, *Railway applications — Infrastructure — Noise barriers and related devices acting on airborne sound propagation — Test method for determining the acoustic performance — Part 3-2: Normalized railway noise spectrum and single number ratings for direct sound field applications*

EN 16272-4, *Railway applications — Track — Noise barriers and related devices acting on airborne sound propagation — Test method for determining the acoustic performance — Part 4: Intrinsic characteristics - In situ values of sound diffraction under direct sound field conditions*

EN 16272-5, *Railway applications — Infrastructure — Noise barriers and related devices acting on airborne sound propagation — Test method for determining the acoustic performance — Part 5: Intrinsic characteristics - Sound absorption under direct sound field conditions*

EN 16272-6, *Railway applications — Infrastructure — Noise barriers and related devices acting on airborne sound propagation — Test method for determining the acoustic performance — Part 6: Intrinsic characteristics - Airborne sound insulation under direct sound field conditions*

CEN/TS 16272-7, *Railway applications — Track — Noise barriers and related devices acting on airborne sound propagation — Test method for determining the acoustic performance — Part 7: Extrinsic characteristics - In situ values of insertion loss*

Any feedback and questions on this document should be directed to the users' national standards body. A complete listing of these bodies can be found on the CEN website.

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: 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 the United Kingdom.

Introduction

This document describes a test method for determining the intrinsic characteristics of sound reflection of noise barriers and related devices acting on airborne sound propagation designed for railways in non-reverberant conditions (a measure of intrinsic performance). It can be applied indoors or outdoors. Indoors, it can be applied in a purposely built test facility (under direct sound field conditions). Outdoors, it can be applied in a purposely built test facilities, e.g. near a laboratory or a factory, as well as *in situ*, i.e. where the noise barriers are installed. The method can be applied without damaging the surface.

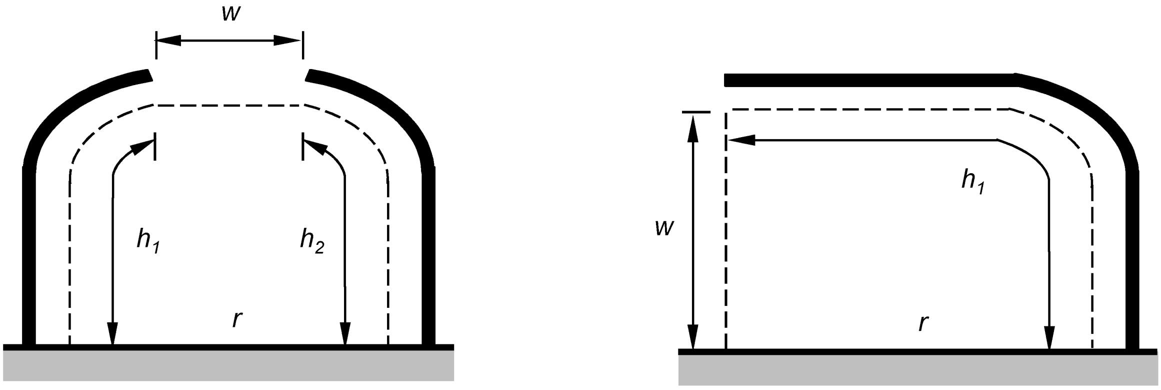
The method can be used to qualify products to be installed along railways as well as to verify the compliance of installed noise barriers and related devices acting on airborne sound propagation to design specifications. Regular application of the method can be used to verify the long-term performance of noise barriers and related devices acting on airborne sound propagation. The method requires the average of results of measurements taken in different points in front of the device under test and/or for specific angles of incidences. The method is able to investigate flat and non-flat products.

The measurement results of this method for sound absorption are not directly comparable with the results obtained under diffuse sound field conditions (e.g. EN 16272-1), mainly because the present method uses a directional sound field, not a diffuse sound field. The test method specified in the present document should not be used to determine the intrinsic characteristics of sound absorption of noise barriers and related devices acting on airborne sound propagation to be installed in reverberant conditions, e.g. claddings inside tunnels or deep trenches.

For the purpose of this document reverberant conditions are defined based on the envelope, e, across the railway formed by the device under test, trench sides or buildings (the envelope does not include the rail surface) as shown by the dashed lines in Figure 1. Conditions are defined as being reverberant when the percentage of open space in the envelope is less than or equal to 25 %, i.e. reverberant conditions occur when $w/e \leq 0{,}25$, where $e = (w+h_1+h_2)$.

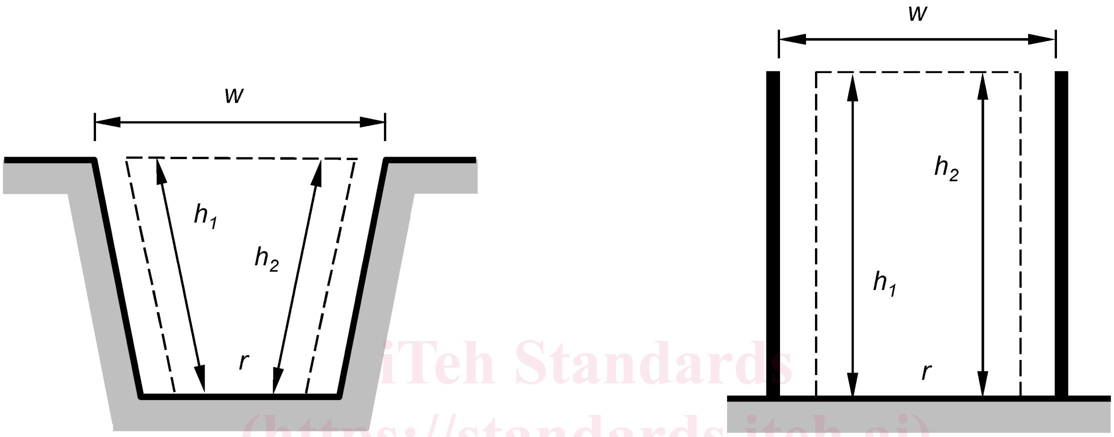
This method introduces a specific quantity, called reflection index, to define the sound reflection in front of a noise barrier, and then calculate a single-number rating for sound absorption from it, while the measurements under diffuse sound field conditions (according to EN 16272-1) give a sound absorption coefficient as a function of frequency and then calculate a single-number rating for sound absorption from it. Values of the sound absorption coefficient measured under diffuse sound field conditions can be converted to conventional values of a reflection coefficient taking the complement to one. In this case, research studies suggest that some correlation exists between diffuse sound field data, measured according to EN 16272-1 and direct sound field data, measured according to the method specified in this document [6], [9], [17], [18], [19], [20].

NOTE This method can be used to qualify noise barriers and related devices acting on airborne sound propagation for other applications, e.g. to be installed nearby industrial sites. In this case the single-number ratings (see EN 16272-3-2) is calculated using an appropriate spectrum.



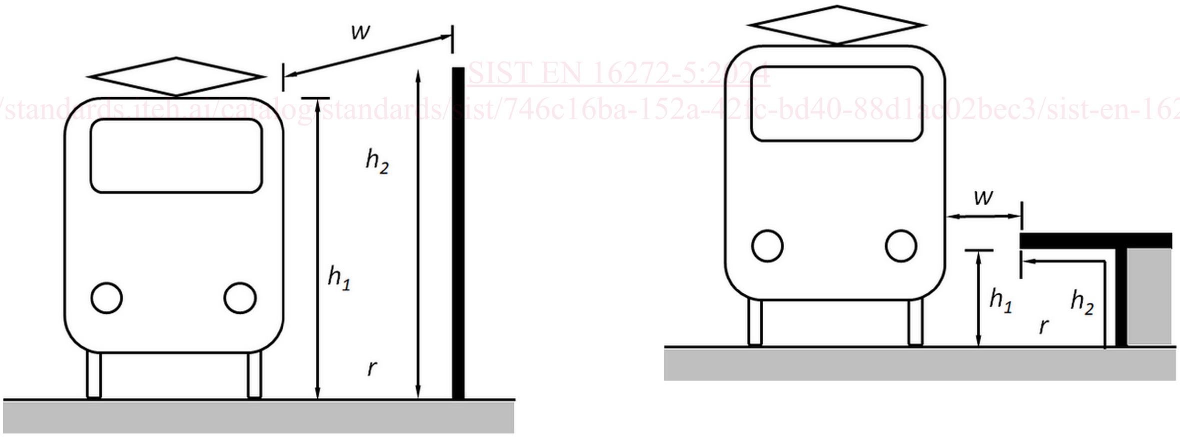
a) Partial cover on both sides of the railway; envelope, $e = w+h_1+h_2$.

b) Partial cover on one side of the railway; $e = w+h_1$, $h_2 = 0$.



c) Deep trench envelope, $e = w+h_1+h_2$.

d) Tall barriers or buildings; envelope, $e = w+h_1+h_2$.



e) Train passing close to a noise barrier; envelope, $e = w+h_1+h_2$

f) Train passing close to a platform at the station. envelope, $e = w+h_1+h_2$

Key

r	rail surface
w	width of open space
h_1	Developed length of element, e.g. cover, trench side, barrier or building
h_2	Developed length of element, e.g. cover, trench side, barrier or building
NOTE	Figure 1 is not to scale.

Figure 1 — (not to scale) Sketch of the reverberant condition check in some cases

1 Scope

This document describes a test method for measuring a quantity representative of the intrinsic characteristics of sound absorption from railway noise barriers and related devices acting on airborne sound propagation, the sound reflection index *RI*, and then calculate a single-number rating for sound absorption from it.

The test method is intended for the following applications:

- determination of the intrinsic characteristics of sound absorption of noise barriers and related devices acting on airborne sound propagation to be installed along railways, to be measured either on typical installations alongside railways or on a relevant sample section;
- determination of the intrinsic characteristics of sound absorption of noise barriers and related devices acting on airborne sound propagation in actual use under direct sound field conditions;
- comparison of design specifications with actual performance data after the completion of the construction work;
- verification of the long-term performance of noise barriers and related devices acting on airborne sound propagation (with a repeated application of the method).

The test method is not intended for the following applications:

- determination of the intrinsic characteristics of sound absorption of noise barriers and related devices acting on airborne sound propagation to be installed in reverberant conditions, e.g. inside tunnels or deep trenches.

Results for the sound reflection index are expressed as a function of frequency, in one-third octave bands, where possible, between 100 Hz and 5 kHz. If it is not possible to get valid measurements results over the whole frequency range indicated, the results are given in a restricted frequency range and the reasons of the restriction(s) are clearly reported.

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 16272-3-2, *Railway applications - Infrastructure - Noise barriers and related devices acting on airborne sound propagation - Test method for determining the acoustic performance - Part 3-2: Normalized railway noise spectrum and single number ratings for direct field applications*

EN 16951-1, *Railway applications - Track - Noise barriers and related devices acting on airborne sound propagation - Procedures for assessing long term performance - Part 1: Acoustic characteristics*

EN 61672-1, *Electroacoustics - Sound level meters - Part 1: Specifications*

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

3 Terms, definitions, symbols and abbreviations

3.1 Terms and definitions

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

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

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp/

NOTE For the purpose of this document, the following definitions take precedence over other definitions from the above websites.

3.1.1
noise barrier
noise reducing device, which obstructs the direct transmission of airborne sound emanating from railways and which will typically span between posts and also may overhang the railway

Note 1 to entry: Noise barriers are generally made of acoustic and structural elements (see 3.1.3 and 3.1.4).

3.1.2
cladding
noise reducing device, which is attached to a wall or other structure and reduces the amount of sound reflected

Note 1 to entry: Claddings are generally made of acoustic and structural elements (see 3.1.3 and 3.1.4).

3.1.3
acoustic element
element whose primary function is to provide the acoustic performance of the device

3.1.4
structural element
element whose primary function is to support or hold in place acoustic elements

3.1.5
added device
added component that influences the acoustic performance of the original noise-reducing device (acting primarily on the diffracted energy)

Note 1 to entry: In some noise barriers, the acoustic function and the structural function cannot be clearly separated and attributed to different components.

3.1.6
railway side exposure
the use of the product as a noise reducing device installed alongside railways

3.1.7
sound reflection index
quantity representing the amount of sound not absorbed by the device under test, specified by Formula (1)

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

3.1.8
measurement grid for sound reflection index measurements

measurement grid constituted of nine equally spaced microphones in a 3x3 squared configuration

Note 1 to entry: The orthogonal spacing between two subsequent microphones, either vertically or horizontally, is s = 0,40 m.

Note 2 to entry: See 4.6 and Figure 3.

Note 3 to entry: Microphones are numbered like in Figure 3.

3.1.9
reference height

height h_S equal to half the height, h_B, of the noise barrier under test: $h_S = h_B/2$

Note 1 to entry: When the height of the device under test is greater than 4 m and, for practical reasons, it is not advisable to have a height of the source $h_S = h_B/2$, it is possible to have $h_S = 2$ m, accepting the corresponding low frequency limitation (see 4.5.7 and 4.6.4).

Note 2 to entry: See Figures 2 and 3.

3.1.10
(source and microphone) reference surface for sound reflection index measurements

ideal, smooth surface facing the sound source side of the noise barrier under test and just touching the most protruding and significant parts of it within the tested area

Note 1 to entry: The reference surface is as smooth as possible, and follows the inclination or curve of the device under test within the tested area. For vertical and flat noise barriers, the reference surface is a vertical plane. For inclined and flat noise barriers, the reference surface is a plane with the same inclination. For curve and flat noise barriers, the reference surface is a curve surface with the same curvature

Note 2 to entry: See Figures 2, 7, 8, and 9.

3.1.11
source reference position

position facing the side to be exposed to noise when the device is in place, located at the reference height h_S and placed so that the horizontal distance of the source front panel to the reference surface is d_S = 1,50 m

Note 1 to entry: See Figures 2 and 3.

3.1.12
measurement grid reference position

position of the measurement grid compliant with all the following conditions:

i) the measurement grid is on the noise barrier side to be exposed to noise when the device is in place;

ii) the central microphone (microphone n. 5) is located at the reference height h_S ;

iii) the shortest distance of the central microphone to the reference surface is d_M = 0,25 m

Note 1 to entry: For flat noise barriers, see Figures 2, and 3. For non-flat noise barriers, see Figure 7. For inclined or curved noise barriers, see Figures 8 and 9.

3.1.13
reference loudspeaker-measurement grid distance

distance between the front panel of the loudspeaker and the central microphone (microphone n. 5) of the measurement grid

Note 1 to entry: The reference loudspeaker-measurement grid distance is equal to d_{SM} = 1,25 m (see Figures 2 and 4).

3.1.14
free-field measurement for sound reflection index measurements

measurement taken with the loudspeaker and the measurement grid in an acoustic free field in order to avoid reflections from any nearby object, including the ground, keeping the same geometry as when measuring in front of the device under test

Note 1 to entry: See Figure 4.

3.1.15
maximum sampled area

surface area, projected on a front view of the device under test for reflection index measurements, which must remain free of reflecting objects causing parasitic reflections

3.1.16
Adrienne temporal window

composite temporal window having a leading edge with a left-half Blackman-Harris shape and a fixed length of 0,5 ms, followed by a flat portion and a trailing edge having a right-half Blackman-Harris shape, so that the lengths of the flat portion and the right-half Blackman-Harris portion have a ratio of 7/3

Note 1 to entry: This type of window is specified in 4.5.6.

3.1.17
background noise

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

3.1.18
signal-to-noise ratio

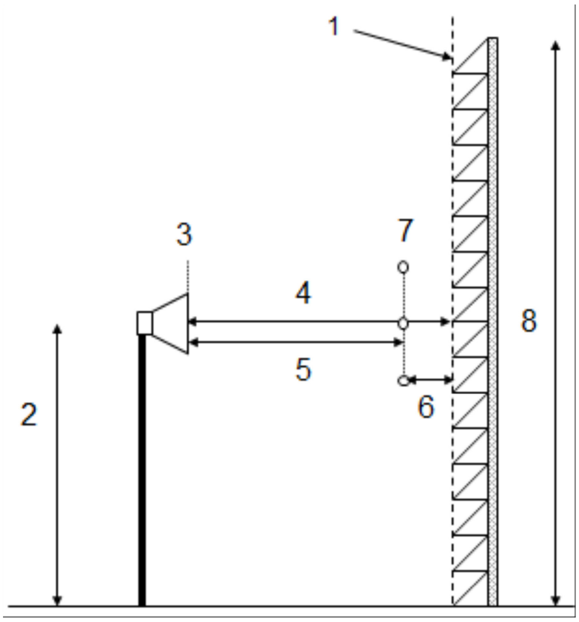
difference in decibels between the level of the test signal and the level of the background noise at the moment of detection of the useful event (within the Adrienne temporal window)

3.1.19
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.



Key

1 source and microphone reference surface

2 reference height h_S [m]

3 loudspeaker front panel

4 distance between the loudspeaker front panel and the reference surface, d_S [m]

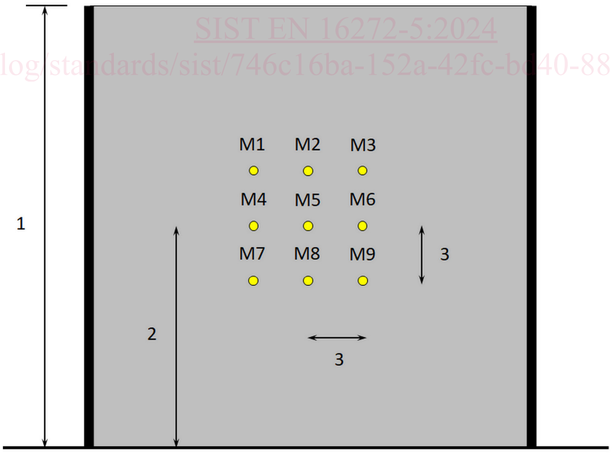
5 distance between the loudspeaker front panel and the measurement grid, d_{SM} [m]

6 distance between the measurement grid and the reference surface, d_M [m]

7 measurement grid

8 noise barrier height, h_B [m]

Figure 2 — (not to scale) Sketch of the sound source and the measurement grid in front of the noise barrier under test for sound reflection index measurements



Key

1 noise barrier height h_B [m]

2 reference height h_S [m]

3 orthogonal spacing between two subsequent microphones s [m]

Figure 3 — (not to scale) Measurement grid for sound reflection index measurements in front of the device under test (sound source side); the yellow circles indicate the microphone positions, labelled from M1 to M9