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Third edition
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Railway applications — Acoustics — Noise measurement inside railbound vehicles

Applications ferroviaires — Acoustique — Mesurage du bruit à l'intérieur des véhicules circulant sur rails

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by the European Committee for Standardization (CEN) Technical Committee CEN/TC 256, *Railway applications*, in collaboration with ISO Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 1, *Noise*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This third edition cancels and replaces the second edition (ISO 3381:2005), which has been technically revised.

The main changes compared to the previous edition are as follows:

— new structure of the document to align it with the structure of ISO 3095;

— an improved selection process of the measurement positions – see Clause 5;

— new measurement procedures for noise in driver's cab – see Clause 7;

— improved specifications of the vehicle conditions for the different types of tests - see 6.4, 7.3, 8.4 and 9.4;

— an improved assessment of the tonality - see 6.7, 8.7 and 9.8.2.

— an improved indirect assessment of the track acoustic characteristics – see 8.3.4, 9.3 and Annex C;

— precisions for measurement in specific environments (tunnels, …) – see Annex D;

— an assessment of measurement uncertainties – see Annex E.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Railway applications — Acoustics — Noise measurement inside railbound vehicles

1 Scope

This document specifies the measurement method and conditions to obtain reproducible noise levels on-board all kinds of vehicles operating on rails or other types of fixed track, hereinafter conventionally called “unit”, except for track maintenance vehicles in working modes.

This document is applicable to type testing. It does not include all the instructions to carry out monitoring testing or evaluation of noise exposure of passengers or drivers over a whole journey.

This document is not applicable to guided buses.

It provides measurement procedures for vehicle interior noise (in general, a vehicle type test is carried out using only a selected subset of these tests):

— when the vehicle is moving at constant speed;

— when the vehicle is stationary;

— when the vehicle is accelerating or decelerating;

— in the driver's cab when an external warning horn is sounding (specifically required for European Union regulation application)

It does not provide measurement procedures for:

— audibility or intelligibility of any audible signals;

— assessment of warning devices other than warning horns.

The assessment of noise exposure of train crew due to operational conditions is not in the scope of this document.

The results can be used, for example:

— to characterise the noise inside these units;

— to compare the internal noise of various units on a particular track section;

— to collect basic source data for units.

The test procedures specified in this document are of engineering grade (grade 2), the preferred grade for noise declaration purposes as defined in ISO 12001. If test conditions are relaxed, for example as they are for monitoring of in-service trains, then the results are no longer of engineering grade.

The procedures specified for accelerating and decelerating tests are of survey grade (grade 3).

2 Normative references

The following referenced documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For undated references the latest edition of the referenced document (including any amendments) applies.

ISO 1996-1:2016, *Acoustics — Description, measurement and assessment of environmental noise — Part 1: Basic quantities and assessment procedures*

ISO 1996-2:2017, *Acoustics — Description, measurement and assessment of environmental noise — Part 2: Determination of sound pressure levels*

IEC 60942, *Electroacoustics — Sound calibrators*

IEC 61260-1, *Electroacoustics — Octave-band and fractional-octave-band filter — Part 1: Specifications*

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

EN 15153-2:2020, *Railway applications — external visible and audible warning devices — part 2: warning horns for heavy rail*

EN 15461:2008+A1:2010, *Railway applications — Noise emission — Characterization of the dynamic properties of track sections for pass by noise measurements*

EN 15610, *Railway applications — Acoustics — Rail and wheel roughness measurement related to noise generation*

3 Terms and definitions

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

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

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

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

3.1
unit
rolling stock which is subject to the application of this document

Note 1 to entry: A unit can be composed of several powered or unpowered vehicles, or cars.

3.2
type test
<noise measurement inside railbound units> measurement performed to prove that, or to check if, a unit delivered by the manufacturer complies with the noise specifications

3.3
acoustic roughness
$r(x)$
variation of the height of the rail running surface associated with rolling noise excitation, expressed as a function of distance x along the rail

[SOURCE: EN 15610:2019]

3.4
track decay rate
rate of attenuation of vibration amplitude of either vertical or lateral bending wave motion in the rail as a function of the distance along the rail

Note 1 to entry: The track decay rate is represented by a one-third octave spectrum of values expressed in decibels per metre (dB/m) representing attenuation over distance.

[SOURCE: EN 15461:2008+A1:2010]

3.5
acoustic track characteristics
ATC
characteristics of the track that are defined in terms of acoustic rail roughness and *track decay rates* (3.4)

3.6
test section
specific section of track that is associated with a particular set of measurements

3.7
impulsive sound
sound characterized by one or more brief bursts of sound pressure and that is such that the duration of a single impulsive noise is usually less than 1 s

EXAMPLE Noise from blowoff valves, relay switches.

Note 1 to entry: The quantification of impulsiveness is set out in Annex B.

[SOURCE: ISO 1996-1:2016, 3.4.8, modified – "brief bursts of sound pressure" replaced with "one or more brief bursts of sound pressure"; former Note 1 to entry is incorporated into the definition as "and that is such that the duration of a single impulsive noise is usually less than 1 s"; Example and new Note 1 to entry added.]

3.8
intermittent source
source that operate at regular or irregular time intervals and is such that its duration is short

EXAMPLE Noise from compressors, exhaust fans, door operation, toilet.

3.9
tonal sound
sound characterized by a single frequency component or narrow band components that emerge audibly from the total sound

[SOURCE: ISO 1996-1:2016, 3.4.9]

4 Instrumentation and calibration

4.1 Instrumentation

The microphones, signal acquisition units and processing algorithms used shall each comply with the requirements of IEC 61672-1 specifications for class 1 measuring equipment.

NOTE Multichannel acquisition systems are generally used to record data.

In the case of measurements of survey grade, this requirement is relaxed to class 2 instruments.

The sound calibrator shall meet the requirements of class 1 according to IEC 60942.

Microphones with free-field or diffuse-field characteristics shall be used. A suitable microphone windscreen should be used.

Where one-third octave frequency band analysis is required, the filters shall meet the requirements of class 1, according to IEC 61260-1.

The conformity of the calibrator with the requirements of IEC 60942 shall have been verified within one year of the test date. The conformity of the instrumentation system with the requirements of IEC 61672 series shall have been within two years of the test date. The date of the last verification of the conformity with the relevant standards shall be recorded.

4.2 Calibration

Before and after each series of measurements, a sound calibrator shall be applied to the microphone(s) for verifying the calibration of the entire measuring system at one or more frequencies over the

frequency range of interest. If the difference between the two calibrations is more than 0,5 dB, all the measurement results in between shall be rejected.

The sensitivity of the measurement chain actually applied in the field shall be documented.

5 Measurement positions

5.1 Division of the unit into areas

5.1.1 General

The entire unit shall be divided into areas. Each area being defined by its type (see 5.1.2) and acoustic characteristics (see 5.1.3).

5.1.2 Definition of area types

Area types are distinguished by their purpose, for example: passenger areas, seating (first class, standard class), standing areas (including aisles), gangway, driver's cab, train manager compartment, galley, lavatories, entrance, lobbies, restaurant, quiet, sleeping or resting areas.

The range of characteristics to be found within an area type depends upon the vehicle type and the proposed operation schemes.

NOTE For example, for trams and metros, it can be appropriate to define a 'passenger area' that does not distinguish between seating and standing areas.

5.1.3 Definition of area acoustics

The acoustics characteristics of areas are distinguished by their acoustic boundaries.

Examples for acoustic boundaries are:

— partition walls;

— draught screens;

— internal doors;

— decks of double deckers.

5.1.4 Selection of areas to be assessed

The number of discrete areas to be characterized by measurement may be reduced by identifying discrete areas that are similar in terms of their type and acoustics characteristics. See Figures 1, 2 and 3.

No area shall cross the boundaries of an acoustic space (partition, wall, doors, …) and of a single vehicle.

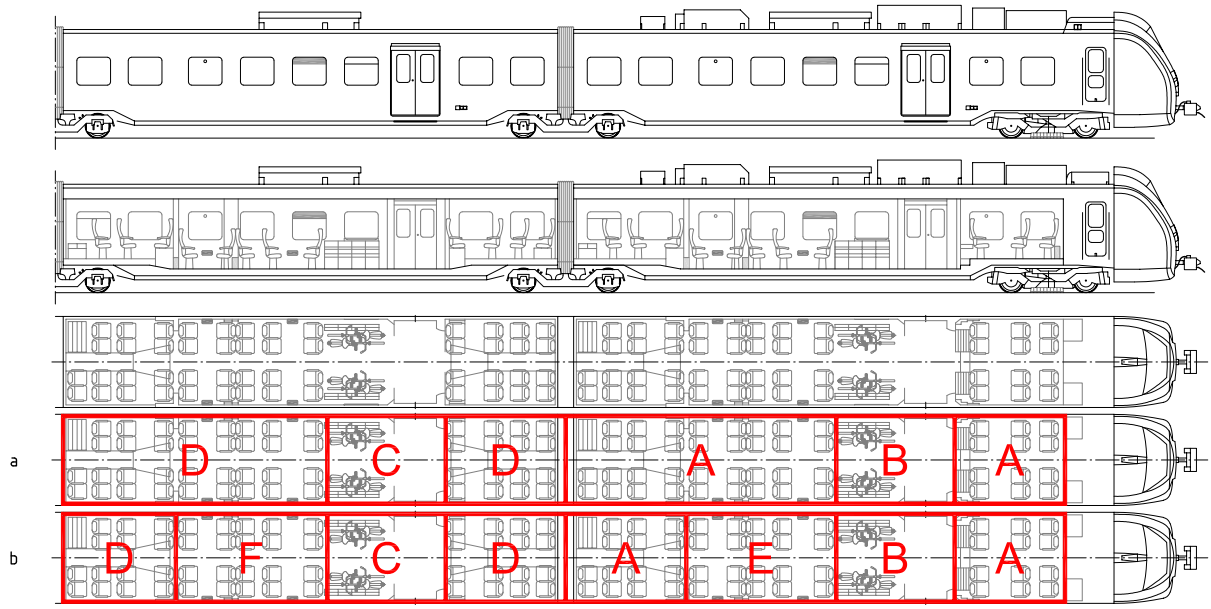
For example, in double-deckers, decks shall be considered as separate areas.

Where there is no specification of the area types to be assessed, a minimum selection may be done assuming that the noise criteria apply only to areas of the types with permanent passenger seats.

Areas to be assessed may be selected taking into account additional criteria (e.g. contractual requirements in a project that can focus on seating area over a bogie, seating area close to a vestibule, …). In dividing the unit into areas, bear in mind two objectives:

a) the efficiency of identifying similar areas to reduce the measurement effort, and

b) compatibility with the level of detail in the stated noise criteria.

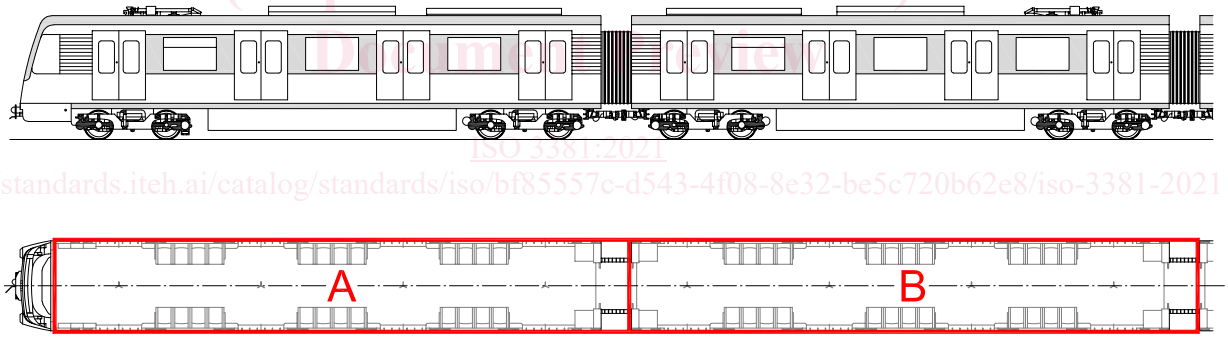


Key

a Selection as a function of seating (areas A and D), multipurpose and vestibule (areas B and C).

b The same case as [a], but include differentiation between floor heights (subdivision of areas A and D).

Figure 1 — Example of a possible choice of areas to be assessed dividing 2 vehicles of a multiple unit



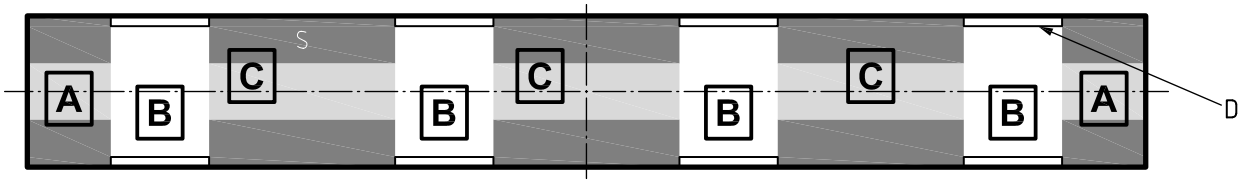
Key

A first car

B second car

NOTE The gangway between the 2 cars is open and not considered as a specific area but included in area A.

Figure 2 — Example of definition of areas (A and B) in the case of a driverless metro



Key

A, B and C areas

D passenger door

S passenger seats

NOTE Areas with seats (A and C); Vestibule areas (B). Areas A are C differentiated in terms of their acoustic boundaries.

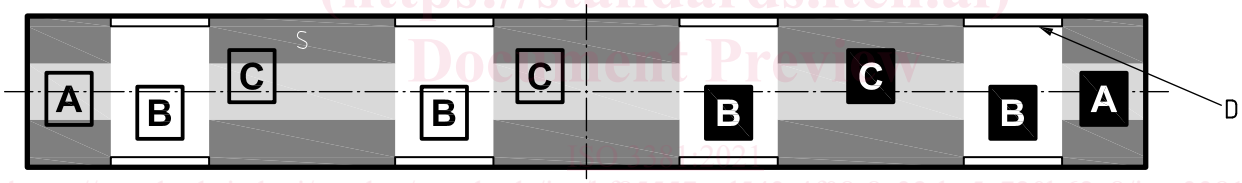
Figure 3 — Example of passenger coach divided into areas

5.2 Measurement positions

Measurements shall be carried out in at least one example of each similar area identified in 5.1 (e.g. one example of each of the areas "A", "B" and "C" in Figure 3).

If measurements are carried out for multiple examples of similar areas, results shall be averaged.

NOTE 1 In that case, the symmetry of the vehicle can be used as a justification to minimize the number of similar areas to be measured (see Figure 4, in which the white character areas can be omitted based on symmetry of the layout.)



Key

A, B and C areas

D passenger door

S passenger seats

Figure 4 — Example of selection of similar measurement areas

Each discrete area that is to be assessed shall be divided into equal segments of maximum length 5 m along the unit, and each segment shall contain at least one measurement position (e.g. see Figure 5).

NOTE 2 This document leaves the freedom to choose measurement locations over a seat or between seats at the same height in order to provide a representative sample of an area.

Some measurement positions can be omitted.

Measurement positions shall not be located closer than 0,3 m to a wall, screen or door.

NOTE 3 Microphone positions at this distance from boundary surfaces are representing the sound field heard by passengers.

Additional measurement positions may be defined but shall be reported separately and not as part of the characterization of an area.

