INTERNATIONAL STANDARD

ISO 3095

Second edition
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Railway applications — Acoustics — Measurement of noise emitted by railbound vehicles

Applications ferroviaires — Acoustique — Mesurage du bruit émis par les véhicules circulant sur rails

Reference number
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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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.

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

ISO 3095 was prepared by the European Committee for Standardization (CEN) in collaboration with Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 1, *Noise*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

Throughout the text of this document, read "...this European Standard..." to mean "...this International Standard...".

This second edition cancels and replaces the first edition (ISO 3095:1975), which has been technically revised.

For the purposes of this International Standard, the CEN annex regarding fulfilment of European Council Directives has been removed.

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Foreword

This European Standard (EN ISO 3095:2005) has been prepared by Technical Committee CEN/TC 256 “Railway applications”, the secretariat of which is held by DIN, in collaboration with Technical Committee ISO/TC 43 "Acoustics".

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of an identical text or by endorsement, at the latest by February 2006, and conflicting national standards shall be withdrawn at the latest by February 2006.

This document has been prepared under a mandate given to CEN/CENELEC/ETSI by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive 96/48.

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this document.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

1 Scope

This European Standard specifies the conditions for obtaining reproducible and comparable measurement results of levels and spectra of noise emitted by all kinds of vehicles operating on rails or other types of fixed track, hereinafter conventionally called “train”, except for track maintenance vehicles in operation.

This standard is applicable for:

— type testing;

— periodic monitoring testing.

The results may be used, for example:

— to characterise the noise emitted by these trains;

— to compare the noise emission of various vehicles on a particular track section;

— to collect basic source data for trains.

The test procedures specified in this European Standard are of engineering grade (grade 2, with a precision of ± 2 dB), that is the preferred one for noise declaration purposes, as defined in EN ISO 12001.

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

NOTE 1 Although this standard is for characterising noise emission for vehicles, the wheel-rail rolling noise often contains a significant and sometimes dominant noise contribution from the track.

NOTE 2 This Standard aims to specify the conditions for obtaining reproducible and comparable measurement results of noise emitted by railbound vehicles and the method described may also be used to monitor the noise emissions in ordinary traffic. In the latter case it is not necessary that track and vehicle conditions fulfil the requirements described in the standard. Therefore the results of such tests are only representative of a “particular” situation.

2 Normative references

The following referenced documents are indispensable for the application 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 60942, *Electroacoustics — Sound calibrators (IEC 60942:2003)*

EN 61260, *Electroacoustics — Octave-band and fractional-octave-band filters (IEC 61260:1995)*

EN 61672-1, *Electroacoustics — Sound level meters — Part 1: Specifications (IEC 61672-1:2002)*

EN 61672-2, *Electroacoustics — Sound level meters — Part 2: Pattern evaluation tests (IEC 61672-2:2003)*

EN ISO 266, *Acoustics — Preferred frequencies (ISO 266:1997)*

3 Terms and definitions

NOTE Definitions from 3.7 to 3.14 apply to values measured either as a frequency spectrum or in a particular frequency band of centre *f* (expressed in Hz).

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

3.1
train
single vehicle or a number of coupled vehicles/units operating on a guided ground transport system

[EN 13452-1]

3.2
type test for noise emission of railbound vehicles
type test
measurement performed to prove that, or to check if, a vehicle delivered by the manufacturer complies with the noise specifications

3.3
monitoring test for noise emission of railbound vehicles
monitoring test
measurement performed to check if the noise of a vehicle has changed since initial delivery or after modification

3.4
environmental assessment test
measurement performed for collecting data to be utilised in prediction method for environmental assessment

3.5
roughness
r
root mean square (RMS) value of the amplitude variation of the running surface of a rail in the direction of motion (longitudinal level) measured over a rail length, expressed in μm

3.6
roughness level
L_r
level given by the equation:

$$L_r = 10 \lg (r/r_0)^2 \text{ dB} \quad (1)$$

where

L_r is the roughness level in dB;

r is the RMS roughness in μm;

r_0 the reference roughness; r_0 = 1 μm.

This definition applies to values measured either as a wavelength spectrum or in a particular wavelength band centred at λ (expressed in m)

3.7
sound pressure
$p(t)$
root mean square (RMS) value of a fluctuating pressure superimposed on the static atmospheric pressure measured over a certain time period, expressed in Pa

3.8
sound pressure level
L_p
level given by the equation:

$$L_p = 10 \lg (p(t)/p_0)^2 \quad \text{dB} \tag{2}$$

where

L_p is the sound pressure level in dB;

$p(t)$ is the RMS sound pressure in Pa;

p_0 the reference sound pressure; p_0 = 20 μPa

NOTE Adapted from ISO 1996-1:2003.

3.9
A-weighted sound pressure level
L_{pA}
sound pressure level obtained by using the frequency weighting A (see EN 61672 –1 and EN 61672-2), given by the following equation:

$$L_{pA} = 10 \lg (p_A(t)/p_0)^2 \quad \text{dB} \tag{3}$$

where

L_{pA} is the A-weighted sound pressure level in dB;

$p_A(t)$ is the RMS A-weighted sound pressure in Pa;

p_0 the reference sound pressure; p_0 = 20 μPa.

3.10
AF-weighted maximum sound pressure level
L_{pAFmax}
maximum value of the A-weighted sound pressure level determined during the measurement time interval T by using time weighting F (fast)

[EN 61672-1]

3.11
A-weighted equivalent continuous sound pressure level
$L_{pAeq,T}$
A-weighted sound pressure level given by the following equation:

$$L_{pAeq,T} = 10 \lg \left(\frac{1}{T} \int_0^T \frac{p_A^2(t)}{p_0^2} dt \right) \quad \text{dB} \tag{4}$$

where

$L_{pAeq,T}$ is the A-weighted equivalent continuous sound pressure level in dB;

T is the measurement time interval in s;

$p_A(t)$ is the A-weighted instantaneous sound pressure in Pa;

p_0 the reference sound pressure; p_0 = 20 μPa.

NOTE Adapted from ISO 1996-1:2003.

3.12
A-weighted equivalent continuous sound pressure level on the pass-by time
L_{pAeq,T_p}
A-weighted sound pressure level given by the following equation:

$$L_{pAeq,T_p} = 10 \lg \left(\frac{1}{T_2 - T_1} \int_{T_1}^{T_2} \frac{p_A^2(t)}{p_0^2} dt \right) \quad \text{dB} \tag{5}$$

where

L_{pAeq,T_p} is the A-weighted equivalent continuous sound pressure level on the pass-by time in dB;

$T_p = T_2 - T_1$ is the measurement pass-by time interval beginning at T_1 and ending at T_2 in s, see Figure 1;

$p_A(t)$ is the A-weighted instantaneous sound pressure in Pa;

p_0 the reference sound pressure; p_0 = 20 μPa.

3.13
single event level
SEL
A-weighted sound level of a single event measured for a time interval T and normalised to T_0 = 1 s. The time interval T will be long enough to include all the acoustic energy related to the event, considering at least the points at – 10 dB below the lower L_{pA} during T. SEL is given by the following equation:

$$\text{SEL} = 10 \lg \left(\frac{1}{T_0} \int_0^T \frac{p_A^2(t)}{p_0^2} dt \right) \quad \text{dB} \tag{6}$$

where

SEL is the A-weighted sound exposure level in dB;

T_0 = 1 s is the reference time interval;

T is the measurement time interval in s;

$p_A(t)$ is the A-weighted instantaneous sound pressure in Pa;

p_0 the reference sound pressure; p_0 = 20 μPa.

single event level, SEL, is related to the A-weighted equivalent continuous sound pressure level, $L_{pAeq,T}$, by the following equation:

$$\text{SEL} = L_{pAeq,T} + 10 \lg (T/T_0) \quad \text{dB} \tag{7}$$

3.14
transit exposure level
TEL
A-weighted sound level of a train passage, measured for a time interval T and normalised to the pass-by time T_p. The time interval T will be long enough to include all the acoustic energy related to the event, considering at least the points at – 10 dB below the lower L_{pA} during T_p. TEL is given by the following equation:

$$\mathrm{TEL} = 10 \lg \left(\frac{1}{T_\mathrm{p}} \int_0^T \frac{p_\mathrm{A}^2(t)}{p_0^2} \mathrm{d}t \right) \quad \mathrm{dB} \tag{8}$$

where

TEL is the A-weighted transit exposure level in dB;

T is the measurement time interval in s;

T_p is the pass-by time of the train in seconds which is the overall length of the train divided by the train speed;

$p_\mathrm{A}(t)$ is the A-weighted instantaneous sound pressure in Pa;

p_0 the reference sound pressure; p_0 = 20 μPa.

transit exposure level, TEL, is related to single event level, SEL, and to the A-weighted equivalent continuous sound pressure level, $L_{p\mathrm{Aeq},T}$ by the following equations:

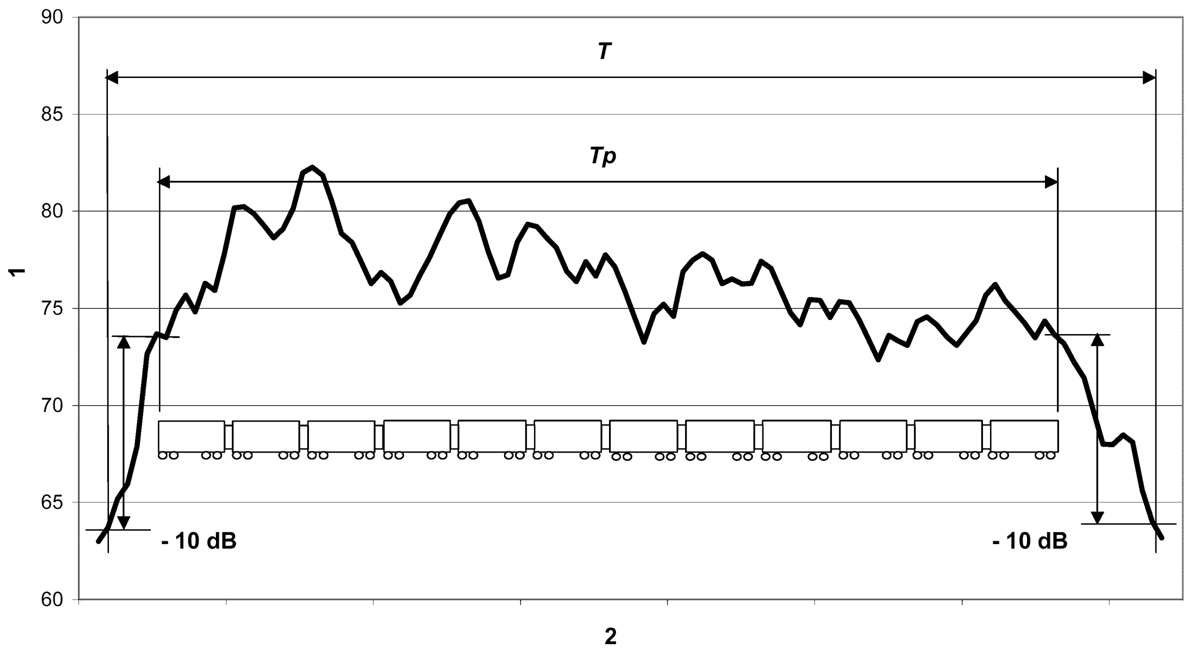
$$\mathrm{TEL} = \mathrm{SEL} + 10 \lg_{10} (T_0/T_\mathrm{p}) \tag{9}$$ and

$$\mathrm{TEL} = L_{p\mathrm{Aeq},T} + 10 \lg (T/T_\mathrm{p}) \tag{10}$$

where T_0 = 1s is the reference time interval

3.15
measurement time interval T, and train pass-by time T_p

measurement time interval, T, is chosen, so the measurement starts when the A-weighted sound pressure level is 10 dB lower than found when the front of the train is opposite the microphone position. The measurement is stopped when the A-weighted sound pressure level is 10 dB lower than found when the rear of the train is opposite the microphone position.



Key

1 A-weighted sound pressure level, dB
2 Time

Figure 1 — Example of selection of measuring time interval, T, for a whole train

NOTE The example illustrates the need for an independent device for measuring the train passage time, as the time cannot be deduced from the sound pressure level versus time.

For measurement of vehicle(s), which form part of a train, the measurement time interval T is the passing time T_p of the vehicle(s) under test.

For the measurement of un-powered vehicles, the measurement time interval T begins when the centre of the first vehicle under test passes in front of the microphone position and ends when the centre of the last vehicle under test passes in front of the microphone position. Figure 2 shows the required measurement time interval T or the measurement of a single un-powered vehicle. Furthermore, it shows an example of the A-weighted sound pressure level, L_{pA}, time history for the passage of a train.

