BS EN 15892:2011

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Railway applications — Noise Emission — Measurement of noise inside driver's cabs

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National foreword

This British Standard is the UK implementation of EN 15892:2011.

The UK participation in its preparation was entrusted to Technical Committee EH/1/2, Transport noise.

A list of organizations represented on this committee can be obtained on request to its secretary.

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ISBN 978 0 580 65156 4

ICS 17.140.30; 45.060.10

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This British Standard was published under the authority of the Standards Policy and Strategy Committee on 28 February 2011.

Amendments issued since publication

Date	Text affected

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 15892

February 2011

ICS 17.140.30; 45.060.10

English Version

Railway applications - Noise Emission - Measurement of noise inside driver's cabs

Applications ferroviaires - Emission de bruit - Mesurage du bruit dans la cabine de conduite

Bahnanwendungen - Geräuschemission - Geräuschmessung im Führerraum

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Foreword

This document (EN 15892:2011) 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of an identical text or by endorsement, at the latest by August 2011, and conflicting national standards shall be withdrawn at the latest by August 2011.

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

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 the Directive 2008/57/EC.

For relationship with EC Directive 2008/57/EC, see informative Annex ZA, which is an integral part of this document.

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1 Scope

This European Standard specifies a type test method to measure noise levels inside the driver's cabs of railway vehicles for assessing compliance with the relevant European legislation.

NOTE The relevant European legislation includes Directive 2003/10/EC of 6 February 2003 and the Commission Decisions of 23 December 2005 (Technical specification for interoperability relating to the subsystem 'rolling stock — noise' of the trans-European conventional rail system) and of 21 February 2008 (Technical specification for interoperability relating to the 'rolling stock' sub-system of the trans-European high-speed rail system).

This method is applicable to:

— the measurement of noise inside driver's cab resulting from the sounding of external warning horns when the vehicle is stationary;

— the measurement of noise inside the driver cab while the vehicle is running.

The method is not applicable to:

— complementary measurements that can be requested for acceptance tests, but which are not required by the TSIs referred to in this standard;

— the measurement of the noise from internal and external audible devices other than external warning horns;

— routine monitoring of the noise exposure of train crew.

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

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 15153-2, *Railway applications — External visible and audible warning devices for high speed trains — Part 2: Warning horns*

EN 60942:2003, *Electroacoustics — Sound calibrators (IEC 60942:2003)*

EN 61672-1:2003, *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/IEC 17025, *General requirements for the competence of testing and calibration laboratories (ISO/IEC 17025:2005)*

3 Terms and definitions

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

3.1
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

[EN 15610:2009]

NOTE For information, see EN 15610.

3.2
acoustic roughness level
L_r
level expressed in decibels, related to 1,0 μm, given by the following equation:

$$L_r = 10 \cdot \lg\left(\frac{r_{RMS}^{\ 2}}{r_0^2}\right) \quad (1)$$

where

L_r is the acoustic roughness level in dB;

r_{RMS} is the root mean square roughness in μm;

r_0 is the reference roughness; r_0 = 1,0 μm.

NOTE 1 Adapted from EN 15610:2009.

NOTE 2 For information, see EN 15610.

NOTE 3 This definition applies to values measured either as a wavelength spectrum or in a particular wavelength band.

3.3
acoustic roughness spectrum
$\tilde{r}(\lambda)$

amplitude of the acoustic roughness level expressed as a function of the wavelength

NOTE Adapted from EN 15610:2009.

3.4
A-weighted equivalent continuous sound pressure level
$L_{pAeq,T}$
A-weighted sound pressure level given by the following equation:

$$L_{pAeq,T} = 10 \lg\left(\frac{1}{T}\int_0^T \frac{p_A^2(t)}{p_0^2}\mathrm{d}t\right) \quad (2)$$

where

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

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

p_0 is the reference sound pressure; p_0 = 20 µPa*;*

T is the measurement time interval, in s

3.5
external warning horn
device or assembly capable of producing audible warning tones to warn of the train's presence, which covers pneumatic or electric horns, whistles and similar devices

4 Measurement quantities

All noise measurements shall be reported in terms of A-weighted equivalent continuous sound pressure level, $L_{pAeq,T}$, over a defined measurement time interval, T in seconds.

5 Instrumentation and calibration

5.1 Instrumentation

Each component of the instrumentation system shall meet the requirements for a type 1 instrument specified in EN 61672-1:2003.

A suitable microphone windscreen shall always be used for external measurements and is recommended for in-cab measurement.

The compliance of the calibrator with the requirements of EN 60942 shall be verified at least once a year. The compliance of the instrumentation system with the requirements of EN 61672-1 and EN 61672-2 shall be verified at least every 2 years.

The date of the last verification of the compliance with the relevant European Standards shall be recorded.

5.2 Calibration

Before and after each series of measurements a sound calibrator meeting the requirements of Class 1 according to EN 60942:2003 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 shall be rejected.

6 Tests when sounding the external warning horn

6.1 Test conditions

6.1.1 Environmental conditions

The train shall be positioned in an open environment, and therefore not in a building or in a tunnel. Except for the ground, there shall not be any acoustically reflective (hard) surfaces comprising such materials as steel or concrete, including other trains and fixed structures, within 10 m of the external surfaces of the sides of the cab within which tests are being undertaken. Similarly, there shall not be any acoustically reflective surfaces within 25 m of the external surface of the front end of the cab.

6.1.2 Vehicle conditions

The vehicle shall be stationary.

Air management systems, including grilles, filters and fans, shall be clear of any obstruction. Windscreen wipers shall not be in operation during the measurements. During the measurements, the doors and windows of the vehicle shall be kept closed. The minimum number of people necessary to carry out the acoustic tests shall be present in the cab during the measurements. The cab shall be in the condition that will apply when in service.

The horns shall be inspected for debris, which shall be removed if found to be present.

NOTE The sound source that is to be measured, the external warning horn, is inherently of high sound level, and therefore typical internal background noise levels in the cab when stationary are unlikely to interfere with the measured results. Nevertheless, it is advisable to run only those systems on the train that are essential to allow the external warning horn to sound, and to avoid positioning the vehicle at locations where other high noise level sources are present.

6.1.3 Track conditions

No track condition.

6.2 Test procedure

The stationary measurements require the noise level in the vicinity of the driver’s ears to be quantified when the external warning horn is sounded.

When the cab contains more than one set of complete driving controls, the test shall be carried out at each of these positions. This is not necessary at auxiliary driving positions where a full set of controls is not present. When the external warning horn has more than one operating control, the test shall be carried out using each of these controls.

If the vehicle or multiple unit has two cabs and is symmetrical about its longitudinal centre, it is only necessary to carry out the full test within one cab provided the horn configuration and installation is identical for both cabs. If this is not the case, the tests shall be carried out in both cabs and the higher resultant level shall be recorded.

Sound pressure levels shall be measured at the normal operational energy level available on the vehicle. When the external warning horn has two or more tones or chords the following tests shall be carried out for both or all of these. When the acoustic warning has an option for a loud or quiet setting, the loud setting shall be used.

Measurement conditions shall comply with EN 15153-2 for the measurement of horn performances. If the value of $L_{pAeq,T}$ measured under these conditions is outside the range specified for this test within EN 15153-2, or if these measured levels before and after the stationary cab noise measurements differ by more than 3 dB, the cab noise results are invalid.

The background noise level within the cab shall be measured and recorded at the beginning and end of the stationary measurement, in terms of $L_{pAeq,T}$ over a measurement time interval, T, of 20 s. This measurement shall be obtained at the same position on both occasions, and that position is to be chosen from one of the available eight locations as defined below.

The measurement shall be carried out at eight evenly spaced microphone positions in a horizontal plane at the height of a seated driver’s ears, at a radius of 25 cm, while the external warning horn is sounding. The position of the seated driver's ears, if not defined elsewhere, shall be taken at 0,80 m ± 0,05 m vertically above the centroid of the unloaded seat surface. If the seat height is adjustable, this adjustment shall be set at midrange. The height of this nominal position for the driver's seat above the floor shall be recorded.

NOTE 1 In case a headrest present hindrance for mounting the microphones, it is permissible to remove the headrest or to use a measurement height as close as possible to the specified measurement height.

If not defined elsewhere, the level of the driver's ear for standing operation shall be taken as 1,6 m above the floor.

The measurements at these eight positions shall be acquired:

— either by using a single microphone which is moved to each required position,

— or by using an array of eight microphones, allowing simultaneous data acquisition,

— or a combination of these approaches using two,

— or more microphones for simultaneous measurement.

NOTE 2 It is recommended that the maximum possible number of channels be acquired simultaneously in order to minimise the number of horn soundings and hence reduce the environmental impact during testing.

No one shall occupy the driver's seat during these stationary tests.

Where one or more of the required eight microphone positions is either not possible to realise because of the presence of structural elements, or where it is within 20 cm of an acoustically-reflective surface, a measurement shall not be required at that position. The number of discrete measurement locations shall then be reduced accordingly.

$L_{pAeq,T}$ values shall be acquired, with a measurement time interval, T, of 3 s. The arithmetic mean of the values of $L_{pAeq,T}$ thus acquired at the discrete measurement positions shall be calculated. This process shall be repeated three times, and the arithmetic mean of the three resulting values shall be calculated and rounded to the nearest integer for comparison with the requirements of the TSI.

If this value does not exceed the greater of the background noise levels measured before and after the measurements by 10 dB or more, the measurements of the external warning horn level are not valid.

7 Tests with the vehicle at maximum speed

7.1 Test conditions

7.1.1 Environmental conditions

The measurements shall be made in open country (ie not in tunnel, deep cutting or in the presence of noise control barriers).

7.1.2 Vehicle conditions

7.1.2.1 General

Air management systems, including grilles, filters and fans, shall be clear of any obstruction. Windscreen wipers should not be in operation during the measurements. During the measurements, the doors and windows of the vehicle shall be kept closed. The minimum number of people necessary to carry out the acoustic tests shall be present in the cab during the measurements. The cab is to be in the condition that will apply when in service.

7.1.2.2 Normal operating conditions

The measurements shall be carried out in normal operating conditions defined as follows:

All equipment that operates continuously when the vehicle is running shall be operating at normal load, which is the performance at an external temperature of 20 °C. For Heating, Ventilation and Air Conditioning (HVAC) systems conditioning passenger areas and working places as well as system supplying energy for this function, climate influence parameters shall be set at: wind speed at 3 m/s, relative humidity at 50 %, 700 W/m^2 energy from sun radiation, one person per seat.

NOTE 1 These settings are derived from EN 14750 (all parts), EN 14813 (all parts) and EN 13129 (all parts) which apply to middle Europe (zone II).

The vehicle shall be in its normal operating conditions and its wheels shall have run in normal conditions at least 1 000 km on track with normal traffic. The wheel treads shall be as free as possible from irregularities, such as flats.

For vehicles with tread brakes (including tread cleaning brakes) the block/tread pair shall be in ground conditions (a run-in condition where block and tread have ground themselves sufficiently). Before starting the cabnoise measurements (typically just before starting the measurements, but not more than 24 h before starting the measurements) such vehicles shall be braked to standstill two times. Braking shall start at 80 km/h or at the maximum vehicle speed in case it is lower than 80 km/h. The vehicles shall be braked until a complete stop with a deceleration which is typical in normal operation, but which ensures, that no wheel flats are generated.

NOTE 2 For vehicles with an UIC brake, it is proposed to brake with a main pipe pressure of 4 bars.

7.1.3 Track conditions

7.1.3.1 Geometry of the line

The radius of curvature r of the track shall be:

— $r \geq 1\,000$ m for tests at train speed $v \leq 70$ km/h;

— $r \geq 3\,000$ m for tests at train speed 70 km/h < $v \leq 120$ km/h;

— $r \geq 5\,000$ m for tests at train speeds $v > 120$ km/h.

Where powered vehicles are tested, the level gradient at the track shall be 5:1000 at the most.

7.1.3.2 Track superstructure

The standard superstructure for the constant speed test is a track with ballast bed and wooden or reinforced concrete sleepers. If other track designs are the normal operating conditions for the vehicle they may be used for the test.

NOTE Measurements results made on other track designs are only comparable with measurements made on that track design.

The track shall not be frozen.

7.1.3.3 Acoustic properties of the track

Noise generated by rolling stock is influenced by acoustic surface roughness of rail head and track dynamic characteristics. There is no requirement to control these track parameters in this standard. However, where track parameters need to be controlled, Annex A should apply.

7.2 Test procedure

If the vehicle or multiple unit has two cabs, it is only necessary to carry out the full test within one cab provided the vehicle is symmetrical about its longitudinal centre. As a minimum, the cab thus identified shall be tested fully and the results recorded. If this is not the case, the test shall be carried out in both cabs and the higher resultant level shall be recorded.

When the cab contains more than one set of complete driving controls, the tests shall be carried out at each of these positions. This is not necessary at auxiliary driving positions where a full set of controls is not present.

Noise levels shall be acquired with the vehicle operating at its maximum speed with a tolerance of 5 %.

If the vehicle being tested is a locomotive, the hauled load shall be at least two-thirds of the maximum permissible value.

NOTE For the purposes of this standard, it is recommended to use the maximum tractive effort that can be generated at maximum speed as a proxy for maximum permissible hauled load. Where appropriate meters and displays are available within the cab of the locomotive under test, the required testing condition may be ensured by operating the locomotive with an indicated tractive effort of at least two-thirds of the maximum available tractive effort. This condition may be more reliably ensured by including an instrumented brake vehicle within the hauled set of vehicles, thus allowing the tractive effort to be controlled precisely during the test period by brake application.

The measurement shall be carried out at the level of the driver's ear when at their operating position, at the centre of a horizontal plane extending from the front window to the rear wall of the cab. The position of the seated driver's ears, if not defined elsewhere, shall be taken at 0,80 m ± 0,05 m vertically above the centroid of the unloaded seat surface. If the seat height is adjustable, this adjustment shall be set at midrange. The height of this nominal position for the driver's seat above the floor shall be recorded. If not defined elsewhere, the level of the driver's ear for standing operation shall be taken as 1,6 m above the floor.

A measurement of $L_{pAeq,T}$ shall be made over a time interval, $T \geq 20$ s. It is permissible to assemble a 20 s sample from a set of shorter samples of at least 5 s duration, which might be necessary when maximum speed running includes sections that are in tunnels or deep cuttings, or where internal or external acoustic warnings are sounded.

8 Test report

The test report shall include a reference to this European Standard and to all relevant details concerning:

a) Nature of the tests, date, location, name and address of organisation performing the measurements (see also EN ISO/IEC 17025),

b) Description of the test site (location, geometry of the line, track superstructure, and, if relevant, acoustic properties of the track),

c) Description of the vehicles (type and serial number, the traction system and their maximum speed, confirmation of the mileage criterion and statement that the vehicle is representative of the type),

d) Description of the vehicle test conditions during the maximum speed test:

   1) Operating condition of the vehicle;

   2) Auxiliary equipment and its operating conditions, when known. Means by which ventilation or air-conditioning was set to run under conditions representative of an external temperature of 20 °C during the maximum speed tests;

   3) Loading of the vehicle (e.g. hauled load, configuration of the brake vehicle, passenger density),

e) Measuring equipment and the type of microphones,

f) Background sound pressure level for the stationary tests,

g) Meteorological conditions during maximum speed tests,

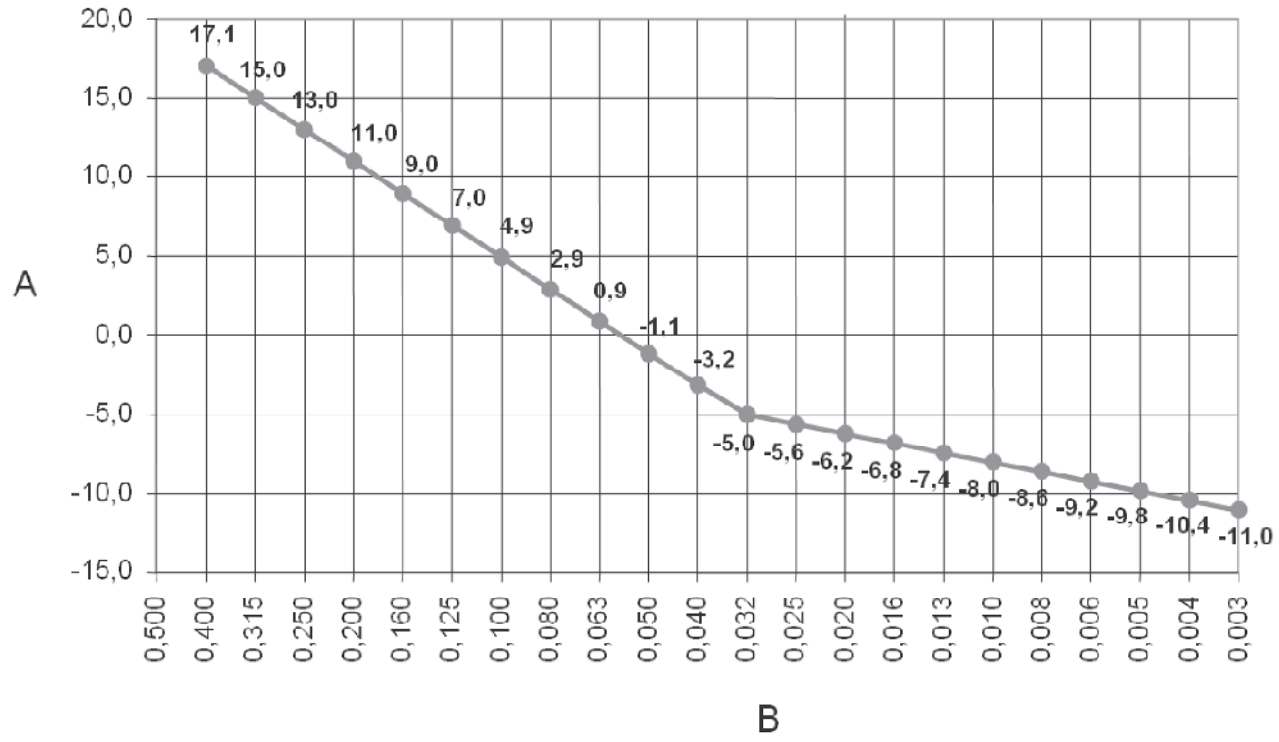
h) Microphone positions for all tests, including heights above the floor.

Annex A
(informative)

Guidance on the quantification of track quality for maximum speed testing

When the track for full speed testing is controlled in terms of its rail head roughness, this will ensure that the quantity being measured is acquired under known conditions while avoiding acoustically adverse track conditions. Furthermore, controlled conditions provide technical information to inform the process of rectifying non-compliance if that should arise, and to improve future acoustic design.

Track conditions can be controlled by identifying a 100 m low-roughness reference track section over which the train will pass during its maximum speed test, and ensuring that the remainder of track over which the train passes during the test is not significantly rougher than this by reference to the cab noise. The acoustic roughness spectrum of the reference track section shall be quantified by applying the direct measurement and sampling methods specified in EN 15610. The recommended upper roughness limit to be applied is the curve shown in Figure A.1.



Key

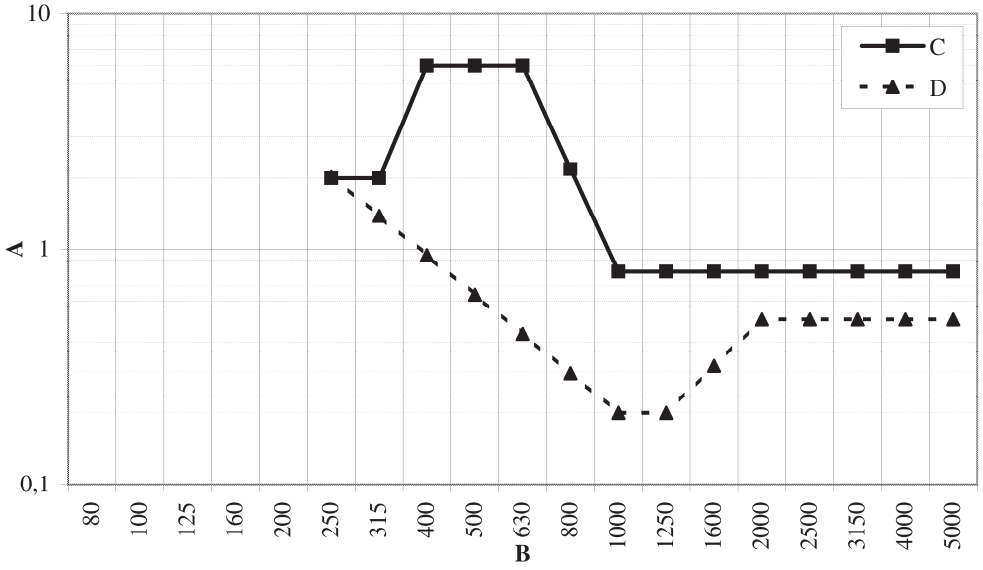
A 1/3 octave band roughness level, dB

B wavelength, m

Figure A.1 — Recommended acoustic roughness limit to be applied to the 100 m reference section of track for maximum speed measurement

In addition the track conditions should be controlled by measuring the vertical and lateral track decay rates of the reference track section in accordance with the method specified in EN 15461.

The lower vertical and lateral track decay rate limits of the reference track section are the curves shown in Figure A.2.



B	C	D
250	2,00	2,04
315	2,00	1,38
400	6,00	0,94
500	6,00	0,64
630	6,00	0,43
800	2,19	0,29
1000	0,80	0,20
1250	0,80	0,20
1600	0,80	0,32
2000	0,80	0,50
2500	0,80	0,50
3150	0,80	0,50
4000	0,80	0,50
5000	0,80	0,50

Key

A Track Decay Rate, dB/m

B frequency, Hz

C TDR limit in the vertical direction

D TDR limit in the lateral direction

Figure A.2 — Recommended vertical and lateral track decay rates limits to be applied to the 100 m reference section of track for maximum speed measurement

The maximum speed running during which measurements are taken shall include a passage over the defined 100 m reference section. Where it is possible to identify the section of cab noise within the time history of the data acquired as the train passed over the reference section, the value of $L_{pAeq,T}$ over that section, $L_{pAeq,T\ (ref)}$, shall be noted. When this value is compared with the value of $L_{pAeq,T}$ while running at maximum speed over a 60 s time interval, $L_{pAeq,T\ (60s\ av)}$, the absolute value of $L_{pAeq,T\ (60s\ av)}$ - $L_{pAeq,T\ (ref)}$, shall not exceed 5 dB if roughness is to be considered as being controlled.

Alternatively, the situation can be considered where the train has passed over the reference section as part of the 60 s of accumulated full speed measurement time, but where its location in the time history of the data is not precisely known. The difference between the maximum cab noise and the minimum cab noise, as measured in terms of a set of $L_{pAeq,T}$ readings where T = 1 s, shall not exceed 5 dB over the entire 60 s sample if its roughness and rail vibration decay rates are to be considered as being controlled.

Annex ZA
(informative)

Relationship between this European Standard and the Essential Requirements of EU Directive 2008/57/EC

This European Standard has been prepared under a mandate given to CEN/CENELEC/ETSI by the European Commission and the European Free Trade Association to provide a means of conforming to Essential Requirements of the New Approach Directive 2008/57/EC[1)].

Once this standard is cited in the Official Journal of the European Union under that Directive and has been implemented as a national standard in at least one Member State, compliance with the clauses of this standard given in Table ZA.1 for Conventional Rail - Rolling Stock - Noise and in Table ZA.2 for High Speed Rolling Stock, confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding Essential Requirements of that Directive and associated EFTA regulations.

Table ZA.1— Correspondence between this European Standard, the TSI Conventional Rail – Rolling Stock – Noise (revised, final draft; 08/57–ST07, version EN02, 17.06.2010; approved on 9 June 2010) and Directive 2008/57/EC

Clauses/subclauses of this European Standard	Chapters / § of TSI	Essential Requirements of Directive 2008/57/EC	Comments
The whole standard is applicable.	4.2. Functional and technical specifications of the subsystem 4.2.3. Interior noise of locomotives, multiple units and driving trailers	Annex III Essential Requirements 1. General requirements 1.4. Environmental protection 1.4.1 1.4.4.	

1) The Directive 2008/57/EC adopted on 17th June 2008 is a recast of the previous Directive 96/48/EC 'Interoperability of the trans-European high-speed rail system' and 2001/16/EC 'Interoperability of the trans-European conventional rail system' and their revision by Directive 2004/50/EC of the European Parliament and of the Council of 29 April 2004 amending Council Directive 96/48/EC on the interoperability of the trans-European high-speed rail system and Directive 2001/16/EC of the European Parliament and of the Council on the interoperability of the trans-European conventional rail system'.

Table ZA 2— Correspondence between this European Standard, the TSI High Speed - Rolling Stock (revised, published 26 March 2008) and Directive 2008/57/EC

Clauses/subclauses of this European Standard	Chapters/§ of TSIs	Essential Requirements of Directive 2008/57/EC	Comments
The whole standard is applicable.	4.2.7. System protection 4.2.7.6 Interior noise	Annex III Essential Requirements 1. General requirements 1.4. Environmental protection 1.4.1 1.4.4.	

WARNING — Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard.

Bibliography

[1] EN 13129 (all parts), *Railway applications — Air conditioning for main line rolling stock*

[2] EN 14750 (all parts), *Railway applications — Air conditioning for urban and suburban rolling stock*

[3] EN 14813 (all parts), *Railway applications — Air conditioning for driving cabs*

[4] EN 15461, *Railway applications — Noise emission — Characterisation of the dynamic properties of track sections for pass by noise measurements*

[5] EN 15610:2009, *Railway applications — Noise emission — Rail roughness measurement related to rolling noise generation*

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

[7] EN ISO 12001, *Acoustics — Noise emitted by machinery and equipment — Rules for the drafting and presentation of a noise test code (ISO 12001:1996)*

[8] Directive 2003/10/EC of 6 February 2003 on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (noise) (Seventeenth individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC), OJ L 42, 15.2.2003, p. 38-44

[9] 2006/66/EC: Commission Decision of 23 December 2005 (Technical specification for interoperability relating to the subsystem rolling stock — noise of the trans-European conventional rail system) (notified under document number C(2005) 5666), OJ L 37, 8.2.2006, p. 1-49

[10] 2008/232/EC: Commission Decision of 21 February 2008 (Technical specification for interoperability relating to the rolling stock sub-system of the trans-European high-speed rail system) (notified under document number C(2008) 648), OJ L 84, 26.3.2008, p. 132–392

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