SLOVENSKI STANDARD
SIST-TS CEN/TS 17843:2022

01-december-2022

Železniške naprave - Preiskave vozil za ocenjevanje tračnih obremenitev pri tirnih polmerih do 250 m

Railway applications - Investigations on vehicles to quantify track loading in curve radii below 250 m

Bahnanwendungen - Untersuchungen an Fahrzeugen zur Quantifizierung des Fahrverhaltens in Bogenradien unter 250 m

Applications ferroviaires - Investigations sur les véhicules pour quantifier la sollicitation de la voie dans les courbes de rayon inférieur à 250 m

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Ta slovenski standard je istoveten z: **CEN/TS 17843:2022**

ICS:

45.060.01	Železniška vozila na splošno	Railway rolling stock in general

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TECHNICAL SPECIFICATION

SPÉCIFICATION TECHNIQUE

TECHNISCHE SPEZIFIKATION

CEN/TS 17843

September 2022

ICS 45.060.01

English Version

Railway applications - Investigations on vehicles to quantify track loading in curve radii below 250 m

Applications ferroviaires - Investigations sur les véhicules pour quantifier la sollicitation de la voie dans les courbes de rayon inférieur à 250 m

Bahnanwendungen - Untersuchungen an Fahrzeugen zur Quantifizierung der Fahrwegbeanspruchung in Bogenradien unter 250 m

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European foreword

This document (CEN/TS 17843:2022) has been prepared by Technical Committee CEN/TC 256 “Railway applications”, the secretariat of which is held by DIN.

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Introduction

EN 14363 defines necessary tests for assessing running behaviour for vehicle homologation. In the acceptance process the range of curve radii tested during on-track testing is defined with R_{min} = 250 m. A vehicle accepted according to the requirements of this document is able to be operated on all standard gauge tracks complying with EN 13803 [1], which means with R_{min} =150 m. Beyond that, operation is also permitted even in smaller curve radii. It is state of the art that the minimum curve radius a vehicle is able to negotiate is validated by tests as described in EN 50215:2009, 9.9.2 [2]. These tests cover verification of adequate clearances for operation of the vehicle under specified limited cases (curvature, cant, etc.) in all load conditions and failure modes of the suspension. Running safety in curve radii below 250 m is covered by these tests as well as the proof of safety against derailment in twisted track according to EN 14363:2016+A1:2018, 6.1 (see A.1).

Regardless of the topic 'curve radius' it is stated in the EN 14363 that "experience over many years has demonstrated that vehicles complying with this document can be operated safely on infrastructure with conditions more severe than the target test conditions, if the current general operating rules are applied." General operating rules, including parameters like cant deficiency or axle load, have an influence on the physical effects that are intended to be controlled by this specification.

Most European infrastructure managers operate vehicles accepted according to EN 14363 without requesting additional on-track testing with curve radii lower than 250 m. Despite this, they have been running safely and reliably for many decades.

Depending on experience from some infrastructure managers, facing damages on tracks with curve radii smaller than 250 m after introduction of new rolling stock and modifications of operating conditions national rules were developed to control this field of operation, for example in Austria [5], the Czech Republic (applying also [5]) and Switzerland [4]. The requirements of these national rules differ in detail and make bilateral acceptance unfeasible.

Therefore, this specification has been developed.

NOTE The experience of many countries over many decades shows that for safe operation with an acceptable level of track loading on the whole network it is sufficient to assess vehicles according to EN 14363. It is not the intention of this specification to initiate new national rules in these fields.

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1 Scope

This document covers the following aspects:

— Definition of a common method to assess track loading of a heavy rail vehicle for lines of 1 435 mm track gauge in curve radii below 250 m (test zone 5), which is not part of the acceptance testing according to EN 14363. This method is restricted to vehicles with maximum vertical wheelset forces up to 225 kN. It includes consideration of:

  — on-track measurements with instrumented wheelsets;

  — on-track measurements with local measurement sites;

  — simulation including description of requirements for use;

  — recalculation of EN 14363 results including description of requirements for use;

  — simple parameter check (dispensation from assessment of track loading).

— Description of available knowledge of running behaviour of existing vehicles.

— Description of observed track wear and damage related to traffic mix, track loading results of vehicles and axle loads related to track design.

The decision which railway line requires these tests is not part of this specification.

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This specification can support national regulations in this field but does not affect directly existing national regulations such as [4] and [5].

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2 Normative references

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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 14363:2016+A1:2018, *Railway applications - Testing and Simulation for the acceptance of running characteristics of railway vehicles - Running Behaviour and stationary tests*

EN 15663, *Railway applications — Vehicle reference masses*

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:

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

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

3.1
test zone 5
combination of test conditions regarding speed, cant deficiency and curve radius for curve radii lower than 250 m for which the assessment of the running behaviour is required according to national rules

Note 1 to entry: The relevant lines for which test zone 5 is required are specified for Switzerland in [4] and for Austria in [5]. In Czech Republic the application of [5] is required for the whole network.

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3.2
test zone 5 category
subset of test conditions covering different operating conditions according to the value of the smallest dedicated curve radius

4 Deviation from requirements

If deviating from some points of the requirements of this specification for a particular assessment, these deviations shall be reported and explained. Then the influence on the assessment of the vehicle in terms of the acceptance criteria shall be evaluated and recorded. The outcome of this study shall be considered as an integral part of the requirements of this specification when applied to the assessment process of the vehicle, as long as evidence can be furnished that compliance with the requirements is at least the equivalent to that ensured by complying with these rules.

5 Test requirements

5.1 General

The test requirements of EN 14363 apply, except where deviations are given below.

5.2 Test extent

The investigation can be restricted to normal mode. Fault modes are not relevant for track loading because they occur only for short time in operation.

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5.3 Test vehicle

The requirements for the test vehicle laid down in EN 14363:2016+A1:2018, 5.3 (selection and status of the vehicle, loading conditions and distribution of static wheel forces) apply also to the tests specified in this document. For vehicles carrying payload, testing may be restricted to the specified loaded condition.

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Deviating from EN 14363 it is acceptable to activate wheel flange lubrication because in curve radii below 250 m experience shows that the outer rails have always to be lubricated to avoid excessive wear on wheels and rails.

NOTE If a vehicle is tested for operation on a line that is not lubricated by other vehicles or track side lubrication devices, testing without flange lubrication could be useful.

5.4 Test conditions

The test conditions of this specification should cover real operating conditions taking into account the more severe influence of coupling and traction conditions in this range of curve radii. To achieve realistic operating modes while testing, coupling friction conditions on buffer plates and coupling conditions should be representative (for example buffers to be greased properly).

According to EN 14363 “the test vehicle should be positioned in the test train in its usual position. If the coupler system is expected to introduce significant external forces on the test vehicle, then loose couplers should be considered” and “the magnitude of tractive and braking effort applied may influence the track forces. The significance of this effect shall be considered in the assessment and the test conditions”.

5.5 Assessment of test results and documentation

The requirements for assessment of test results and the documentation of the tests laid down in EN 14363:2016+A1:2018, 5.4 and 5.5 apply also to the tests specified in this document.

Due to the fact that the test conditions of this document are more severe than the test conditions in the EN 14363 adjusted limit values have to be used for the assessment (for example, see Annex C).

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To achieve comparable wheel-rail-friction-coefficients in the assessment of measuring results it is possible to recalculate the estimated maximum values using $(Y/Q)_i$ according to EN 14363.

6 Test zone 5 – dynamic performance assessment

6.1 General

The aim of the tests is to quantify track loading of vehicles in curve radii below 250 m in a comparable way in order to cover particularities, which may not be covered by extrapolation of the results from tests according to EN 14363:2016+A1:2018. The general approach of this specification is to refer to test requirements of EN 14363 in order to enable reasonable application of both documents.

The tests according to this specification provide information that supports the definition of operating conditions for the vehicle on different networks.

To achieve assessment quantities under different operation conditions it is proposed to use multiple regression. It should be noted, that the use of simulation models could help to understand the impact of different influencing parameters and therefore to improve the reliability of the assessment.

6.2 Choice of measuring method

Instrumented wheelsets (normal measuring method) are mandatory for testing according to this specification. Deviating from this it is allowed to apply Annex B, if the vehicle is allowed to be tested with the simplified measuring method according to EN 14363:2016+A1:2018, 7.2.2. Nevertheless, it is recommended to use existing instrumented wheelsets if available.

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6.3 Performing on-track tests

6.3.1 General

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The curve radii of existing networks operated in normal service go down to about 100 m. The tons per year on these tracks are very different, but normally such extra narrow curves are located on regional lines. These conditions lead to a wide range of test results. Therefore, test zone 5 is further categorised.

6.3.2 Test zone 5 categories and track sections

The test conditions in this specification are grouped in three categories defined in Table 1 (based on the characteristics of the defined test lines in [4] and [5]).

The running conditions during tests (and also for numerical simulations) must respect the definitions for the selected category in Table 1.

The test results achieved in category 5b cover the conditions of category 5a. The test results achieved in category 5c cover the conditions of category 5a and 5b if the required maximum cant deficiency is respected.

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Table 1 — Target conditions for test zones and track sections

Target test conditions	Test zone 5 Category a (exceptional case)	Test zone 5 Category b (general case)	Test zone 5 Category c (special case)
Covered range of radii	200 m ≤ R < 250 m	150 m ≤ R < 250 m	100 m ≤ R < 250 m
Minimum Curve Radius included in tests	R_{min} ≤ 240 m	R_{min} ≤ 180 m	R_{min} ≤ 130 m
Mean curve radius	R_m ≤ 245 m	R_m ≤ 206 m	R_m ≤ 180 m
Admissible cant deficiency at $R = R_{min\,0}^{+10}$	130 mm	130 mm	110 mm [a]
Cant deficiency range	$0 \le I \le 1{,}15 \cdot I_{adm}$ at least 3 track sections $1{,}05 \cdot I_{adm} \le I \le 1{,}15 \cdot I_{adm}$		
Jointed track testing	See 6.6.3.1		
Geometric track quality target level	No sections with single defects above 21 mm vertical and 18 mm lateral		
Requirements for wheel/rail contact geometry	No requirements, but wheel/rail contact geometry shall be documented		
Wheel rail friction conditions	Dry rails, rail flanges lubricated (concerning operation mode) (see Note in 5.3)		
Minimum number of physical test sections	25		
Length of track section	50 m ±10 m		
Max. speed variation within each track section	2 km/h		

[a] If the test in category 5c shall cover also 5b and 5a it is recommended to test with I_{adm}=130 mm.

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6.3.3 Test operation

The test operation shall be performed according to EN 14363:2016+A1:2018, 7.3.4.

6.4 Measured quantities and measuring points

For test zone 5 tests the measuring quantities and measuring points of the normal method according to EN 14363:2016+A1:2018, 7.4 shall be applied.

6.5 Assessment quantities and limit values

6.5.1 General

Assessment quantities for track loading are used to assess the interaction between vehicle and track and mainly describe the wheel/rail system response. It shall be investigated whether the estimated values from the statistical evaluation in the test zone 5 respect specified limit values from national rules.

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For track loading details, see Annex A, A.2.

The track loading assessment quantities correspond to EN 14363. In this specification, no common limit values for test zone 5 are defined.

The following track loading assessment quantities shall be documented:

- quasi-static lateral wheel force $Y_{j,a,qst}$;
- quasi-static vertical wheel force $Q_{j,a,qst}$;
- maximum vertical wheel force $Q_{j,a,max}$;
- quasi-static rail load quantity $B_{j,a,qst} = |Y_{a,qst}|+0{,}83 \cdot Q_{a,qst}$;
- maximum lateral wheel force $Y_{j,a,max}$;
- maximum rail load quantity $B_{j,a,max} = (|Y|+0{,}91 \cdot Q)_{max}$;
- rail fastening ratio $(Y/Q)_{a,qst}$;
- rail surface damage quantity T_{qst} (if available).

For examples of limit values, see informative Annex C.

6.5.2 Quasi-static guiding force

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If during the test some individual $(Y/Q)_{i,qst}$ values exceeded 0,40, according to EN 14363:2016+A1:2018, 7.6.3.2.6 (step 1) the normalization of $Y_{a,qst}$ by the friction on the inner rail $(Y/Q)_i$ is allowed. Step 2, related to curve radii, does not apply.

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If $B_{a,qst}$ comply with a certain limit value of $B_{a,qst,max}$, guiding forces $Y_{a,qst}$ exceeding their limits could be acceptable.

NOTE This definition could be valid for standard mixed traffic only. Locomotives and passenger coaches together are supposed to keep track loading beneath normal limit value.

6.6 Test evaluation

6.6.1 Statistical evaluation

For the statistical evaluation, the same procedure is used as in EN 14363:2016+A1:2018, 7.6.3 for test zone 4. The estimated values shall be taken at the target test conditions, given in Table 1.

For two-dimensional evaluation, the independent parameter is the cant deficiency I. The target values for cant deficiency are $1{,}0 \cdot I_{adm}$ for the quasistatic quantities and $1{,}1 \cdot I_{adm}$ for the others.

6.6.2 Calculation of results using multiple regression

For multiple regression, the independent parameters are the curvature $1/R$ and the cant deficiency I.

The target value of radius for each category is equal to the maximum mean radius R_m specified in Table 1. The target values for cant deficiency are $1{,}0 \cdot I_{adm}$ for the quasistatic quantities and $1{,}1 \cdot I_{adm}$ for the others.

It is suggested to include measuring results from test zone 4 in the multiple regression if the operating conditions in both test zones were similar.

Due to low vehicle speed it is not necessary to include track quality data.