SLOVENSKI STANDARD

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Železniške naprave – Preskušanje voznih karakteristik pri prevzemu železniških vozil – Preskušanje obnašanja med vožnjo in mirovanjem

Railway applications - Testing for the acceptance of running characteristics of railway vehicles - Testing of running behaviour and stationary tests

Bahnanwendungen - Fahrtechnische Prüfung für die fahrtechnische Zulassung von Eisenbahnfahrzeugen - Prüfung des Fahrverhaltens und stationäre Versuche

Applications ferroviaires - Essais en vue de l'homologation du comportement dynamique des véhicules ferroviaires - Essais en ligne et a poste fixe

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Railway applications - Testing for the acceptance of running characteristics of railway vehicles - Testing of running behaviour and stationary tests

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Foreword

This document (EN 14363:2005) has been prepared by Technical Committee CEN/TC 256 “Railway Applications”, the secretariat of which is held by DIN.

NOTE WG10 have recently been reactivated and have defined their future workload. Following this, it was considered necessary to complement EN 14363 by further parts.

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of an identical text or by endorsement, at the latest by December 2005, and conflicting national standards shall be withdrawn at the latest by December 2005.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

— Council Directive 96/48/EC of 23 July 1996 on the Interoperability of the trans-European high-speed rail system[1)].

For relationship with EU Directive, 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 the United Kingdom.

1) Official Journal of the European Communities No L 235/6 of 17.09.96

Introduction

This document covers the testing for acceptance of the running characteristics of railway vehicles. It was established by Working Group 10 Vehicle/Track Interaction of CEN Technical Committee 256 Railway Applications.

The establishment of this document was based on existing rules, practices and procedures. The following principles were applied:

1) The railway system requires comprehensive technical rules in order to ensure an acceptable interaction of vehicle and track.

2) Due to the numerous national and international regulations new railway vehicles had to be tested and homologated before putting them into service. In addition, existing acceptance had to be checked when operating conditions were extended.

3) In view of the increasing significance of international traffic, in particular of high speed traffic, the standardisation of existing regulations is required. In some cases, additional rules are required as well. An update of existing regulations is also needed due to the considerable progress achieved in the field of railway-specific methods for measuring, evaluation and data processing.

4) It is of particular importance that the existing level of safety and reliability is not compromised even when changes in design and operating practices are demanded, e.g. by the introduction of higher speeds, higher wheel forces, etc.

This document takes account of the present state of the art which is generally applicable for test procedures and the evaluation of stationary and 'on-track' tests.

This document is derived in essential parts from UIC 518 which has not yet been fully validated by experience. In addition, the regulations about running characteristics of freight wagons of UIC 432 will be implemented after the discrepancies between UIC 432 and UIC 518 are solved by the expert group of UIC. The Working Group is aware that the combination of the test conditions is not always achievable. In some cases, the existing regulations may require exceptions for which justification will be provided to the acceptance body. In this event, the conditions which are not fulfilled will be identified.

This also concerns the future inclusion of turnout runs in switches with $R \leq 190$ m in the normal and simplified measurement method. The assessment will be done based on the stresses in critical sections (e.g. switch blade) of a switch. The test conditions will be fixed after further investigations.

The group expects that existing shortcomings will be recognized in further investigations and during frequent application of the rules.

1 Scope

This document regulates the testing for acceptance of the running characteristics of railway vehicles (hereafter called vehicles). The testing of the running characteristics applies principally to all vehicles used in public transport which operate without restriction on standard gauge tracks (1 435 mm).

NOTE 1 The testing of the running characteristics of:

— railways with different track layout, e.g. tramways, metros and underground railways;

— railways with non-standard gauge tracks

can be conducted by analogy with this document.

The testing of running characteristics is part of the type testing of vehicles which

— are newly developed,

— have had relevant design modifications, or

— have changes in their operating regimes.

The testing and acceptance of running characteristics refers to the complete vehicle including the running gear. If a running gear, which has already been tested and accepted, is to be used under a vehicle body of another design, this is considered to be a design modification. The procedure as described in 5.2 is used.

NOTE 2 In addition to the testing of running characteristics for the acceptance of vehicles, the regulations can be generally applied in other technical tasks, e.g.:

— the checking for compliance against development contracts;

— the optimisation of components, vehicles or running gear;

— the testing of influences, influencing parameters and relationships of dependence;

— the monitoring of track or vehicles in operational use.

Testing of running characteristics consists of preliminary approval tests (mainly stationary tests) and tests of running behaviour (on-track tests).

The application of the full method and the stated limit values reflect (unrestricted) international operation.

Variations from the conditions specified in this document are allowed as specified by the article 7.1 of directive 91/440 of EC.

Testing for acceptance of vehicles is based on some reference conditions of track. If these are not respected on certain lines, appropriate measures will be taken (speed modifications, additional tests, etc.).

For national or multinational operations the infrastructure managers concerned may authorize variations to the defined conditions. Permissible deviations are indicated in this document.

It is allowed to deviate from the rules laid down if evidence can be furnished that safety is at least the equivalent to that ensured by complying with these rules.

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 13674-1, *Railway applications; Track — Rail — Part 1: Vignole railway rails 46 kg/m and above*

prEN 13715, *Railway applications — Wheelsets and bogies — Wheels — Tread profile*

EN 13848-1, *Railway applications -Track — Track geometry quality — Part 1: Characterisation of track geometry*

WI 00256129, *Railway applications — Method for determining the equivalent conicity*

UIC 432:2002, *Wagons — Running speeds — Technical conditions techniques to be observed*[2)]

UIC 505-1:2003, *Railway transport stock — Rolling stock construction gauge*[2)]

UIC 505-4:1977, *Effects of the application of the kinematic gauges defined in the 505 series of leaflets on the positioning of structures in relation to the tracks and of the tracks in relation to each other*[2)]

UIC 505-5:1977, *Basis conditions common to leaflets 505-1 to 505-4 — Notes on the preparation and provisions of these leaflets*[2)]

UIC 518:2003, *Testing and approval of railway vehicles from the point of view of their dynamic behaviour — Safety — Track fatigue; Ride quality*[2)]

UIC 530-2:1997, *Wagons — Running safety*[2)]

3 Terms and definitions

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

3.1
testing for acceptance of running behaviour
obtaining numerical values of evaluation variables which describe the running and ride characteristics. The evaluation variables together with limit values are used in the acceptance process of the vehicle

The purpose of testing running characteristics is either

— testing of vehicles which are newly developed, or

— extending the scope for an already proven vehicle (e.g. relevant design modification of the vehicle or alteration of the operation conditions)

3.2
test elements
related regulations for the

— measurement of parameters (accelerations, forces, displacements, on the vehicle) and evaluation of variables which characterise the performance of the vehicle;

2) May be purchased from: Railway Technical Publications (ETF) 16 rue Jean Rey, F-75015 Paris

— collection of the relevant conditions of the track, operation and environment;

— description of test procedures, measurement and evaluation methods;

— assessment of conditions for acceptance

NOTE Figure 1 shows the structure of the test elements.

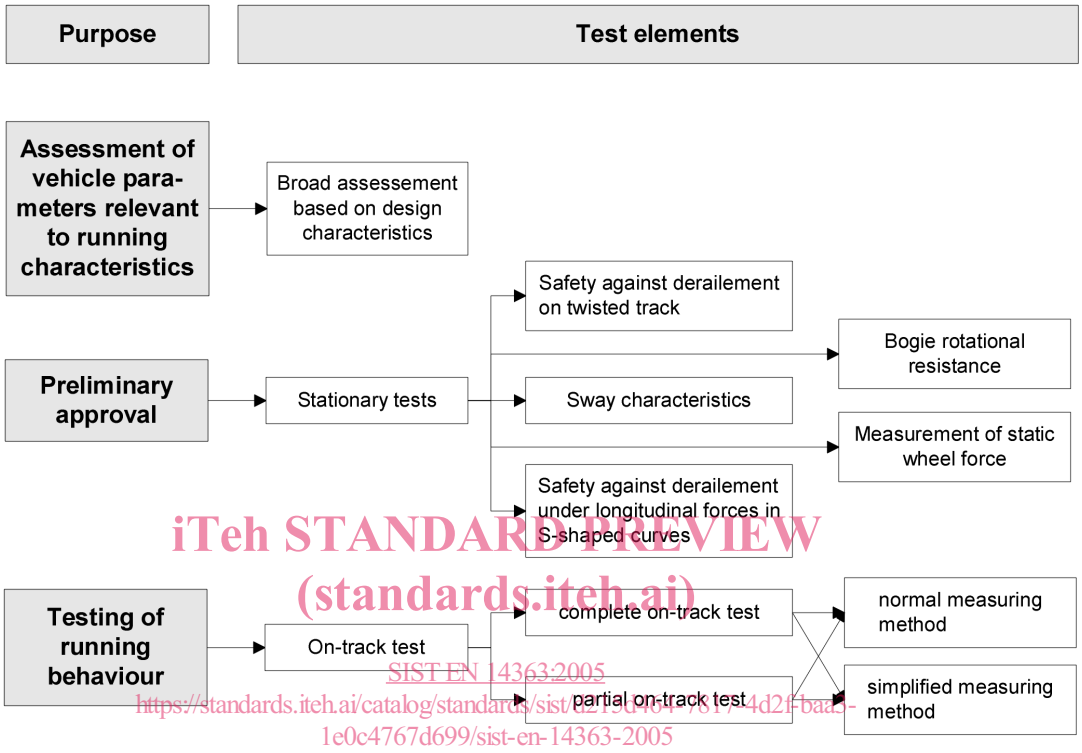

Figure 1 — Structure of test elements

3.3
vehicle parameters relevant to running characteristics
technical data of a vehicle relevant to running characteristics, e.g.:

— planned maximum permissible speed of the vehicle;

— planned permissible cant deficiency;

— smallest curve radius that shall be negotiated;

— wheel arrangement;

— wheel-base and distance between bogie centres;

— centre of gravity height;

— weight of the vehicle;

— wheel force and axle force distribution;

— unsprung mass;

— primary suspended mass;

— secondary suspended mass;

— moments of inertia of vehicle body (around z-axis);

— torsional stiffness of vehicle body;

— torsional stiffness of bogie frame;

— tractive effort;

— dimensions of wheel and wheelset;

— wheel profiles;

— characteristics of primary vertical suspension;

— characteristics of secondary vertical suspension;

— characteristics of axle guiding;

— characteristics of secondary lateral suspension;

— rotational torque of bogie;

— moment of inertia of bogie (around z-axis).

These parameters are defined and comply with the relevant construction and maintenance requirements. Compliance will be confirmed prior to the testing of running characteristics.

3.4
preliminary approval tests
testing of vehicles capability to operate under geometrical limit conditions of track layout

NOTE Preliminary approval tests are generally static and/or quasistatic. They mainly include the measurement of forces and displacements between the different components of a vehicle. They should be carried out before commencing the 'on-track' testing.

3.4.1
measurement of static wheel force
test to determine the individual vertical forces per wheel

3.4.2
bogie rotational resistance
test to evaluate the torque required to rotate a bogie while supporting a vehicle

3.4.3
safety against derailment on twisted track
test to evaluate the safety against derailment of a vehicle during negotiating track with limit conditions of twist

3.4.4
safety against derailment under longitudinal forces in S-shaped curves
test to evaluate safety against derailment of a vehicle under longitudinal forces in S-shaped curves

3.4.5
sway characteristics
test to measure the lateral and roll displacements of a vehicle when subjected to cant excess or deficiency

3.5
running behaviour
characteristics of a vehicle or running gear with regard to the interaction between vehicle and track. Running behaviour is a general term covering the following specific terms:

— running safety,

— track loading, and

— ride characteristics.

The following parameters are used for the assessment:

— forces between wheel and rail, or

— lateral forces between wheelset and axle-box (lateral axle-box forces), and/or

— accelerations.

The testing is based on 'on-track' tests.

3.6
on-track' tests
tests taking place on selected, relatively short sections of test track with specific characteristics of track layout. 'On-track' tests are used for the assessment of running behaviour within the planned range of speed and cant deficiency of the vehicle.

Depending on the test conditions 'on-track' tests may be:

— complete ‘on-track’ tests;

— partial ‘on-track’ test

3.6.1
complete 'on-track' test
test of running behaviour in the full defined test range

3.6.2
partial 'on-track' test
test of running behaviour used for an extension of acceptance (see explanation in Clause 1) which allows a reduced extent of test

3.7
measuring method
type and number of measuring quantities used during on-track test. Depending on the characteristics of the vehicle and the purpose of test

— normal measuring method, or

— simplified measuring method

is used

3.7.1
'on-track' test with normal measuring method
test of running behaviour for the assessment of

— running safety,

— track loading and

— ride characteristics of the vehicle

with direct measured forces between wheel and rail and accelerations in running gear and in the vehicle body

3.7.2
'on-track' test with simplified measuring method
test of running behaviour for the assessment of

— running safety and

— ride characteristics of the vehicle

with measured lateral axle-box forces and/or accelerations at the bogie frame and in the vehicle body

3.8
extent of tests
fixed number of test variants during ‘on-track’ test. The amount of tests is defined by:

— test zones, given by track layout;

— loading conditions of the test vehicle;

— degraded suspension conditions;

— rail inclination of test tracks

3.9
test track
selected section of the track for the 'on-track' test. It is chosen depending on:

— track layout;

— track geometry;

— rail inclination;

— wheel-rail contact geometry;

— type and number of the evaluation sections

corresponding to the planned operational area

3.10
test vehicle
vehicle representative of the production vehicles and which respects:

— the vehicle parameters relevant to running characteristics;

— construction and maintenance status

of the vehicle series.

3.10.1
conventional-technology vehicle
vehicles which

— are operated under normal operating conditions and

— correspond completely or in those construction parts which are relevant to the running behaviour to the proven state of the art

3.10.2
special vehicle
vehicles which are either unique or found in low numbers, belonging to either of the following types

— track maintenance vehicles (including rerailing vehicles);

— vehicles for special transport.

3.10.3
new-technology vehicle
all vehicles which are not categorized as conventional-technology vehicles or special vehicles

3.10.4
equivalent conicity tan γ_e
parameter for characterization of the wheel-rail contact. For a given wheelset running on given track it equals the tangent of the taper angle of a tapered profile wheelset whose transverse movement has the same wavelength of kinematic yaw as the wheelset under consideration. To determine the numerical values of the equivalent conicity, the wheel profiles are combined with track with the parameters

— rail profile,

— installed inclination of rails and

— track gauge

and then the function $\tan \gamma_e = f(y)$ is calculated, then evaluated for an amplitude ± 3 mm

NOTE An extensive evaluation of the curve of the calculated function $\tan \gamma_e = f(y)$, for example for the range 1 mm ≤ y ≤ 8 mm, may be necessary to clarify any questions relating to the running behaviour.

Calculation of equivalent conicity should be done respecting the regulations in WI 00256129.

4 Stationary tests

4.1 Safety against derailment for railway vehicles running on twisted track

4.1.1 General

The tests described in this clause are intended to ensure that vehicles can run safely on twisted tracks. The existence of track twist in railway tracks is fundamental. They are a result of transition layout between levelled track and canted track as well as cross level deviations (maintenance limits).

This test shall be done for initial acceptance of all vehicles. For the extension of acceptance (see NOTE in 5.2.1) the test shall be repeated if the variation of parameters increases the risk of derailment. The most important factors influencing the safety against derailment are given in A.1.

The limit value $(Y/Q)_{lim}$ for initiating flange climbing is influenced by:

— the flange angle;

— the friction forces between flange and rail. These forces are determined by the characteristic of the surface of wheel and rail at the contact point and by the angle of attack between wheel and rail.

If there is a tested reference vehicle with a validated calculation of safety against derailment according to the test conditions, tests may be dispended if the new calculation results are lower than a reduced limit value $(Y/Q)_{lim}$ = 0,9 * 1,2 = 1,08 (safety margin of 10 % to the limit value).

4.1.2 Test conditions

4.1.2.1 General

The risk of flange climbing is described by the ratio between horizontal guiding force ***Y*** and vertical wheel force ***Q***.

The evaluation considers the quasistatic guiding force of the outer leading wheel negotiating a curve of R = 150 m.

Reduction of vertical wheel force includes the following effects:

— twist on bogie wheel base (see 4.1.2.2.3);

— twist on bogie centre distance or axle distance for non bogied vehicles (see 4.1.2.2.3);

— torsional hysteresis during the twisting;

— eccentricity of centre of gravity and twist of the bogie and vehicle body as a result of tolerances;

— eccentricity of the centre of gravity due to cant excess or deficiency - this influence is eliminated in the test;

— roll torque of the lateral axle-box forces.

So, the influence of cant excess is not considered. It is assumed that the reduction in the guiding forces in larger curve radii have a stronger influence on the safety against derailment than the higher offloading of the guiding wheel due to the higher allowed cant excess in these radii.

4.1.2.2 Track conditions

4.1.2.2.1 General

In practice it is possible to anticipate a combination of all of the worst condition which could occur. The simultaneous application of these conditions would result in an unrealistic situation, which experience has shown is not necessary.

Information about the relations that have led to the definition of the test conditions for European mainline railways can be found in the reports of B 55 and C 138. In the present document no information about different track layout can be given.

NOTE These test conditions have been developed by ERRI and are documented in several reports of B 55 and C 138. They have been applied since 1983 in Europe and have resulted in the safe operation of vehicles.

4.1.2.2.2 Track twist limit

The track twist limit, including design twist and the cross level deterioration before maintenance, which is used in European railways is:

$$g_{\lim} = \min(7{,}0\,;\,\frac{20}{2a} + 3{,}0)$$

with ***2a*** as longitudinal base in m and $g_{\lim}$ in ‰. The validity of the formula is limited to ***2a*** ≤ 20 m. [3)]

4.1.2.2.3 Vehicle test twist

Recognising the above remarks the condition to be used for vehicle test is

— for bogie test twist:

$$g^{+}_{\lim} = 7 \qquad \text{if } 2a^{+} \le 4 \text{ m and}$$

$$g^{+}_{\lim} = \frac{20}{2a^{+}} + 2{,}0 \qquad \text{if } 2a^{+} > 4 \text{ m}$$

with $2a^{+}$ as the bogie wheel base in m and $g_{\lim}{}^{+}$ in ‰.

— for vehicle body test twist:

$$g^{*}_{\lim} = 7 \qquad \text{if } 2a \le 4 \text{ m and}$$

$$g^{*}_{\lim} = \frac{20}{2a} + 2{,}0 \qquad \text{if } 4 \text{ m} < 2a \le 20 \text{ m}$$

$$g^{*}_{\lim} = 3 \qquad \text{if } 20 \text{ m} < 2a \le 30 \text{ m}$$

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3) Several measurements were made on the tracks of DB, NS, ÖBB, PKP and SNCF which lead to a limit for track twist in relation of the longitudinal basis. The analysis of the measurements was carried over a range of 1,8 m to 19,8 m.