BS EN 15686:2010

Railway applications — Testing for the acceptance of running characteristics of railway vehicles with cant deficiency compensation system and/or vehicles intended to operate with higher cant deficiency than stated in EN 14363:2005, Annex G

ICS 45.060.01

National foreword

This British Standard is the UK implementation of EN 15686:2010.

The UK participation in its preparation was entrusted to Technical Committee RAE/1/-/8, Railway Applications - Vehicle/Track Interaction.

"Normative" - A (mandatory) requirement defined as an "expression in the content of a document conveying criteria to be fulfilled if compliance with the document is to be claimed and from which no deviation is permitted" [CEN/CENELEC Internal Regulations, Part 3: Rules for the Structure and Drafting of European Standards (PNE-Rules)].

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

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This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 June 2010

ISBN 978 0 580 68513 2

Amendments/corrigenda issued since publication

Date	Comments

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 15686

May 2010

ICS 45.060.01

English Version

Railway applications - Testing for the acceptance of running characteristics of railway vehicles with cant deficiency compensation system and/or vehicles intended to operate with higher cant deficiency than stated in EN 14363:2005, Annex G

Applications ferroviaires - Essais en vue de l'homologation du comportement dynamique des véhicules ferroviaires avec système de compensation et/ou véhicules désignés pour circuler avec une insuffisance de dévers plus élevée que définie dans l'EN 14363:2005, Annexe G

Bahnanwendungen - Fahrtechnische Prüfung für die fahrtechnische Zulassung mit Kompensation für Überhöhungsfehlbetrag, um mit höherem Fehlbetrag als in EN 14363:2005, Anhang G zu fahren

This European Standard was approved by CEN on 25 March 2010.

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Management Centre: Avenue Marnix 17, B-1000 Brussels

Ref. No. EN 15686:2010: E

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Foreword

This document (EN 15686:2010) 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 November 2010, and conflicting national standards shall be withdrawn at the latest by November 2010.

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 EU Directive 2008/57/EC.

For relationship with EU Directives, see informative Annex ZA, which is an integral part of this document.

It is intended the requirements of this European Standard will be incorporated into EN 14363 when it is revised.

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

Introduction

This European Standard covers the on-track testing for acceptance of the running characteristics of railway vehicles equipped with a cant deficiency compensation system and/or vehicles intended to operate with a higher cant deficiency than stated in EN 14363:2005, Annex G. It was established by Working Group 10 Vehicle/Track Interaction of CEN Technical Committee 256 Railway Applications as a supplement to EN 14363, which is related to the acceptance of railway vehicles with conventional curve speeds. It is foreseen to implement the requirements of this European Standard in a revision of EN 14363.

The establishment of this European Standard 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 standardization 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.

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

NOTE This European Standard is derived in essential parts from UIC 518-1 which has not yet been fully validated by experience.

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.

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

1 Scope

This European Standard specifies the on-track testing for acceptance of the running characteristics of railway vehicles equipped with a cant deficiency compensation system and/or vehicles intended to operate with a higher cant deficiency than stated in EN 14363:2005, Annex G.

In most cases the procedure is the same as defined in EN 14363, only the differences for the special case are listed.

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,

— railways with non-standard gauge tracks

can be conducted by analogy with this European Standard.

The testing of running characteristics is part of the test for the acceptance of running characteristics 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 optimization 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.

The application of the full method and the stated limit values reflects unrestricted international operation.

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, variations may be authorized from the defined conditions. Permissible deviations are indicated in this European Standard.

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 document is 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 14363:2005, *Railway applications — Testing for the acceptance of running characteristics of railway vehicles — Testing of running behaviour and stationary tests*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 14363:2005 apply.

4 Stationary tests

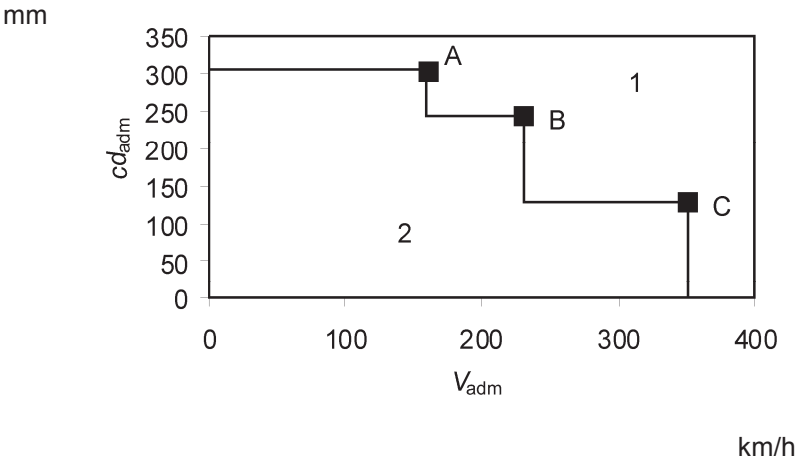
For stationary tests the requirements of EN 14363 shall apply.

5 On-track tests

5.1 General

When planning on-track tests the operational limiting parameters V_{adm} and cd_{adm} for the vehicle have to be selected. The chosen values determine the future use of the vehicle.

It can be necessary to test a vehicle for more than one combination of V_{adm} and cd_{adm} as shown in Figure 1. Point A, point B and point C are related to the different test conditions.



Key

1 vehicle not homologated

2 vehicle homologated

Figure 1 — Example of limiting operating conditions achieved during on-track testing

NOTE 1 For convenience it is recommended to use standardised values for cd_{adm} of 275 mm or 300 mm for acceptance. Using values equal to or higher than the maximum limiting values stated in FprEN 13803-1 will give the least restrictions for future operation. For national operation, other values of operational parameters can be a better choice.

NOTE 2 It is not necessary for acceptance to distinguish between admissible cant deficiencies which differ by no more than 2 %.

NOTE 3 Reasons for limiting operating conditions could be restricted capabilities of vehicle design or restricted availability of suitable test tracks.

The homologated operation conditions shall be documented in the test report.

For the acceptance of a vehicle within the scope of this European Standard the following modification of the procedure defined in EN 14363 shall be respected:

— for speeds of at least 200 km/h and non-conventional cant deficiencies an additional test zone with curve radii between 600 m and 900 m shall be included[1)];

— for the assessment of the running safety the overturning value η is used as additional parameter. A special assessment method for the estimated maximum value of this parameter is defined;

— the simplified measuring methods are only applicable for extensions of acceptance without extension of cant deficiency;

— for the transition curves the results shall be presented depending on three types of transition curves.

The symbols of quantities and characteristics used in Clause 5 are defined in Annex F of EN 14363:2005.

5.2 Type of on-track test and measuring method

5.2.1 Choice of on-track test type

In principle the same procedure as defined in EN 14363:2005, 5.2.1 shall be applied.

For the extension of an acceptance state, Annex A gives the conditions for dispensation or application of partial on-track tests. They are depending on the test methods of the initial and the new acceptance as well as on the results achieved during the initial acceptance and the modifications of relevant parameters.

NOTE The conditions for the choice of on-track test type for an extension of an acceptance state are slightly different from EN 14363. They are based on the process described in UIC 518:2009. WG 10 intends to modify EN 14363 accordingly during its revision.

5.2.2 Choice of measuring method

In principle the same procedure as defined in EN 14363:2005, 5.2.2 shall be applied.

For the extension of an acceptance state, Annex A gives the conditions by the use of one of the simplified measuring methods including the indication of required axle box force measurement. They are depending on the test methods of the initial and the new acceptance as well as on the results achieved during the initial acceptance and the modifications of relevant parameters.

1) If a vehicle is tested for high values of cdadm according to the test zones defined in EN14363, the track sections with curve radii between 600 m and 900 m are excluded from the assessment, because test zone 2 requires testing in the area of permissible speed and permissible cant deficiency.

NOTE The conditions for the choice of measuring method for an extension of an acceptance state are slightly different from EN 14363. They are based on the process described in UIC 518:2009. It is intended to modify EN 14363 accordingly at its next revision.

5.3 Assessment, limit and measuring values

5.3.1 Assessment values

The assessment values for vehicles with special equipment for the negotiation of curves are the same as defined in EN 14363. Additionally in the normal measuring method the overturning criterion:

$$K = \frac{\sum_{bogie} Q_{jA} - \sum_{bogie} Q_{jB}}{\sum_{bogie} Q_{jA} + \sum_{bogie} Q_{jB}}$$

for each bogie where wheel-rail forces are measured shall be evaluated as parameter of running safety.

Signal processing of that quantity is presented in 5.5.7.

5.3.2 Limit values

All limit values of EN 14363 are also applied to vehicles with special equipment for the negotiation of curves.

In addition for the normal measuring method the limit for the overturning criterion:

$|K|_{lim} = 1{,}0$

shall be respected.

5.3.3 Measured values and measuring points

The same regulations as defined in EN 14363 shall be applied.

5.4 Performing on-track tests

5.4.1 Test conditions

The requirements of EN 14363 shall be fulfilled.

NOTE As well as for all other parameters of EN 14363 the evaluation of overturning risk does not consider the effect of side wind. Weather conditions during test runs will be such that the wind does not significantly influence the test results.

5.4.2 Test zones

The test zones for vehicles with special equipment for the negotiation of curves are fundamentally the same as in EN 14363, but an additional test zone 2a for curve radii between 600 m and 900 m is defined, when the maximum speed of the vehicle V_{adm} is at least 190 km/h.

5.4.3 Test vehicle

The requirements of EN 14363 shall be fulfilled. In addition to the tests defined in 5.4.3.4 of EN 14363:2005 failure tests on an active tilt system and its active sub-systems (for instance an integrated hold-off device) shall be carried out on track as follows:

— the main failures of the tilting system, as identified by the risk analysis, shall be tested;

— the test shall be done in a full curve section and with a cant deficiency as close as possible to cd_{adm}. The vehicle shall be in a normal load condition. When each defined failure mode is tested, safety quantities ΣY_{2m}, Y/Q_{2m} and κ shall be measured and calculated, then the maximum value shall be compared to the corresponding limit values. No statistical processing of the measured quantities is to be carried out;

— the test curve is chosen in the radius group with the smallest margin from the standpoint of the safety criteria;

— the test shall be carried out in left and right hand curves.

If the failure may result in a sustained downgraded condition, additional verification may be needed. The extent of the test procedure shall be defined by reference to the risk analysis.

5.4.4 Test tracks

The requirements of EN 14363 shall be fulfilled.

5.4.5 Track sections

5.4.5.1 Full curve sections

The requirements for vehicles with special equipment for the negotiation of curves are fundamentally the same as in EN 14363. For the additional test zone 2a with medium radius curves (600 m < R ≤ 900 m) the following requirements shall be fulfilled when testing a vehicle for a maximum speed V_{adm} which is at least 190 km/h:

Table1 shows the additional requirements for this radii class.

Table 1 — Test conditions for track sections in curves

Test characteristic	Test zone			
	2	**2a** [b] **600 m < R ≤ 900 m**	**3 400 m ≤ R ≤ 600 m**	**4 250 m ≤ R < 400 m**
Length of track section L_{ts} [a] **a) V ≤ 140 km/h** **b) 140 km/h < V ≤ 220 km/h** **c) V > 220 km/h**	see EN 14363	250 m	see EN 14363	see EN 14363
Minimal number of track sections $n_{ts,min}$		25		
Minimal total length of track sections $\Sigma L_{ts,min}$		not defined		
Mean value of curve radius of all track sections R_{mwa}		not defined		

[a] Tolerance for the length of the individual track section: ± 20 %.

[b] The requirements of this subsection shall apply only when the maximum speed V_{adm} is at least 190 km/h.

5.4.5.2 Transition curve sections

The track configuration produces three different types of transition curves:

1) transition curve between straight line and full curve,

2) transition curve between reverse curves,

3) transition curve between two full curves in the same direction.

The rules to be observed for data collection are the same as in EN 14363 except the classification in the three above types.

If it is not possible to test every type of transition curve in the network for that traffic, this shall be stated in the test report.

5.4.6 Test operation

The requirements of EN 14363 shall be applied.

The cant deficiencies and speeds during the test runs including test zone 2a are given in Table 2.

Table 2 — Test conditions for speed and cant deficiency

Test conditions	Test zone				
	1 Straight track	2 Curves	2a Curves $600 < R \leq 900$ m	3 Curves $400 \leq R \leq 600$ m	4 Curves $250 \leq R < 400$ m
Speed V	see EN 14363	see EN 14363	$(V \leq 1{,}1 \times V_{adm})$ and $V_{adm} \geq 190$ km/h	see EN 14363	
Cant deficiency cd			$0{,}75 \times cd_{adm} \leq cd \leq 1{,}1 \times cd_{adm}$		
Tolerance			$\pm 0{,}05 \times cd_{adm}$		

5.4.7 Extent of test

The same procedure as defined in EN 14363:2005, 5.4.7 shall be applied for the choice of test extension.

For the extension of an acceptance state, the required extent of a partial on-track is given in Annex A. It depends on the modifications, the test methods of the initial and the new acceptance as well as on the results achieved during the initial acceptance.

NOTE The required test extent for an extension of an acceptance state is slightly different from EN 14363. It is based on the process described in UIC 518:2009 with the deviation that possible restrictions for contact geometry conditions are stated based on the modified parameters. It is intended to modify EN 14363 accordingly at its next revision.

5.5 Test evaluation

5.5.1 Recording the measuring signals

The same procedure as defined in EN 14363:2005, 5.5.1 shall be applied.

5.5.2 Processing the measuring signals

The processing of the measuring signals follows the procedures in EN 14363:2005, 5.5.2 with its Table 12.

The results of the additional test zone 2a shall be handled like the results in the test zones 2, 3 and 4.

The values relative to the overturning criterion are processed as presented in Table 3 and only for full curve sections.

Table 3 — Conditions for the processing of the measuring signals – Normal method

Assessment value	Sym-bol	Unit	Filtering for evaluation	Method of classification	Character-istic values [d]	Grouping and Conversion	
						Test zone 1	Test zones 2, 2a, 3, 4
Track loading							
Guiding force wheelset 1, 2	Y_{qst}	kN	Low-pass filter 20 Hz [a]	Random sampling method [b]	h_0 = 50,0 %		Per wheelset group external wheels $y_{j1}(h_0)$ (left-hc [e]) and $y_{j2}(h_0)$*(-1) (right-hc)
Wheel force wheels 11, 12, 21, 22	Q_{qst}						Per bogie group external wheels $y_{j1}(h_0)$ (left-hc) and $y_{j2}(h_0)$ (right-hc)
	Q_{max}				h_2 = 99,85 %	Per bogie group all wheels $y_{jk}(h_2)$	Per bogie group external wheels $y_{j1}(h_2)$ (left-hc) and $y_{j2}(h_2)$ (right-hc)
Running safety							
Sum of guiding forces wheelset 1, 2	ΣY_{max}	kN	Low-pass filter 20 Hz [a]	Sliding mean method with - window length 2,0 m - step length 0,5 m	h_1 = 0,15 % h_2 = 99,85 %	Per wheelset group $y_j(h_1)$ * (-1) and $y_j(h_2)$	Per wheelset group $y_j(h_2)$ (left-hc) and $y_j(h_1)$ * (-1) (right-hc)
Quotient leading wheelset	$(Y/Q)_{max}$	-					For leading wheelset group external wheels $y_{11}(h_2)$ (left-hc) and $y_{12}(h_1)$ * (-1) (right-hc)
Acceleration at bogie wheelset 1,2	$\ddot{y}^{+}_{max}$	m/s^2	Low-pass filter 10 Hz [a]	Random sampling method [b]		Per wheelset group $y_j(h_1)$ * (-1) and $y_j(h_2)$ [g]	Per wheelset or end group $y_j(h_2)$ (left-hc) and $y_j(h_1)$ * (-1) (right-hc) [g]
Acceleration in vehicle body end I, II	$\ddot{y}^{*}_{Smax}$ [g]		Low-pass filter 6 Hz [a]			Per end group $y_j(h_1)$ * (-1) and $y_j(h_2)$	
Overturning parameter	κ	-	Low-pass filter 1,5 Hz [a]			Per bogie group $y_j(h_1)$ and $y_j(h_2)$ [f]	Per bogie group $y_j(h_1)$ for cd < 0 $y_j(h_2)$ for cd > 0 [f]

Table 3 *(continued)*

Assessment value	Sym-bol	Unit	Filtering for evaluation	Method of classification	Characteristic values [d]	Grouping and Conversion	
						Test zone 1	**Test zones 2, 2a, 3, 4**
Instability criterion	ΣY_{rms}	kN	Band-pass filter [a] f_0 [c] ± 2 Hz	Sliding rms method with - window length 100m - step length 10 m	max-values	Per wheelset	Per wheelset
Ride characteristics							
Acceleration in vehicle body end I, II	$\ddot{y}^*_{qst}$	m/s²	Low-pass filter e.g. 20 Hz [a]	Random sampling method [b]	h_0 = 50,0 %		Per end group external wheels $y_{j1}(h_0)$ (left-hc) and $y_{j2}(h_0)$ *(-1) (right-hc)
	$\ddot{y}^*_{max}$ $\ddot{z}^*_{max}$		Band-pass filter 0,4 Hz to 10 Hz [a]		h_1 = 0,15 % h_2 = 99,85 %	Per end group $y_j(h_2)$ and $y_j(h_1)$ * (-1)	
	$\ddot{y}^*_{rms}$ $\ddot{z}^*_{rms}$				*rms*-values	Per end	Per end
Influencing parameters							
Speed	V	km/h	Low-pass filter 4 Hz	Random sampling method [b]	h_0 = 50,0 %		
Cant deficiency	cd	mm					

[a] Filter with cut-off frequency at –3 dB, gradient ≥ 24 dB/octave, tolerance ± 0,5 dB up to the cut-off frequency, ± 1 dB beyond that value.

[b] Sampling frequency at least 200 Hz.

[c] f_0 is the instability frequency. It is defined as the dominant frequency in the case of unstable behaviour. It has to be determined before evaluation of test results.

[d] See definition in EN 14363:2005, 5.5.3.

[e] Means “left hand curve”.

[f] Bidimensional analysis (see Annex B).

[g] Carried out in view of a subsequent extension of acceptance using a simplified measuring method.

5.5.3 Calculation of frequency values, rms-values and max-values for each track section

The calculation of the frequency values, rms-values and max-values for each track section follows the requirements of EN 14363.

5.5.4 Calculation of estimated mean, maximum and rms values for each test zone

In principle, the calculation of the estimated mean, maximum and rms values follows the regulations of EN 14363.

However, when a vehicle does not comply with the limit values on one or more test zones, supplementary analysis shall be made to determine the following:

1) the reduced cant deficiency cd_{red} permissible over the whole range of that class of radii,

2) the ranges of radii on which the cant deficiency cd_{adm} is practicable.

NOTE Example of a supplementary analysis for determining cd_{red}:

In a test zone where the maximum estimated value for the assessment quantity X reaches $X_{lim} + dX$:

— Determine the linear regression of X as a function of cd to the equation: $X = a + b \times cd$.

— The admissible cant deficiency cd_{adm} shall be reduced to a new value of cd_{red} in order to compensate the exceedance $dX = b\ (cd_{adm}-cd_{red})$ thus $cd_{red} = cd_{adm} - dX / b$.

For the overturning parameter κ defined in 5.3.1 a special analysis shall be performed in order to take into account a possible asymmetry: After calculation of the frequency values $y(h_j)$ (see EN 14363:2005, 5.5.3), a special bi-dimensional analysis of the maximum $y_{max,i}$ values according to EN 14363:2005, 5.5.4 versus cant deficiency shall be performed with the regulations defined in Annex B in order to treat the effect of quasi-static accelerations on each side of the vehicle separately.

In this special case, the estimated maximum value is given by the maximum of the absolute values of the linear functions Y_P at 1,5 cd_{adm} and Y_N at -1,5 cd_{adm}.

5.5.5 Calculation of safety factors

For the calculation of safety factors λ, the same procedure as defined in EN 14363:2005, 5.5.5 shall be applied taking into account κ as additional parameter.

5.5.6 Verification of stability

The verification of stability follows the procedure given in EN 14363:2005, 5.5.6.

5.5.7 Evaluation of test results in transition curves

For each safety parameter $(\Sigma Y)_{2m}$ or $(Y/Q)_{2m,}$ one shall calculate the maximum value of the assessment quantities xi grouped by the categories of curves and transition types shown in 5.4.5.2. This maximum value shall be compared with the limit given in 5.3.2.

For transition curves on which the limiting value of $(\Sigma Y)_{2m}$ or $(Y/Q)_{2m}$ is reached or exceeded, additional information (design of the transition, track fault etc.) shall be given to help find the reasons.

5.6 Documentation of results

The same procedure as defined in EN 14363 shall be applied including the results for the overturning parameter κ together with the homologated operation conditions.

Annex A
(normative)

Conditions for extension of an acceptance

Table A.1 and Table A.2 define the conditions for an extension of an acceptance.

Table A.1 — Definition of test method and extent depending on initial acceptance

<table>
<tr><th colspan="11">Extension of acceptance
Definition of test method and test extent</th></tr>
<tr><td>Performance of tests for initial approval</td><td colspan="5">Normal method</td><td colspan="5">One of the simplified methods</td></tr>
<tr><td>General conditions for application of a simplified method</td><td colspan="5">Not to be considered</td><td colspan="4">To be fulfilled after modification of parameters</td><td>Not fulfilled</td></tr>
<tr><td>λ</td><td colspan="4">$\lambda \geq 1{,}1$</td><td>$\lambda < 1{,}1$</td><td colspan="3">$\lambda \geq 1{,}1$</td><td>$1{,}0 \leq \lambda < 1{,}1$</td><td>Not considered</td></tr>
<tr><td>Changed parameters</td><td>Inside the range defined in column 2a</td><td colspan="2">Inside the range defined in column 2b</td><td>Outside the range defined in column 2b</td><td>Not considered</td><td>Inside the range defined in column 2a</td><td>Inside the range defined in column 2b</td><td>Outside the range defined in column 2b</td><td colspan="2">Not considered</td></tr>
<tr><td>Test method and extent</td><td>Dispensation</td><td colspan="2">Simplified method with extent defined in col. 3a-e depending on the modified parameters</td><td>Normal method with extent defined in col. 3a-e depending on the modified parameters</td><td>Dispensation</td><td colspan="3">Simplified method with extent defined in col. 3a-e depending on the modified parameters</td><td colspan="2">Normal method with extent defined in col. 3a-e depending on the modified parameters</td></tr>
</table>

Table A.1 *(continued)*

Extension of acceptance **Definition of test method and test extent**							
Performance of tests for initial approval	**Normal method**				**One of the simplified methods**		
H-forces to be measured if required for the modified parameters		– in col. 2b			– in col. 2b or - by the general conditions for application of a simplified method	– by the general conditions for application of a simplified method only	
Special Require-ments		When using method without H-forces: New limits to be applied for y..+s and y..*s depending on test results of initially accepted vehicle (see EN 14363: 2005, §5.3.2.2 d, e)			□	□	

Table A.2 — Definition of test methods and extent depending on the modification

Required test conditions for an extension of acceptance								
1	2a	2b	2c	3a	3b	3c	3d	3e
Modified parameter	**Applicable range of parameter change**			**Test extent** defined for changed parameters outside the range of dispensation (column 2a)				
	for test dispensation	**for a reduced test extent according to Column 3a-3d when testing with a simplified measuring method (required H-force measurement is indicated)**	**for a reduced test extent according to Column 3a-3d when testing with the normal measuring method**	**Straight track 4**	**Large-radius curves 3**	**Medium-radius curves 2a**	**Small and very small-radius curves 1,2**	**Conicity range to be tested [c]**
Operational parameters								
Increase of permissible maximum speed	Dispensation not allowed	0 to +10 km/h	0 to +10 km/h	Empty	Empty	-	-	1)
		0 to +20 km/h (H-forces required above +10 km/h)	0 to +A [a] km/h	Empty Loaded	Empty Loaded	-	-	1)
Increase of permissible cant deficiency	Full test required							1)

Table A.2 *(continued)*

Vehicle parameters								
Distance between bogie centres	-5 % to +20 %	-10 % to +20 %	-100 % to +20 %	Empty	-	-	-	3)
		+20 % to A [a]	+20 % to +A [a]	Empty	-	-	Empty	3)
Virtual lateral position of centre of gravity Γ [b]	-20 % to +10 %	-40 % to +20 %	-100 % to +A [a]	Empty	Empty	Empty	-	4)
Unsprung mass	-5 % to +5 %	-10 % to +10 %	-100 % to +A [a]	Empty	Empty			2)
Primary suspended mass	-5 % to + 5%	-10 % to +10 %	-100 % to +A [a]	Empty	Empty	-	-	2)
Secondary suspended mass	-10 % to +10 %	-10 % to +10 %	-100 % to +A [a]	Empty Loaded				2) if <-10 % 3) if >10 %
Moment of inertia of vehicle body (around z-axis)	-10 % to +10 %	-10 % to +10 %	-100 % to +A [a]	Empty Loaded				2) if <-10 % 3) if >10 %

Table A.2 *(continued)*

Required test conditions for an extension of acceptance								
1	2a	2b	2c	3a	3b	3c	3d	3e
Modification of the cant deficiency compensating system	Full test required							1)
Bogie parameters								
Bogie wheel base	0 % to +5 %	0 % to +20 % (H-Forces required above +5 %)	0 % to +A[a]	-	-	-	Loaded	4)
		-5 % to +0 %	-100 % to 0 %	Empty	Empty	-	-	2)
Nominal wheel diameter	-10 % to +15 %	-10 % to +15 %	-100 % to +A[a]	Empty Loaded				2) if <-10% 1) if >+15%
Stiffness of primary vertical suspension	-20 % to +20 %	-20 % to +20 %	-100 % to +A[a]	Empty Loaded				4)
Stiffness of secondary vertical suspension	-10 % to +10 %	-40 % to +40 %	-100 % to +A[a]	Empty	Empty	-	-	4)
Axle guiding stiffness	0 % to +10 %	-10 % to 0	-100 % to +10 %	Empty	Empty			2) if <0 %
		0 to +10 %	0 to +A[a]			Loaded	Loaded	4)

Table A.2 *(continued)*

Axle guiding Damping, clearances etc.	-10 % to +10 %	-10 % to +10 %	-100 % to +A [a]	Empty Loaded				2) if <-10 %
Rotational torque of bogie	-10 % to +10 %	-20 % to +10 %	-100 % to +10 %	Empty	Empty	-	-	2) if <-10 %
		-10 % to +20 % (H-forces required above +10 %)	-10 % to +A [a]	-	-	-	Empty	4)
Moment of inertia of whole bogie (around z-axis)	-100 % to +5 %	-100 % to +10 %	-100 % to +A [a]	Empty	Empty	-	-	2) if >+5 %
Secondary lateral suspension stiffness	-10 % to +10 %	-10 % to +10 %	-100 % to +A [a]	Empty Loaded				1)
Secondary lateral suspension: Damping, clearances, etc.	-10 % to +10 %	-10 % to +10 %	-100 % to +A [a]	Empty Loaded				1)

Table A.2 *(continued)*

[a] No limitation from this document, there may be restrictions from other regulations.

[b] $$\Gamma = \left(\frac{c d_{\mathrm{adm}}}{2 b_{\mathrm{A}}} h_{\mathrm{g}} + b \right)$$

h_g - height or centre of gravity relative to top of rail in mm

$2b_A$ - lateral distance between contact points of the wheels in mm (1 500 mm for standard gauge)

$b = b_{nom} + b_{qst}$ where

b_{nom} is the nominal lateral distance of the centre of gravity from the vehicle centre line in mm

b_{qst} is the quasi-static displacement of the centre of gravity due to curving, including effects from suspension displacement,
a possible cant deficiency compensating system and any other similar system in mm.

[c] No specific requirement on equivalent conicity is specified for testing in medium, small and very small radius curves. On tangent track and large radius curves the following applies:

1) modifications have a possible influence on running gear stability and low frequency body motions: Testing shall include track sections with a contact geometry in a range as defined in EN 14363:2005, 5.4;

2) modifications have a possible influence only on running gear stability: Testing should be restricted to track sections with known high conicity typical of the intended operational route;

3) modifications have a possible influence only on low frequency body motions: Testing should be restricted to track sections with known low conicity typical of the intended operational route;

4) modifications have no influence on running gear stability and low frequency body motions: No specific requirements for contact geometry in straight track apply.

Annex B
(normative)

Statistical evaluation for the overturning criterion

For the overturning parameter κ a bidimensional analysis of the maximum values versus cant deficiency shall be performed with the following rules:

— in curved zones, only full curve sections shall be used;

— only one analysis is made after all $yj(h_i)$ of same curve direction have been gathered whatever the radii are;

— for curve sections (test zones 2, 2a, 3 and 4), only $yj(h_1)$ is used for negative cant deficiencies and only $yj(h_2)$ is used for positive cant deficiencies.
For tangent track and very large curve radii (test zone 1), both $yj(h_1)$ and $yj(h_2)$ are used. That means, that positive cant deficiencies will correspond to $yj(h_2)$ and negative cant deficiencies will correspond to $yj(h_1)$;

— the total mesh is divided into two parts: one for $yj(h_1)$, the other for $yj(h_2)$. Two trend lines are calculated, one for each mesh:

$$Y_B = a_B + b_B \cdot cd \text{ and } Y_A = a_A + b_A \cdot cd$$

— the standard deviation s_B of the vertical distance from the points $\{yj(h_1), i=1...N_1\}$ and s_A of the vertical distance from the points $\{yj(h_2), i=1...N_2\}$ to the corresponding trend line are calculated. Two new lines are determined: one for measures corresponding to $yjyj(h_2)$ $(+cd)$

$$Y_P = Y_A + 3s_A,$$

the other for measures corresponding to $yj(h_1)$ $(-cd)$

$$Y_N = Y_B - 3s_B.$$

Figure B.1 shows an example.

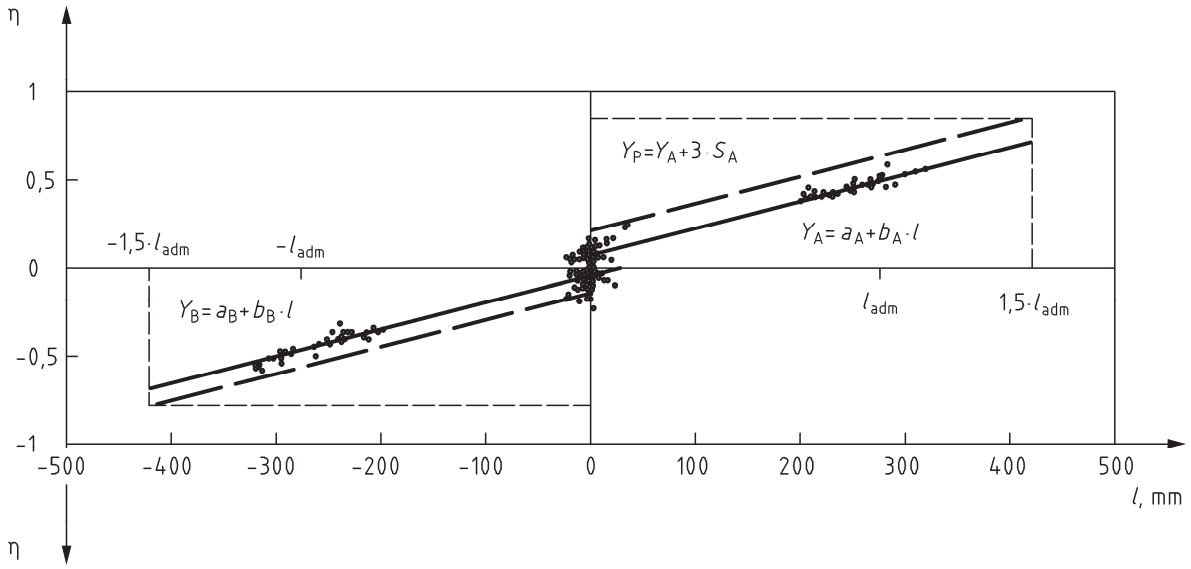


Figure B.1 — Plot and trend lines for evaluation of the overturning criterion

Annex C
(informative)

Symbols

Relevant symbols for this standard are contained in EN 14363:2005, Annex F. The Table C.1 contains the symbols of parameters not mentioned in EN 14363.

Table C.1 — Symbols

Symbol	Significance
Reference system on vehicle	
Assessment values - on-track tests	
Q_{jA}	- wheel load, wheelset j, side A of the vehicle
Q_{jB}	- wheel load, wheelset j, side B of the vehicle
κ	- overturning parameter
Other quantities	
Γ	- virtual lateral position of centre of gravity
h_g	- height of centre of gravity relative to top of rails
b_{nom}	- nominal lateral distance of the centre of gravity from the vehicle centre line
b_{qst}	- quasi-static displacement of the centre of gravity due to curving, including effects from suspension displacement, a possible cant deficiency compensating system and any other similar system
Quantities of statistical evaluation	
$Y_{A,B}$	- Coordinate of regression line for vehicle side A, B
$Y_{P,N}$	- Coordinate of regression line for side A+3sA, for side B-3sB
$s_{A,B}$	- standard deviations from regression lines for the measuring results separately for vehicle side A and B

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 Directive 2008/57/EC[2)].

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 HS Rolling Stock and Table ZA.2 for CR Locomotives and Passenger 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 HS RST TSI published in OJEU dated March 26th 2008 and Directive 2008/57/EC

Clause/ sub-clauses of this European Standard	Chapter/§of the TSI	Corresponding text, articles/§/annexes of the Directive 2008/57/EC	Comments
The whole standard is applicable	4. Characterisation of the subsystem 4.2.3.4 Functional and technical specifications of the subsystem, Track interaction and gauging, Rolling stock dynamic behaviour	Annex III, Essential requirements 1 General requirements 1.1 Safety Clauses 1.1.1, 1.1.2 1.5 Technical compatibility 2 Requirements specific to each subsystem 2.4 Rolling stock 2.4.3 Technical compatibility §3	This standard is not a self standing standard and shall be used with EN 14363:2005 pending the revision of EN 14363 which should integrate the requirements of this EN 15686. Some sub-clauses of EN 14363 are referred in the TSI and become therefore mandatory as the sub-clause of this EN 15686 which adapted EN 14363 to specific railway vehicles.

2) This Directive 2008/57/EC adopted on 17th June 2008 is a recast of the previous Directives 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 revisions thereof by 2004/50/EC 'Corrigendum to 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 CR LOC and PASS RST TSI (preliminary/final draft Rev 2.0 dated 14 November 2008) and Directive 2008/57/EC

Clause/ sub-clauses of this European Standard	Chapter/§of the TSI	Corresponding text, articles/§/annexes of the Directive 2008/57/EC	Comments
The whole standard is applicable	4. Characteristics of the subsystem 4.2.3.4.2 Functional and technical specifications of the subsystem, Track interaction and gauging Running dynamic behaviour	Annex III, Essential requirements 1 General requirements 1.1 Safety Clauses 1.1.1, 1.1.2 1.5 Technical compatibility 2 Requirements specific to each subsystem 2.4 Rolling stock 2.4.3 Technical compatibility §3	This standard is not a self standing standard and shall be used with EN 14363:2005 pending the revision of EN 14363 which should integrate the requirements of this EN 15686. Some sub-clauses of EN 14363 and this EN 15686 are referred in the TSI and become therefore mandatory The CR TSI Locomotives and Passenger RST is still a draft subject to change without notice

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

Bibliography

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

[2] EN 13715, *Railway applications — Wheelsets and bogies — Wheels — Wheels tread*

[3] FprEN 13803-1[3)], *Railway applications — Track — Track alignment design parameters — Track gauges 1435 mm and wider — Part 1: Plain line*

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

[5] UIC 518-1:2004, *Supplement to UIC leaflet 518*: *application to vehicles equipped with a cant deficiency compensation system and/or to vehicles intended to operate with a higher cant deficiency than stated for categories I to III*[4)]

[6] UIC 518:2009, *Testing and approval of railway vehicles from the point of view of their dynamic behaviour — Safety — Track fatigue — Ride quality*

3) To be published.

4) Can be purchased from: Railway Technical Publications (ETF), 16 rue Jean Rey, F-75015 Paris.

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