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BSI Group Headquarters

389 Chiswick High Road London W4 4AL

Tel: +44 (0)20 8996 9000

Fax: +44 (0)20 8996 7400

www.bsigroup.com

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Responsible Committee Secretary: Ms Elizabeth Ingram (BSI)

Direct tel: 020 3142 5522

E-mail: elizabeth.ingram@rssb.co.uk

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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/ Figure/Table/Note	Type of comment	Comment (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	

English Version

Railway applications - Testing and simulation for the
acceptance of running characteristics of railway vehicles
operated on the heavy rail network - Part 4: On-track
testing

Applications ferroviaires - Essais en vue de l'évaluation
du comportement dynamique des véhicules
ferroviaires circulant sur un réseau du système
ferroviaire lourd - Partie 4 : Essais en ligne

Bahnanwendungen - Prüfungen und Simulationen für
die Bewertung der fahrtechnischen Eigenschaften von
Schienenfahrzeugen, die auf dem Vollbahnnetz
betrieben werden - Teil 4: Streckenfahrversuche

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 256.

If this draft becomes a European Standard, CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

This draft European Standard was established by CEN in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

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Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

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COMITÉ EUROPÉEN DE NORMALISATION
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European foreword

This document (prEN 14363-4:2025) has been prepared by Technical Committee CEN/TC 256 “Railway applications”, the secretariat of which is held by DIN.

This document is currently submitted to the CEN Enquiry.

This document together with prEN 14363-2:2025, prEN 14363-3:2025, prEN 14363-4:2025 and prEN 14363 5:2025, will supersede EN 14363:2016+A2:2022.

The EN 14363 Series “*Railway applications — Testing and Simulation for the assessment of running characteristics of rail vehicles operated on the heavy rail network*” consists of the following parts: The EN 14363 Series “*Railway applications — Testing and Simulation for the assessment of running characteristics of rail vehicles operated on the heavy rail network*” consists of the following parts:

- prEN 14363-1:2025, *General*;
- prEN 14363-2:2025, *Safety against derailment on twisted track*;
- prEN 14363-3:2025, *Stationary tests that are not obligatory on European level*;
- prEN 14363-4:2025, *On-track testing*;
- prEN 14363-5:2025, *Simulations/calculations*;
- prCEN/TR 14363-6:2025, *Technical Report providing background information to the EN 14363 series of standards* (under development).

This document has been prepared under a standardization request addressed to CEN by the European Commission. The Standing Committee of the EFTA States subsequently approves these requests for its Member States.

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

Introduction

General information for the application of this document is given in prEN 14363-1:2025.

1 Scope

This document applies to all railway vehicles including OTM's and Road-rail machines, which are operated on the heavy rail network with standard track gauge 1 435 mm and nominal static vertical wheelset forces up to 350 kN.

This document may also be applicable (partly or in full) to:

- rail systems with different track layout, e.g. urban rail systems and/or;
- rail systems with other than 1 435 mm nominal track gauge and/or;
- non-public rail networks and vehicles, e.g. mine rail systems.

NOTE For rail systems other than 1 435 mm track gauge or urban rail systems, the related post analysis, limit values and test conditions could be different. They are specified nationally taking into account track design and operating conditions.

This document contains methods to assess the dynamic behaviour of railway vehicles by on-track testing, including simplifications for special vehicles and for extension of the field of application based on similarities, applicable to vehicles which:

- are newly developed;
- have had relevant design modifications; or
- have changes in their operating conditions.

The following items are not, in this document, handled by on-track testing:

- the strength of the vehicle and the strength of mounted parts,
- passengers and train crew vibration exposure,
- ride comfort,
- load security and,
- effects of cross wind.

2 Normative references

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.

prEN 14363-1:2025, *Railway applications — Testing and Simulation for the assessment of running characteristics of rail vehicles operated on the heavy rail network — Part 1: General*

EN 13848-1:2019, *Railway applications — Track — Track geometry quality: Characterization of track geometry*

EN 13848-2:2020, *Railway applications — Track — Track geometry quality: Measuring systems — Track recording vehicles*

EN 14033-2:2017, *Railway applications — Track — Railbound construction and maintenance machines — Technical requirements for travelling and working*

EN 15302:2021, *Railway applications — Wheel-rail contact geometry parameters — Definitions and methods for evaluation*

EN 15663:2017+A1:2019, *Railway applications — Vehicle reference masses*

EN 16235:2023, *Railway applications — Testing for the acceptance of running characteristics of railway vehicles — Freight wagons — Conditions for dispensation of freight wagons with defined characteristics from on-track tests according to EN 14363*

EN 17343:2023, *Railway applications — General terms and definitions*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in prEN 14363-1:2025 and EN 17343:2023 apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp/>
- IEC Electropedia: available at <https://www.electropedia.org/>

4 Dynamic performance assessment

4.1 General

All new or modified vehicles shall be checked with regard to their dynamic characteristics to evaluate the running safety, the track loading and the ride characteristics of the vehicle. An initial assessment may be carried out of the vehicle type or it may be for an extension of the field of application. The assessment is based on the evaluation of the performance of the vehicle while running on a sample of track sections (including curves with different radii and straight tracks) with defined assessment conditions. Then a statistical analysis of the assessed parameters is performed and the results are compared with limit values. If the conditions described in this sub clause are fulfilled, this gives the foundation for the vehicle's type approval.

The initial assessment of the dynamic performance of a vehicle type shall generally be performed based on on-track tests. The conditions for carrying out this process are given in this sub clause. In certain circumstances the tests may be supplemented by simulation (see prEN 14363-5:2025) or other means, e.g. when the combination of the target test conditions cannot be achieved during the test.

An extension of the field of application for vehicles that are of the same basic design, or that have gained acceptance and subsequently undergone engineering change, is possible. This assessment shall be carried out either by means of a partial on-track test or by simulation of an on-track test or a combination of both. The procedure (test extent and measuring method) to be applied for the partial on-track test (including dispensation from test) is defined in normative Annex J. The possible application of simulation is described in prEN 14363-5:2025.

For multiple units, the individual vehicles may have different parameters (e.g. forces, stiffness). In this case, selected vehicles may be used as reference vehicles. All other vehicles are regarded as vehicles with extension of the field of application due to changes of vehicle parameters. Therefore, the allowable differences in vehicle parameters, as given in J.3.2, determine the extent of measurements and tests.

For freight wagons equipped with established or standardized running gear as described in EN 16235:2023, a dispensation from Clause 4 requirements (on-track testing) is granted if the requirements described in EN 16235:2023 are fulfilled.

It may be necessary to test a vehicle for more than one combination of V_{adm} and I_{adm} as shown in informative Annex A.

For convenience standardized values for I_{adm} should be used for the assessment as given in informative Annex A.

NOTE 1 Using values equal to or higher than the maximum limiting values stated in EN 13803:2017 will give the least restrictions for future operation. For national operation, other values of operational parameters may be a better choice. In many European countries operation within the standard timetables requires a minimum performance of the vehicles (see informative Annex A).

It is not necessary for demonstration of compliance to distinguish between admissible cant deficiencies which differ by no more than 2 %. This is the difference e.g. resulting from inaccuracy converting cant deficiency to uncompensated lateral acceleration using $g = 10 \text{ m/s}^2$ instead of $g = 9,806 \text{ m/s}^2$.

In case of a deactivation of a tilting system, the cant deficiency is to be reduced, e.g. to the maximum allowed values for conventional vehicles. In consequence the vehicle shall also be tested under these operational conditions.

NOTE 2 It is recognized that locomotives or power heads, which are operated with cant deficiencies higher than used for conventional trains without a tilting system (e.g. SJ-X2000) exist.

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

As the target test conditions of equivalent conicities for stability testing are depending on the speed, it may also be necessary to test vehicles with high admissible speeds for more than one combination of speed and equivalent conicity.

Test procedures are based on the classification of the test vehicle into:

- locomotives, multiple units (EMU, DMU) and passenger coaches;
- freight wagons;
- special vehicles.

In prEN 14363-2:2025, 3.16, special vehicles are defined as such according to their use. However, their testing requirements are based on their design characteristics. Informative Annex I describes basic principles to be applied to special vehicles, before considering general test requirements of the present Clause 4.

Vehicles with maximum admissible speed $V_{adm} \leq 60 \text{ km/h}$ and a $P_{F0} \leq 250 \text{ kN}$ are granted dispensation from dynamic performance assessment according to this document. Instead, functional dynamic running type tests taking into account the intended operating conditions (speed, cant deficiency, load conditions, working modes, push/pull operation in S-shaped curves etc., whatever relevant) on tangent track and curved track shall be performed to demonstrate safe behaviour of the vehicle. The test conditions and the observations shall be documented. It is not required to measure any assessment quantities specified in this document.

4.2 Choice of measuring method

4.2.1 General

On-track tests can use the two different measuring methods:

- normal measuring method;
- simplified measuring method.

Figure 1 gives an overview of the assessment quantities used in both measuring methods.

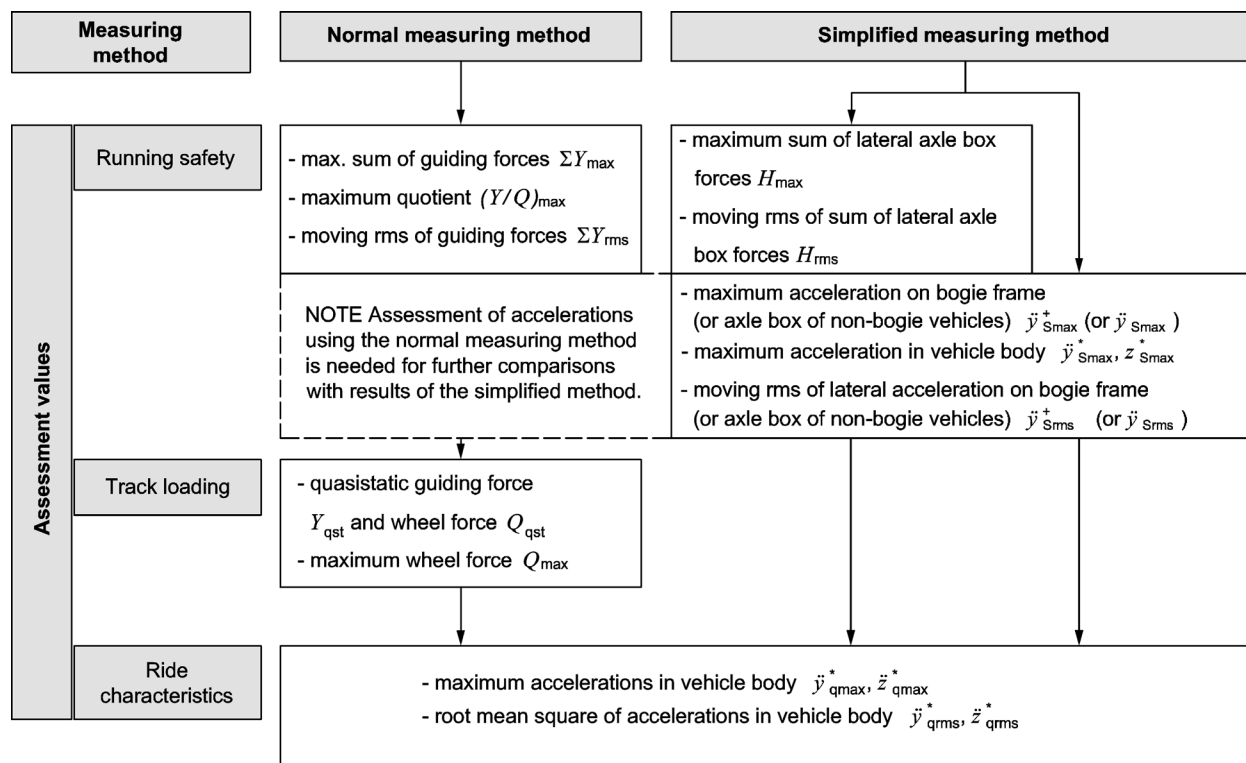


Figure 1 — Measuring methods and assessment quantities

On-track test with normal measuring method includes the assessment of:

- running safety;
- track loading;
- ride characteristics of the vehicle;

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

On-track test with simplified measuring method includes the assessment of:

- running safety;
- ride characteristics of the vehicle;

with measured accelerations at the running gear and accelerations in the vehicle body. In some cases lateral forces between wheelset and axle box are also measured. If the simplified measuring method is

applicable, it is assumed that the vehicle will comply with track loading limit values, without needing a direct assessment of the associated quantities.

For the initial assessment of a vehicle the simplified measuring method is only applicable if the base conditions in 4.2.2 are fulfilled.

For an extension of the field of application, additional conditions for the use of the simplified measuring method are given in normative Annex J including the indication of required axle box force measurement. They are dependent upon the measuring methods used for the reference vehicle and the new assessment as well as on the results achieved during the assessment of the reference vehicle and the modifications of relevant parameters.

4.2.2 Base conditions for the use of the simplified measuring method and measurement of axle box forces

In general the simplified measuring method may be applied to conventional technology vehicles, if all of the conditions in Table 1 are fulfilled:

Table 1 — Base conditions for the use of a simplified measuring method

Running gear type one of the following:	
— single wheelsets; — bogie with two wheelsets $2a^+ \leq 3,3$ m; — bogie with three or more wheelsets with spacing between outer wheelsets $\leq 4,5$ m with additional measurement of lateral axle box forces H.	
Vehicle configuration one of the following:	
Single vehicles — with two single wheelsets; — with two bogies.	
Articulated vehicles consisting of two or more vehicle bodies, with the following possible arrangements of running gears per vehicle body — up to two single wheelsets; — up to two bogies.	
Nominal static vertical wheelset force P_{F0} (for all vehicles)	≤ 200 kN ^a
Maximum admissible speed of the vehicle V_{adm}^b	
vehicles with single wheelsets	≤ 100 km/h
freight wagons with bogies	≤ 120 km/h
other vehicles with bogie mass $m^b > 10$ t	≤ 120 km/h
other vehicles with bogie mass $m^b > 10$ t and additional measurement of lateral axle box forces H	≤ 160 km/h
other vehicles with Bogie Mass $m^b \leq 10$ t and $(P_{F0} \cdot V_{adm}) \leq 34\,000$ [kN km/h] ^a	≤ 200 km/h
Admissible cant deficiency I_{adm}	
freight wagons	≤ 130 mm
multiple units with nominal static vertical wheelset forces $P_{F0} \leq 170$ kN ^a	≤ 165 mm

and $V_{adm} \leq 160$ km/h	
other vehicles	≤ 150 mm
^a P_{F0} is the nominal static vertical wheelset force of the highest loaded wheelset of the vehicle in the assessed load configuration (see 5.3.2). ^b It is allowed to use a simplified measuring method, independently from the operational speed, providing that the assessment of the vehicle under the dedicated investigation is limited to straight track and curves with curve radii >600 m and all other base conditions are complied with.	

4.2.3 Simplifications for separate stability testing

If stability testing is performed separately, the application of the simplified measuring method is sufficient as this method is consistent with the normal measuring method.

NOTE This permits the required high conicity condition to be achieved also by modification of the wheel profile on a running gear without instrumented wheelsets and to keep normal profiles on the instrumented wheelsets. For testing stability, the instrumentation of running gear (or in the case of a vehicle without a running gear frame, with instrumentation on the vehicle body) is sufficient.

If a vehicle is equipped with an instability monitoring system based on established standards, results collected by this system may be used to demonstrate running stability.

4.3 Performing on-track tests

4.3.1 General

The running conditions during tests (and also for numerical simulations) shall include defined combinations of:

- speed;
- cant deficiency;
- curve radius.

Therefore, the assessment is carried out on different test zones. In each test zone, the test conditions for track and operation differ with regard to the ranges of test parameters to be examined. To allow a statistical evaluation of test results, the test lines are divided into track sections. The measured results from the track sections in which the required test parameters were fulfilled are allocated to the corresponding test zone. If multiple regression is used (see normative Annex H) all track sections in curves form together the basis for the statistical evaluation calculated at different target values specified for the different test zones.

Table 2 defines the test zones and the associated ranges of values for track layout (also in Table 3 and Table 4). In the first part it also gives the objective of the testing and anticipated vehicle dynamic behaviour. In a second section the target test conditions for track layout, track quality, wheel/rail contact and operation (speed and cant deficiency) are defined. These target test conditions shall be complied with as far as possible in on-track testing of running characteristics. A third section specifies the requirements for the track sections.

NOTE As it was found in the DYNOTRAIN project, that the nominal rail inclination has no influence on test results, testing on two networks is no longer necessary, if profiles representative for the service of the vehicle are used during testing. In that case the range of contact conditions varies sufficiently for the statistical evaluation due to variations of gauge and rail shape on test lines.

Vehicles with $P_{F0} > 250$ kN shall be tested in test zone 3 or test zone 4 also with cant excess, see Table 2 and Table 3.

As the effects of aerodynamic forces are outside the scope of this document, they shall not have a significant influence on the tests. This should be assumed unless there are reasonable grounds to believe otherwise.

Table 2 — Target conditions for on-track testing – one- and two-dimensional statistical method

Description		Test zone			
		1	2	3	4
		Tangent track and very large radius curves ^a	Large radius curves	Small radius curves	Very small radius curves
Test Objectives	Objective	Testing in the area of the vehicle's admissible speeds	Testing the combinations of the vehicle's admissible speeds and cant deficiencies	Testing in the area of the vehicles admissible cant deficiency. Including track sections with contact geometry that creates adverse steering conditions for a wheelset in test zone 4	
	Anticipated vehicle dynamic behaviour	There are no or only low quasi-static guiding forces or accelerations, but larger dynamic content in all assessment quantities	Superposition of quasi-static and dynamic contents of all assessment quantities	Larger quasi-static guiding forces, vertical wheel forces and accelerations, dynamic content generally decreases	
Target Test Conditions	Curve radius	—		400 m ≤ R ≤ 600 m	250 m ≤ R < 400 m
	Mean value of curve radius of all track sections R _m	—		500 m (±50 m) ^c ,	300 m (+50 m, −20 m) ^{b, c}
	Test speed V ^d	V _{adm} ≤ V ≤ 1,1 · V _{adm}		V ≤ 1,1 · V _{adm}	
	Tolerance of evaluation range ^{d, e}	±5 km/h			
	Test cant deficiency I (evaluation range) ^d	I ≤ 40 mm	0,70 · I _{adm} ^m ≤ I ≤ 1,15 · I _{adm}		

Description		Test zone			
		1	2	3	4
		Tangent track and very large radius curves ^a	Large radius curves	Small radius curves	Very small radius curves
Target Test Conditions	Additional test cant deficiency, vehicles with $P_{F0} > 250$ kN	—		-90 mm ≤ I ≤ 0 mm	
	Distribution of test cant deficiency ^d	—	— one dimensional evaluation: at least 20 % of track sections $1,05 \cdot I_{adm} \leq I \leq 1,15 \cdot I_{adm}$ — two dimensional evaluation: at least 3 track sections $1,05 \cdot I_{adm} \leq I \leq 1,15 \cdot I_{adm}$ ¹		
	track geometry quality target level according to normative Annex F	90 % value of distribution for longitudinal level and alignment above lower limit of target test range $TL90$ in speed range of V_{adm} , see Clause F.4 with Table F.3. Compliance with $TL90$ is not mandatory (see Clause F.4). Possibly exclude exceptional track sections with single defects > $QN3$, see Table F.4.	90 % value of distribution for longitudinal level and alignment above lower limit of target test range $TL90$ in speed range of V_{adm} , see Clause F.4 with Table F.3. Possibly exclude exceptional track sections with single defects > $QN3$, see Table F.4.	90 % value of distribution for longitudinal level and alignment above lower limit of target test range $TL90$ in speed range 80 km/h < $V \leq 120$ km/h, see Clause F.4 with Table F.3. Possibly exclude exceptional track sections with single defects > $QN3$, see Table F.4.	

Description		Test zone			
		1	2	3	4
		Tangent track and very large radius curves ^a	Large radius curves	Small radius curves	Very small radius curves
Target Test Conditions	Requirements for wheel rail contact geometry ^{f, g} see also normative Annex K, and EN 15302:2021	— the majority of conditions shall be representative of normal service ^k — avoid a narrow range of contact geometry conditions (equivalent conicities) ^k — possibly exclude track sections with exceptional values of conicity outside the expected range of operation	—	avoid a narrow range of contact geometry conditions (radial steering index and/or the rolling radii coefficient) ^k	
	Wheel rail friction conditions ^h	Dry rails in at least 80 % of the track sections			
	Length of track section L_{ts} ⁱ	$V_{adm} \leq 160$ km/h: 100 m $160 \text{ km/h} < V_{adm} \leq 220$ km/h: 250 m $V_{adm} > 220$ km/h: 500 m		100 m	70 m
Track Sections	Minimal number of track sections $n_{ts,min}$ ^j	25 for each test zone.			
	Minimal total length of track sections $\Sigma L_{ts,min}$	10 km	5 km	—	
	Maximum speed variation within each track section	10 km/h		5 km/h	

Description	Test zone			
	1	2	3	4
	Tangent track and very large radius curves ^a	Large radius curves	Small radius curves	Very small radius curves
^a It is recommended to include some track sections with curves of very large radius in test zone 1. ^b Test zone 4 shall include track sections with a curve radius below 300 m and track sections with a curve radius above 350 m. ^c For national and multinational restricted operation the range of conditions for the test zones may be varied. In this case associated quantities (e.g. R_m) shall be adapted. ^d In fault mode (see prEN 14363-1:2025, 5.2.2) it is sufficient to investigate the vehicle only up to the admissible values of speed and cant deficiency. The ranges for evaluation shall be adapted accordingly. ^e The intention of the tolerance is not to change the target test speed but to allow for a natural variation around the target test speed. ^f For independently rotating wheels there are no requirements for wheel rail contact geometry. ^g If the vehicle allows testing with the simplified measuring method with accelerations only, no requirements for contact geometry apply. ^h Flange lubrication equipment may spread lubrication substance to the running surface, if not adjusted correctly, and that may reduce the lateral wheel rail forces. Therefore, tests shall be conducted with deactivated on-board lubrication systems on all vehicles in the test train. ⁱ Tolerance for the length of the individual track section: $\pm 20\%$. The minus tolerance shall only be used if it permits additional track length to be included in the analysis. ^j $n_{ts,min}$ is the minimum required number of unique sections in the evaluation range of speed and cant deficiency. ^k For more information, see 4.3.2. ^l It should be noted that a low number of sections close to the target value of $1,1 \cdot I_{adm}$ may lead to an unnecessary high confidence interval leading to high estimated values. ^m For two-dimensional evaluation including lower cant deficiencies can improve the reliability of the analysis.				

Table 3 — Target conditions for on-track testing – multiple regression statistical method

Test objectives		Test zone			
		1	2	3 ^m	4 ^m
	Description	Tangent track and very large radius curves ^a	Large radius curves	Small radius curves	Very small radius curves
	Objective	Testing in the area of the vehicle's admissible speeds	Testing the combinations of the vehicle's admissible speeds and cant deficiencies	Testing in the area of the vehicles admissible cant deficiency Including track sections with contact geometry that creates adverse steering conditions for a wheelset in test zone 4	
	Anticipated vehicle dynamic behaviour	There are no or only low quasi-static guiding forces or accelerations, but larger dynamic content in all assessment quantities	Superposition of quasi-static and dynamic contents of all assessment quantities	Larger quasi-static guiding forces, vertical wheel forces and accelerations, dynamic content generally decreases	
Target test conditions	Curve radius ⁿ	—	Usually, all results of curved track ($R > 250$ m) form the basis for the evaluation of the estimated values. If there is clear evidence of a bi-linear behaviour related to curvature, the regression analysis can be carried out using two different sub-ranges of curve radii. ^b		
	Test speed $V^{c, n}$	$V = V_{adm}^d$	$V_{adm} \leq V \leq 1,1 \cdot V_{adm}^d$	$V \leq 1,1 \cdot V_{adm}$	
	Test cant deficiency I (evaluation range) ^{c, n}	$I \leq 40$ mm	$40 \text{ mm} \leq I \leq 1,15 \cdot I_{adm}$		

	Additional test cant deficiency, vehicles with $P_{F0} > 250$ kN	—	$-90 \leq I \leq 0$	
	Distribution of test speed and test cant deficiency ^k	The distribution of speed shall be as even as possible and cover V_{adm} .	At least 3 track sections with each of the following conditions ^{k, l} , : — $I \geq I_{adm}$ and $R \leq 350$ m — $I \geq I_{adm}$ and $R \geq 500$ m — $I \geq I_{adm}$ and $V \geq V_{adm}$	
	Geometric track quality target level according to normative Annex F Fehler! Verweisquelle konnte nicht gefunden werden. ⁿ	For longitudinal level and alignment <i>TL50</i> as specified for the speed $V = V_{adm}$, see Clause F.4 with Table F.3, possibly exclude exceptional track sections with single defects $> QN3$, see Table F.4	For longitudinal level and alignment <i>TL50</i> as specified for the speed $V \leq 120$ km/h, see Clause F.4 with Table F.3, possibly exclude exceptional track sections with single defects $> QN3$, see Table F.4.	
	Requirements for wheel rail contact geometry ^{e, f} , see also Annex K, Annex L, and EN 15302:2021	— the majority of conditions shall be representative of normal service ⁱ — avoid a narrow range of contact geometry conditions (equivalent conicities) ⁱ — possibly exclude track sections with exceptional values of conicity outside the expected range of operation	—	avoid a narrow range of contact geometry conditions (radial steering index and/or the rolling radii coefficient) ⁱ

	Wheel rail friction conditions ^g	Dry rails in at least 80 % of the track sections		
	Length of track section L_{ts} ^h	$V_{adm} \leq 160$ km/h: 100 m $160 \text{ km/h} < V_{adm} \leq 220$ km/h: 250 m $V_{adm} > 220$ km/h: 500 m	100 m	70 m
Track sections	Minimal number of track sections $n_{ts,min}$ ⁱ	A total of 100	A total of 200	
	Maximum speed variation within each track section	10 km/h	5 km/h	
^a It is recommended to include some track section with curves of very large radius in test zone 1. ^b Experience shows that the transition in the bi-linear behaviour often is in the range of 600 m to 1 000 m. Some track sections with a curve radius below 300 m shall be included in the data set or at least in the sub-range for the smaller curve radii. ^c In fault mode (see prEN 14363-1:2025, 5.2.2) it is sufficient to investigate the vehicle only up to the admissible values of speed and cant deficiency. If a statistical evaluation is conducted, the ranges for evaluation shall be adapted accordingly. ^d In test zone 1 and test zone 2, it is recommended to include test results with lower speeds down to max (60, $V_{adm}/2$). ^e For independently rotating wheels there are no requirements for wheel rail contact geometry. ^f If the vehicle allows testing with the simplified measuring method with accelerations only, no requirements for contact geometry apply. ^g Flange lubrication equipment may spread lubrication substance to the running surface, if not adjusted correctly, that may reduce the lateral wheel rail forces. Therefore, tests shall be conducted with deactivated on-board lubrication systems on all vehicles in the test train. ^h Tolerance for the length of the individual track section: ± 20 %. The minus tolerance shall only be used if it permits additional track length to be included in the analysis. ⁱ $n_{ts,min}$ is the minimum required number of unique sections in the evaluation range of speed and cant deficiency. ^j For more information, see 4.3.2. ^k It should be noted that a low number of sections close to any target value may lead to an unnecessary high confidence interval leading to high estimated values. Due to this it may be beneficial to have several sections close to the target value.				

- ^l If, for the investigated vehicle, the lateral characteristics (force displacement curve) of the suspension, including the hard stop on the outer side of the curve, is independent from the curve radius in the range $R > 250$ m, it is not necessary to have the 3 sections with cant deficiency $\geq I_{adm}$ in each of the specified ranges of radii. A total of 9 sections with $I \geq I_{adm}$ can be selected from any of the available radii. At least 3 sections shall be selected from sections covering $I \geq I_{adm}$ and $V \geq V_{adm}$.
- ^m If the investigated vehicle is limited to operation on lines with curve radii > 600 m, it is not required to execute tests on sections with curve radii ≤ 600 m.
- ⁿ Target values for the evaluation are given in 4.6.3.2.1.

Table 4 — Target conditions for on-track testing – testing for stability and low frequency body motion

Test objectives		Test zone	
		Stability	Low frequency body motion
	Description	Tangent track	Tangent track
	Objective	Testing the vehicles running stability	Testing for resonance effects (low frequency body motion)
	Anticipated vehicle dynamic behaviour	Highest probability of unstable running behaviour	Highest probability of not acceptable low frequency body motions
Target test conditions	Curve radius	—	
	Test speed V^a	$V_{adm} \leq 100 \text{ km/h: } V = V_{adm} + 10 \text{ km/h}$ $100 \text{ km/h} < V_{adm} \leq 300 \text{ km/h: } V = 1,1 \cdot V_{adm}$ $V_{adm} > 300 \text{ km/h: } V = V_{adm} + 30 \text{ km/h}^g$	$V_{adm} > 120 \text{ km/h: } V = V_{adm}$, gradually stepwise reduced speed with a ratio of neighbouring speed levels not higher than 1,25. ^h
	Tolerance of evaluation range ^{a, b}	$\pm 5 \text{ km/h}$	
	Test cant deficiency I (evaluation range) ^a	$I \leq 40 \text{ mm}$	
Target test conditions	Requirements for wheel rail contact geometry ^{c, f} , see also normative Annex K, Annex L, and EN 15302:2021	Minimum requirements for $\tan \gamma_e$. ^d — for $V \leq 120 \text{ km/h: } \tan \gamma_e \geq 0,40$ — for $120 \text{ km/h} < V \leq 300 \text{ km/h: } \tan \gamma_e \geq 0,534 - V/900$ (rounded to two decimal digits) — for $V > 300 \text{ km/h: } \tan \gamma_e \geq 0,20$ Possibly exclude track sections with exceptional values of conicity outside the expected range of operation	In each evaluation section, the median value of $\tan \gamma_e$ shall be $\leq 0,05$ and the mean value of $(TG-SR) \geq 7 \text{ mm}$.
	Wheel rail friction conditions ^e	Dry rails	

	Length of track section L_{ts}	100 m	$V_{adm} \leq 160$ km/h: 250 m $V_{adm} > 160$ km/h: 500 m
Track sections	Minimal number of track sections $n_{ts,min}$	≥ 3 (for each tested speed, overlapping sections are not allowed)	
	Maximum speed variation within each track section	10 km/h	
a In fault mode (see prEN 14363-1:2025, 5.2.2) it is sufficient to investigate the vehicle only up to the admissible values of speed and cant deficiency. The ranges for evaluation shall be adapted accordingly. b The intention of the tolerance is not to change the target test speed but to allow for a natural variation around the target test speed. c For independently rotating wheels there are no requirements for wheel rail contact geometry in the stability test zone. d If lower in-service values of equivalent conicity are ensured by the characteristics of the network and the maintenance regime of the wheelsets, stability testing may be performed for these lower maximum equivalent conicities. This shall be documented. For example: For a wheel profile EN 13715:2020, 1:40 (which is a coned profile) with a short reprofiling interval of e.g. 50 000 km, stability can be investigated on test zone 1 tracks, no further requirements apply. e The coefficient of friction between flange and gauge corner does not influence the measured wheel rail forces. However, flange lubrication equipment may spread lubrication substance to the running surface, if not adjusted correctly, that may reduce the lateral wheel rail forces. Therefore, tests shall be conducted with deactivated on-board lubrication systems on all vehicles in the test train. f In the case harmonic oscillations below the safety limits occur during testing of stability or low frequency body motions and if the gauge clearance is small (for example $(TG-SR) \leq 4$ mm), it is recommended to investigate the effect of increased gauge on this behaviour, for example for gauge clearance $(TG-SR)$ up to 10 mm. It could be that typical national requirements to test stability at higher conicities than required by this document are not realistic in combination with such a large gauge clearance. Therefore, the recommended investigations for a gauge clearance up to 10 mm are probably not suitable for high conicities above the values specified in this document. This is not handled at European level. g The required test speed above V_{adm} is to ensure a certain margin against unstable running. It is possible to define other means to obtain the same safety margin. Such means could be – but are not necessarily limited to – testing at a higher equivalent conicity, removing anti-yaw dampers or increase the bogie’s yaw moment of inertia. Simulation may be a useful tool to demonstrate that the defined mean is adequate. h As an example, a vehicle with $V_{adm} = 300$ km/h may have the speed levels 300 km/h, 250 km/h, 200 km/h, 160 km/h and 130 km/h. The speed can also be stepwise increased.			

4.3.2 Wheel/rail contact conditions

Wheel/rail contact conditions for on-track testing are determined by the wheel profile, rail profile, rail inclination and track gauge. In order to cover the range of contact conditions representative for the service of the vehicle, required test conditions are specified in this document on:

- high and low equivalent conicity (see Table 4);
- radial steering index or rolling radii coefficient.

It is not normally necessary to investigate contact conditions with measured rail profiles on the tracks used for the tests. The reason is that contact conditions have a minor influence on the results of the statistical evaluation of the assessment quantities compared to other influences.

If a narrow range of wheel/rail geometric contact conditions was observed, e.g. in test zone 3 and test zone 4, simulation in accordance with prEN 14363-5:2025 allows to assess the vehicle under the target test conditions.

For the choice of a suitable (representative) wheel profile for testing, the following aspects should be taken into account:

- “pure” conical profiles (Example: GV 1:40 according to EN 13715:2020) deliver a narrow range of contact geometry conditions and are therefore not suitable. An exception could be a vehicle in which the frequency of re-profiling allows a permanent conical profile (e.g. 50 000 km);
- any other new profile (Examples are S1002 and EPS according to EN 13715:2020) provides a range of contact conditions in combination with the rail profiles of the test lines which generally vary along the test routes and could be generally suitable;
- any worn profile that emerged during operation as a result of operation over a long distance is generally suitable (an example is the R-profile which is used in France as test profile for vehicles equipped with new GV 1:40 profiles according to EN 13715:2020);

Independently from the points above it is recommended to avoid test wheel profiles, which would not be used in normal service conditions on the network on which the tests are performed (One example that should be avoided for the purpose of testing is an S1002 profile in the UK-network) as the vehicle response could be unnecessarily unfavourable. This includes theoretical wheel profiles which might have been created to test stability under extreme conditions or low conicity conditions.

Investigations of contact conditions (equivalent conicity) using measured rail profiles are only necessary in a few sections to:

- exclude possibly track sections with exceptional values of conicity outside the expected range of operation (which is not required but could avoid unfavourable results);
- quantify the maximum equivalent conicity for which the stability of the vehicle was tested.

The assessment is not linked to any specific wheel profile, rail profile or rail inclination, but is valid for all wheel/rail combinations, as long as they are covered by the range of tested contact conditions, equivalent conicity and radial steering index or rolling radii coefficient.

EXAMPLE An assessment of tests performed with S1002 wheel profiles covers later operation with e.g. EPS (or any other wheel profile with a similar range of contact conditions).

4.3.3 Test zones and track sections

Each track section used for the statistical evaluation shall have a certain length L_{ts} depending on the speed and/or the curve radius. Speed and cant deficiency shall remain approximately constant over the entire length of a track section. Therefore, track sections with speed deviations outside the range given in Table 2 shall be excluded from the evaluation.

It is permitted to use the same track section in zone 2 and zone 3 (or zone 4) when it meets the requirements for both, speed and cant deficiency for zone 2 and radius and cant deficiency for zone 3 (or zone 4).

In some cases (low maximum speed) zone 2 may cover the range of radii of zone 3 (or zone 4). In these cases, evaluation on zone 3 (or zone 4) is not necessary.

NOTE Experience shows that when V_{adm} is 80 km/h to 120 km/h test zone 2 and zone 3 (or zone 4) often more or less coincide.

Track sections can be sequential or not, however, they may not overlap and have to fulfil the geometric requirements. The combination of non-consecutive parts to form one track section is not permitted.

To allow an assessment of test results in transition curves, separate track sections shall be defined which include the transition curve itself plus a suitable part of the surrounding track to take transient effects into account. Due to the changing test parameters in these track sections, a statistical evaluation is not performed.

The track sections are determined using the following process:

- select potential straight track sections and curved track sections to be used for statistical evaluation;
- select transition sections only adjacent to curves that contain curved track sections used for evaluation in test zone 2, test zone 3 and test zone 4;
- taking into account the vehicle length, a track length of up to 20 m on either side of the constant curvature may be included in the transition (to address transient effects);
- there should be no gap between the first section in the full curve and the preceding transition.

Figure 2 shows a typical arrangement of track sections on a test line.

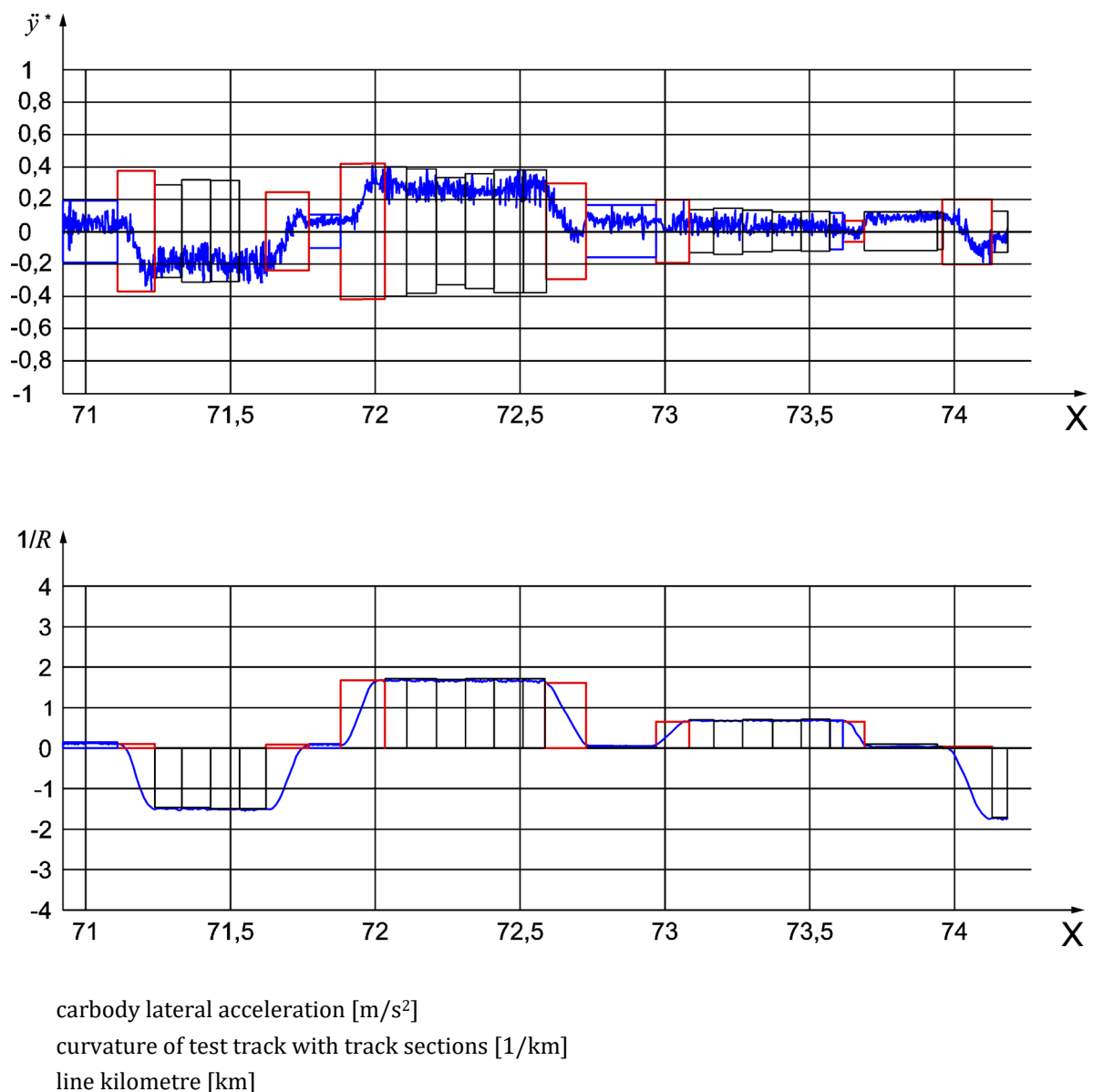


Figure 2 — Arrangement of track sections on a line

4.3.4 Extent of tests

For complete on-track tests (e.g. for initial assessment) the combinations of the following test conditions:

- test zones;
- loading condition (see prEN 14363-1:2025, 5.3.2):
 - empty;
 - loaded;

shall be reviewed, the critical combinations shall be identified and included in the test programme.

NOTE 1 Usually, stability testing needs only to be performed in the empty condition.

For some vehicles it might be sufficient to test them in a single appropriate intermediate load case and follow for the evaluation the method of extension of field of application, see normative Annex J.

NOTE 2 For example, for a special vehicle a variation from -15% to $+10\%$, according to informative Annex I, of the tested nominal static vertical wheelset force is allowed.

It is acceptable that during the tests, consumables are reduced (e.g. due to fuel consumption) in a range that is normal for the operation of the vehicle. For locomotives and special vehicles, for loading condition loaded or if empty and loaded is the same and if the normal measuring method is required, only test results with a load above the operational mass in working order according to EN 15663:2017+A1:2019 are acceptable.

For some vehicles, collection, transport and distribution of various items (ballast, track components, weed killer liquid...) may result in a large variable mass. For such vehicles the following rules shall be applied:

- fuel used for a vehicle's own propulsion and other items quoted in EN 15663:2017+A1:2019, Table 6 shall be taken into account as “consumables”; for EN 15663: 2017+A1:2019, Clause 5, the vehicle is not considered as a freight vehicle, meaning that the design mass of consumables is considered greater than the operational mass of consumables;
- all items used in the working process, which can be collected and/or distributed or spread along the railway track, shall be considered as “payloads”.
- if a certain loading condition is only applicable in working mode or travelling mode as described in EN 14033-2:2017 (max. speed ≤ 60 km/h), then this loading condition does not need to be considered for on-track testing according to this document.

Using the same approach as for fault modes (prEN 14363-1:2026, 5.2.2) it shall also be determined whether the partially occupied or partially loaded vehicle with unsymmetrical load distribution is the most unfavourable condition. This applies especially to freight vehicles with two stage suspension. If a partial load condition is found to be unfavourable, this condition shall be included in the assessment.

Vehicles that are tested on high-speed lines with $V_{adm} \geq 250$ km/h shall be tested additionally on lines with maximum line speed in the range from 160 km/h to 230 km/h. If one-dimensional analysis or simple regression is applied, these tests shall be separately analysed according to the requirements of test zone 1 and test zone 2 with a V_{adm} according to the maximum line speed. If multiple regression is applied, these test results shall be included in the analysis and an additional target value V_{adm} and track geometry level $TL50$ according to the maximum line speed (see Clause F.4) shall be applied.

NOTE 3 The aim of this additional test is to include also track sections with a lower track quality typical of conventional lines.

The on-track tests shall be completed by tests in fault modes where appropriate (prEN 14363-1:2025, 5.2.2). The extent of these tests shall be defined after an analysis of the critical conditions.

Vehicles intended to be operated outside the normal operating conditions (e.g. with higher speeds or cant deficiencies) or which are equipped with active systems that modify the vehicle response significantly shall be subjected to an analysis to determine whether additional testing is necessary, e.g. specific tests in transition curves between reverse curves or transition curve between two full curves in the same direction.

4.3.5 Test operation

The speed V and the cant deficiency I shall be defined for the test runs by taking account of:

- the intended operation envelope of the vehicle, see informative Annex A;

- the permissible local speeds of the test tracks or the speeds approved for test operation;
- the requirements for the test zone.

NOTE 1 Especially for high speed trains it is often not possible or necessary to include the combination of maximum speed and maximum cant deficiency in the test programme. This will define the proven operation envelope.

In principle, 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.

Where it is not possible to test vehicles in their usual position in the train, it is possible to test them in a position inside the test train. The test should be designed so that the couplers do not introduce non-representative external forces.

NOTE 2 For example, in test zone 4, if a locomotive is positioned inside the test train non-representative forces from the couplings can be avoided by using loose coupling at the leading end and tightened coupling at the trailing end.

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.

NOTE 3 The normal test conditions with constant or maximum speed do not necessitate high tractive or braking effort. Only when operating on tracks with high gradient significant forces can influence the results depending on the tractive or braking characteristics.

NOTE 4 Vehicles with side buffers and screw couplers at their ends are preferred to be tested with no or small tension between coupler and buffer in curves (loose couplers in straight track).

NOTE 5 Vehicles with draw bars or automatic couplers can be tested in their normal coupling condition – coupler adapters are also possible to use (if safe test operation is guaranteed).

NOTE 6: If the single wagons of permanently coupled units with diagonal buffers as described in EN 16235:2023, Annex J, would be tested alone, an equal distribution of the sum of guiding forces occur. Testing of a single 2-axle wagon under such conditions cover also operating conditions with unequal coupling conditions at both ends. If such permanently coupled units are tested with loose couplers or with tightened couplings at their ends, and with a tightened coupler at the inner coupling, an unequal distribution of the sum of guiding forces will occur. Such test conditions are therefore more demanding than the test conditions for a single two-axle wagon, while the covered range of safe operating conditions are the same. Therefore, the required safety level is also achieved, if such a permanently coupled unit is tested in a coupling condition providing similar yaw tension at the outer and the inner coupling of the unit.

4.4 Measured quantities and measuring points

Table 5 shows all measured parameters and measuring points used for on-track tests. They are defined in the vehicle coordinate system according to pREN 14363-1:2025, Figure A.1.

The choice of bogies to be instrumented shall cover the variety of running gear and its application, considering their influence on the dynamic performance of the vehicle, such as:

- type (powered, non-powered, various designs, etc.);
- location (end or intermediate, leading or trailing, etc.);
- nominal static vertical wheelset force.

Forces at wheel/rail contact or axle box forces shall be measured on each wheelset of instrumented bogies or each wheelset of a non-bogie vehicle. However, the number of measuring wheelsets to be used can be reduced when the vehicle or trainset is symmetrical, and the tests are performed in both running directions. Annex B provides examples of possible configurations.

Deviations from relevant parameters of the vehicle due to instrumentation shall be assessed (e.g. unsuspended mass of instrumented wheelset).

Table 5 — Measured quantities and measuring points

Reference point of measurement ^a	Direction	Symbol	Unit	Purpose of measurement
Forces between wheel and rail				
Guiding force Y				
Wheelset j , right wheel	lateral	Y_{j1}	kN	Normal measuring method: Running safety Track loading
Wheelset j , left wheel	lateral	Y_{j2}	kN	
Vertical wheel force Q				
Wheelset j , right wheel	vertical	Q_{j1}	kN	Normal measuring method: Running safety Track loading
Wheelset j , left wheel	vertical	Q_{j2}	kN	
Forces at bogie				
Lateral axle box force H				
Wheelset j	lateral	H_{j2}	kN	Simplified measuring method (where required): Running safety
Accelerations				
Accelerations of wheelset $\ddot{y}$				
Axle box wheel 11 (or wheel 12)	lateral	$\ddot{y}_{11}$	m/s ²	Simplified measuring method ^b (only single axle running gear): Running safety (including stability)
Axle box wheel 21 (or wheel 22)	lateral	$\ddot{y}_{21}$	m/s ²	
Accelerations of bogie frame above the outer wheelsets $\ddot{y}^+$				
Bogie frame, above wheel 11 (or wheel 12)	lateral	$\ddot{y}_{11}^+$	m/s ²	Simplified measuring method ^b (only bogie vehicles): Running safety (including stability)
Bogie frame, above wheel 21 (or wheel 22)	lateral	$\ddot{y}_{21}^+$	m/s ²	

Reference point of measurement ^a	Direction	Symbol	Unit	Purpose of measurement
Accelerations on the floor of vehicle body $\ddot{y}', \ddot{z}'$				
Vehicle body, above running gear I	lateral	$\ddot{y}_I^*$	m/s ²	Simplified measuring method without <i>H</i> -force measurement ^b : Running safety All measuring methods: Ride characteristics
Vehicle body, above running gear II	lateral	$\ddot{y}_{II}^*$	m/s ²	
Vehicle body, above running gear I	vertical	$\ddot{z}_I^*$	m/s ²	Simplified measuring method ^b : Running safety All measuring methods: Ride characteristics
Vehicle body, above running gear II	vertical	$\ddot{z}_{II}^*$	m/s ²	
Centre of vehicle body (only recommended)	lateral	$\ddot{y}_M^*$	m/s ²	All measuring methods: Ride characteristics (Recommended only for long vehicles and double deck vehicles where major acceleration levels could be observed.)
	vertical	$\ddot{z}_M^*$	m/s ²	
Influencing quantities				
Speed	—	<i>V</i>	km/h	
Cant deficiency	—	<i>I</i>	mm	
^a The measured quantities and measuring points described in this table are related to vehicles with two running gear. On vehicles with differing wheelset arrangements the measuring points shall be adapted accordingly.				
^b It can be useful to measure these quantities when carrying out the normal measuring method to enable comparison with other wheelsets and for extension of the field of application.				

4.5 Assessment quantities and limit values

4.5.1 General

Assessment quantities for running behaviour are measured directly, derived from other measurements or generated by the use of simulation. They are used to assess the interaction between vehicle and track and mainly describe the wheel/rail system or are closely related to it. Table 6 summarizes all assessment quantities generally used together with their limit values. It shall be investigated whether the estimated values from the statistical evaluation in the test zone 1 to test zone 4 respect these limit values.

The reported measuring results from the transition curves shall be compared with the limit values. Any values exceeding the limit shall be investigated and where appropriate justified, e.g. taking into account track geometry.

NOTE 1 The given limit values reflect international operation and are derived from UIC. For national or multinational operation these limits may be varied. Differing limit values may be possible or necessary because of track conditions differing from those used by UIC as the basis. Examples are systems with slab track, systems with stronger rails or special conditions on mountain lines. Also track geometric quality different from those defined in normative Annex F can necessitate differing limit values.