SLOVENSKI STANDARD
SIST EN 15654-2:2019

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Železniške naprave - Meritve vertikalnih kolesnih in osnih obremenitev - 2. del: Preskus v delavnici za nova, spremenjena in vzdrževana vozila

Railway applications - Measurement of vertical forces on wheels and wheelsets - Part 2: Test in workshop for new, modified and maintained vehicles

Bahnanwendungen - Messung von vertikalen Rad- und Radsatzkräften - Teil 2: Test im Werk für neue, umgebaute und instandgesetzte Fahrzeuge

Applications ferroviaires - Mesurage des forces verticales à la roue et à l'essieu - Partie 2 : Essai en atelier des véhicules neufs, modifiés ou maintenus

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ICS:

45.060.01	Železniška vozila na splošno	Railway rolling stock in general

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Railway applications - Measurement of vertical forces on wheels and wheelsets - Part 2: Test in workshop for new, modified and maintained vehicles

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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European foreword

This document (EN 15654-2:2019) 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of an identical text or by endorsement, at the latest by October 2019, and conflicting national standards shall be withdrawn at the latest by October 2019.

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

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive 2008/57/EC.

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

This document is the second part of a three-part standard collectively referred to as *Railway applications — Measurement of vertical forces on wheels and wheelsets* and which covers:

— static and quasi-static wheel force measurements of new, modified or maintained rail vehicles in workshops and

— the evaluation of derived quantities such as the vertical wheelset forces, axle loads and other quantities that describe the vertical wheel force distribution of a vehicle.

Part 1: On-track measurement sites for vehicles in service deals with the measurement of wheel forces and axle loads of in-service rail vehicles.

Part 3: Approval and verification of on-track measurement sites for vehicles in service (CEN/TR) is in preparation and deals with the approval and verification of local measuring sites in-service.

A migration rule is specified in Annex G.

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

Introduction

There are many national and local procedures and methods for the measurement of wheel forces of new, modified and maintained vehicles in use across Europe.

The existing multiplicity of different procedures and methods of calculating parameters can lead to confusion in the interpretation of test data. By having a common set of defined assessment quantities the possibility of confusion and misinterpretation is reduced.

To achieve comparable results for the same vehicle, when the wheel forces are measured at different sites the uncertainty of the whole measurement process needs to be assessed.

The current situation leads in some cases to non-comparable results from different sites. The normative requirements of this standard are based on current experience but these will not necessarily lead to comparable results, being obtained, when a vehicle is measured on two or more different systems. In order to improve this situation, methods are described in the informative part of this standard, to assess the relevant uncertainties of the whole measuring process.

1 Scope

This document applies to the measurement of vertical wheel forces of railway vehicles in maintenance workshops and at manufacturing sites. It also deals with derived quantities that are used to describe the vehicle's vertical wheel force distribution.

The document defines the assessment and acceptance criteria for the measurement process. The requirements for this assessment support the specification, the design and the operation of the measurement process. It is considered that the measurements are made either statically or quasi-statically. This document is applicable to all railway vehicles.

The commercial weighing of vehicles is not covered by the scope of this document, nor does it define in which cases the wheel forces of a vehicle will be measured.

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.

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

EN 14363, *Railway applications - Testing and Simulation for the acceptance of running characteristics of railway vehicles - Running Behaviour and stationary tests*

EN 15663, *Railway applications - Vehicle reference masses*

EN ISO 1101, *Geometrical product specifications (GPS) - Geometrical tolerancing - Tolerances of form, orientation, location and run-out (ISO 1101)*

EN ISO 7500-1:2015, *Metallic materials - Calibration and verification of static uniaxial testing machines - Part 1: Tension/compression testing machines - Calibration and verification of the force-measuring system (ISO 7500-1:2015)*

EN ISO 10012, *Measurement management systems - Requirements for measurement processes and measuring equipment (ISO 10012)*

ISO/IEC Guide 99:2007, *International vocabulary of metrology - Basic and general concepts and associated terms (VIM)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC Guide 99:2007 and those listed below apply in this document.

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

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

3.1
individual static (vertical) wheel force
Q_{F0}
static vertical part of the total wheel force at the reference point D_0 of the wheel profile as specified in EN 13715, when all the reference points of a vehicle are in a horizontal plane and with the vehicle at rest

Note 1 to entry: Where the symbol $Q_{F0,jk}$ is used, j is the axle number and k is the side of the vehicle on which the wheel is located:

— k = R denotes the right-hand side in the coordinate system of the vehicle;

— k = L denotes the left-hand side in the coordinate system of the vehicle.

Note 2 to entry: For standard gauge applications the lateral distance between the reference points of a wheelset is 1 500 mm. For other applications such as special wheel profiles or other gauges this definition should be applied using the same principle.

Note 3 to entry: The static vertical wheel force is the result obtained by the measurement process described in this standard.

3.2
single measurement
value representing the wheel force of one wheel from one measurement unit which forms a part of the measurement device

3.3
measurement results
documented results
results for wheel forces and derived quantities evaluated in one regular measurement process for the report

4 Measurement process

4.1 General

The measurement process is the set of operations, devices and procedures, performed on the vehicle to evaluate its vertical wheel forces.

The measurement process and its influence parameters are illustrated in Figure 1.

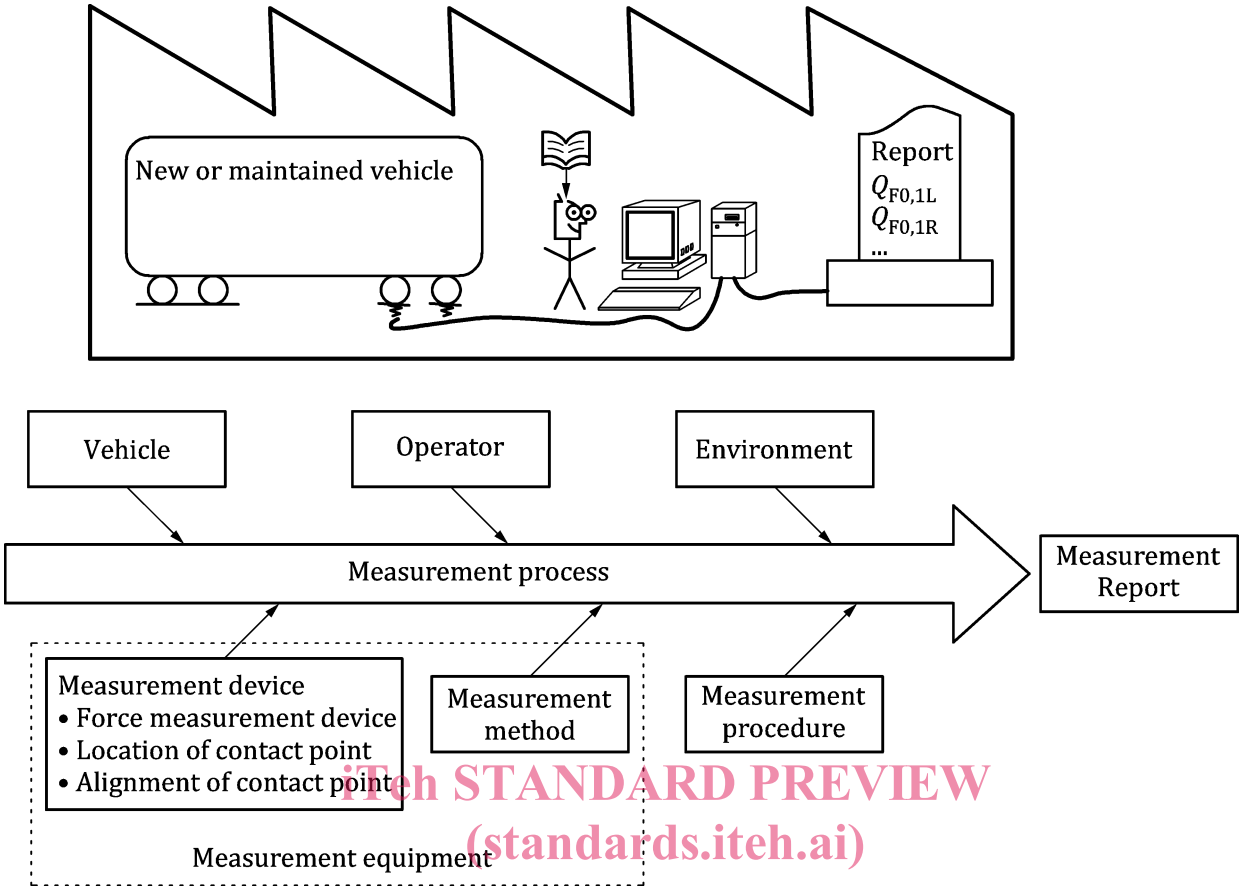


Figure 1 — Measurement process of vertical wheel force

4.2 Measurement equipment

4.2.1 Description of the measurement equipment

The measurement equipment shall be described and documented in a manner that all users can understand.

4.2.2 Measurement method

4.2.2.1 Static Measurements

Static measurements are made with the vehicle at rest and standing on the measurement devices.

Static measurements are performed:

— wheelset by wheelset (requiring for example one measurement section according to Figure 2),

— running gear by running gear (requiring for example one measurement section according to Figure 2 for each wheelset of the running gear), or

— for the whole vehicle (by one device).

4.2.2.2 Quasi Static (Dynamic) Measurements

Quasi-static measurements are made when the vehicle is moved along the measuring track. The aim is to obtain from the vehicle running at low speed representative measurements which under ideal conditions will be similar to those that can be obtained from the vehicle in the stationary condition.

A number of test runs shall be made at a slow and nearly constant speed (for example at up to 5 km/h ± 2 km/h on the measuring track).

To minimize dynamic effects on the uncertainty of the measurement, the speed shall be low and the track quality good. The vertical movement of the vehicle body shall be negligible.

4.2.2.3 Measurements of vehicle under twist

Measurements with the vehicle under twist are taken with the vehicle located on a device that applies twist.

Vertical wheel forces and the applied twist are measured continuously while the twist is being applied to the running gear or to the vehicle both in a positive and in a negative direction with respect to a horizontal reference plane. A full hysteresis loop shall be performed. The result of this measurement is the mean value between the maximum and minimum force measured in the horizontal reference plane (position without twist).

This method reduces the influence of hysteresis on measuring results. The type and the amplitude of the applied twist (vehicle or bogie twist or both) shall be specified taking into account the characteristics of the suspension system of the vehicle.

NOTE Results achieved by the application of vehicle and/or bogie test twist according to EN 14363 are adequate.

4.2.3 Measurement device

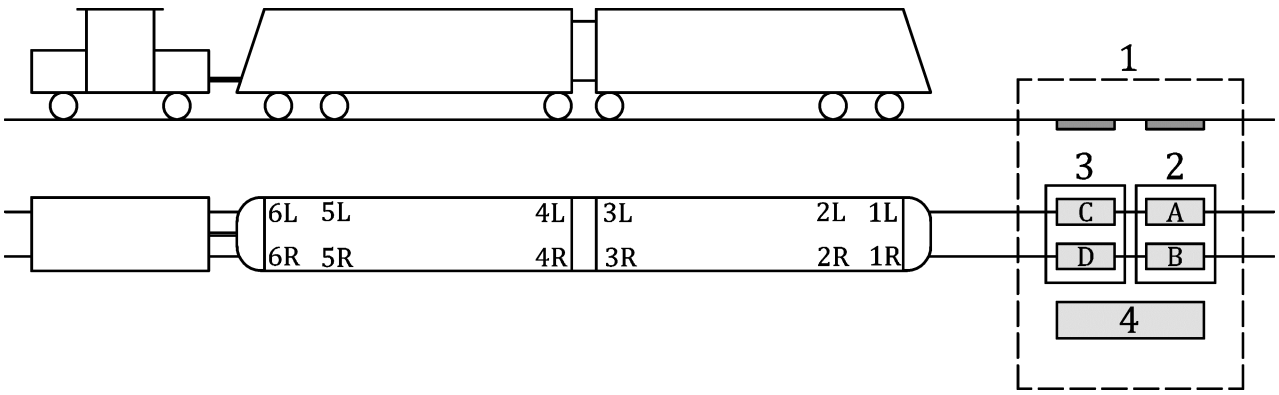
4.2.3.1 Force measurement device (load cells, strain gauges, shear-force sensors, etc.)

The force measurement device converts the mechanical force into a proportional signal that is then processed and transferred to an output device. The measurement device consists of a structure that supports the wheelset, the measuring sensors, the processing instrumentation and a displaying device.

A force measurement device may consist of different sections that are located at different points along the track. Each section consists usually of two units. Each unit provides one single measurement (see Figure 2). Each unit usually contains one or more load cells, strain gauges or shear-force sensors.

Measurement devices shall be manufactured and tested according to generally accepted standards.

NOTE Information about the use of strain gauge installations is given in Annex D.



Key

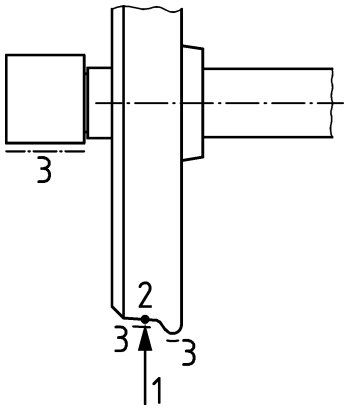
1 measurement device
2 measurement section including units A and B
3 measurement section including units C and D
4 displaying device

Figure 2 — Example for measurement device consisting of two measurement sections (four units)

4.2.3.2 Location of contact points (Running surface, flange top, axle boxes)

The contact points between the vehicle wheels and the measurement devices are usually on the wheel tread profiles at/or near to the reference points shown in Figure 3.

Other contact points on the wheel flange or on the axle box can be used. In these cases, Q_{F0} (the vertical wheel forces at the reference points) shall be calculated from the measured values taking into account the difference between the location of the contact point and the reference point.



Key

1 vertical wheel force Q_{F0}
2 reference point D_0
3 possible locations of contact point (running surface, flange, axle box) for measurement device

Figure 3 — Reference points and typical contact point areas on a wheelset

4.2.3.3 Alignment of contact points / Track characteristics definition

The following geometric characteristics are specified with the intention of ensuring that the contact points of the wheel treads of the vehicle are in a horizontal plane.

The whole section of a track where contact points of the wheelsets of a measured vehicle are positioned during the measurement procedure shall be nominally plane, straight and untwisted.

For the geometry of the measurement device (usually the track) the following tolerance requirements shall be applied:

1) the flatness tolerance (see EN ISO 1101) of the rail tops (on running surface, see EN 13848-1) at the possible positions of the wheelsets along the track inside a measured running gear shall not exceed 1 mm;

2) the algebraic difference in the cross levels (see EN 13848-1) at the positions of any two wheelsets of a running gear shall not exceed 1 mm;

3) the flatness tolerance (see EN ISO 1101) of the rail tops at possible positions of wheelsets along the track in a measured running gear and any possible position of the wheelsets of an adjacent running gear belonging to the same vehicle body shall not exceed 2 mm;

4) the algebraic difference between the mean values of the cross levels (see EN 13848-1) at the positions of the wheelsets in a measured running gear and any possible position of the wheelsets of an adjacent running gear belonging to the same vehicle body shall not exceed 2 mm;

5) the straightness tolerance (see EN ISO 1101) of the centre line of the track (evaluated in the range up to 14 mm below top of rails) shall not exceed 10 mm. This applies to the distance between the wheelsets in a measured running gear and any possible position of the wheelsets of an adjacent running gear belonging to the same vehicle body;

6) The longitudinal gradient of a reference plane given by the possible positions of the wheelsets of two adjacent running gear shall not exceed 0,4 %. The lateral gradient shall not exceed 0,1 %.

NOTE 1 The requirement related to the longitudinal gradient of the reference plane allows to measure one running gear in a lifted position (for example on the flanges).

If the car bodies of measured vehicles are connected by a device that transfers torsional moments around the longitudinal axis, the influence of further running gear shall be considered as specified in Table 1.

It is possible to apply larger tolerances than given in Table 1 for vehicles with more than two connected car bodies. In this case an analysis shall be performed in order to demonstrate that the uncertainties of the measured wheel forces are not dominated by these larger tolerances (see Annex B).

If measurements are not taken on a track, the alignment of the contact points on the support (e.g. under the flange or under the axle box) shall be made in way that it is ensured, that the alignment of the reference points D_0 of the wheel treads of the vehicle follow equivalent rules. The effect of vertical deflections due to the load of a representative vehicle shall be respected for the flatness measurements (see above requirements 1 and 3 and in Table 1).

For the above requirements related to the algebraic differences between two cross levels (2 and 4 and in Table 1) deflections can be neglected, if the difference between the vertical deflections of the left and right rail at the same wheelset position does not exceed 0,2 mm.

This specification is a minimum specification. In some cases a better track quality is useful. Annex B gives more information about the influence of track quality on the measured results.

NOTE 2 Experience has shown that butt welds between rails, rail joints and the use of worn rails lead to problems with compliance with the requirements.

Table 1 — Requirements of the geometry for the measurement device

Area wheelset 1	Area wheelset 2	Flatness tolerance (see EN ISO 1101) of the rail tops on running surface mm	Algebraic difference in the cross levels (see EN 13848-1) at the positions of any two wheelsets mm
Possible positions of the wheelsets along the track inside a measurement section	Possible positions of the wheelsets along the track inside a measured running gear	1	1
Possible positions of the wheelsets along the track inside a measurement section	Possible positions of wheelsets along the track in a measured running gear and any possible position of the wheelsets of an adjacent running gear belonging to the same vehicle body	2	2
Representative position(s) of the wheelsets along the track inside a measurement device	Over 20 m up to 30 m distance from the nearest measurement section	3	3
Representative position(s) of the wheelsets along the track inside a measurement device	Over 30 m up to 40 m distance from the nearest measurement section	4	4
Representative position(s) of the wheelsets along the track inside a measurement device	Over 40 m up to 50 m distance from the nearest measurement section	5	5
Representative position(s) of the wheelsets along the track inside a measurement device	Over 50 m up to 60 m distance from the nearest measurement section	6	6
Representative position(s) of the wheelsets along the track inside a measurement device	Over the total length of the vehicle from the nearest measurement section if greater than 60 m	6	6

4.2.3.4 Lead-on and lead-off track

If the chosen measurement process require lead-on and/or lead-off tracks to improve the reproducibility the characteristics (for example the length) shall be specified. They will depend on the measuring method used and on the overall length of the vehicles being measured.

It shall be specified, if special excitation elements for the suspension (for example wedges and/or check rails) are to be included in the lead-on track(s).

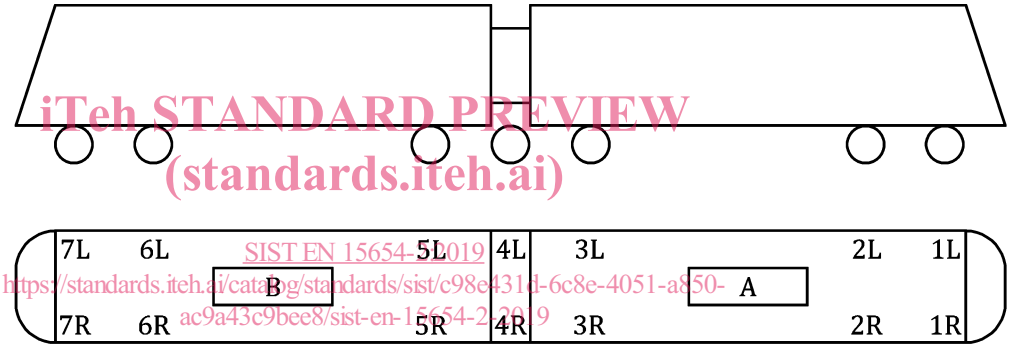
4.3 Vehicle

4.3.1 General

The wheel forces of a vehicle shall be measured after finishing all assembly work on the vehicle and adjustments of the suspension system. If changes are made to the vehicle, which may result in an unacceptable distribution of the wheel forces, the measurement shall be repeated.

4.3.2 Description of the vehicle

A vehicle based identification system, such as illustrated in Figure 4, shall be used to identify each wheel in an unambiguous way.



1								
2				B		A		
3	*i*		III		II		I	
4	*j*		7 6		5 4 3		2 1	
5	*k*				R/L			
6	n_{Veh}				7			
7	*x*		6		3		1	
8	*z*		2		3		2	

Key

1 vehicle type
2 vehicle body number
3 running gear number
4 wheelset number
5 wheel index (*k* = R: right wheel, *k* = L: left wheel)
6 number of wheelsets per vehicle
7 first wheelset number in running gear *i*
8 number of wheelsets of running gear *i*

Figure 4 — Example of a vehicle based identification system for the description of the wheel arrangement