SLOVENSKI STANDARD
kSIST-TP FprCEN/TR 17373:2019

01-junij-2019

Železniške naprave - Železniška vozila - Ugotavljanje položaja tirnih vozil med vožnjo po tirnih protikrivinah in izračun prekrivanja odbojnikov

Railway applications - Railway rolling stock - Investigation of vehicles position on the reserve curve tracks during running and calculation of buffer overlap

Bahnanwendungen - Schienenfahrzeuge - Untersuchung der Fahrzeugstellungen im Gleis bei Durchfahrt von S-Bögen mit Ermittlung der Pufferüberdeckung

Applications ferroviaires - Synthèse des calculs de la largeur des tampons pour appareils de choc et traction

Ta slovenski standard je istoveten z: FprCEN/TR 17373

ICS:

45.060.01	Železniška vozila na splošno	Railway rolling stock in general

kSIST-TP FprCEN/TR 17373:2019 en

TECHNICAL REPORT

RAPPORT TECHNIQUE

TECHNISCHER BERICHT

FINAL DRAFT
FprCEN/TR 17373

January 2019

ICS

English Version

Railway applications - Railway rolling stock - Investigation of vehicles position on the reserve curve tracks during running and calculation of buffer overlap

Applications ferroviaires - Synthèse des calculs de la largeur des tampons pour appareils de choc et traction

Bahnanwendungen - Schienenfahrzeuge - Untersuchung der Fahrzeugstellungen im Gleis bei Durchfahrt von S-Bögen mit Ermittlung der Pufferüberdeckung

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

CEN members are the national standards bodies of 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 United Kingdom.

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.

Warning : This document is not a Technical Report. It is distributed for review and comments. It is subject to change without notice and shall not be referred to as a Technical Report.

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

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

Ref. No. FprCEN/TR 17373:2019 E

Contents

Page

European foreword ... 3
Introduction ... 4
1 Scope ... 6
2 Normative references ... 6
3 Terms and Definitions ... 6
4 Symbols and abbreviations ... 6
5 Boundary conditions ... 7
6 Vehicle dynamic ... 11
6.1 Coefficient of displacement *k* ... 11
6.2 Geometric overthrow *dg* or *F* ... 12
6.3 Location of the vehicle in the track and displacement dy_p ... 12
6.4 Position of the vehicles in the S-curve ... 13
6.4.1 Bogie vehicles ... 13
6.4.2 Other vehicles ... 14
7 Calculation of the displacement of the vehicle body centre (dy_p) ... 15
7.1 dy_p calculated with UIC 527-1 assumptions ... 15
7.1.1 General ... 15
7.1.2 Basic vehicle ... 16
8 Determination of the minimum half width of the buffer head ... 16
8.1 Calculation (simplified formula derived from UIC 527-1) ... 16
8.2 Verification ... 18
8.2.1 General ... 18
8.2.2 Drawing methodology with UIC 527-1 assumptions ... 18
8.2.3 Simulation methodology ... 18
9 Comparison of the values ... 20
10 Buffer overlap of investigated vehicles ... 20
11 Summary ... 21
Annex A (informative) Position of the vehicles on the track calculated and compared with estimation according UIC 527-1 assumption ... 23
Annex B (informative) Drawing methodology — Examples ... 27
Annex C (informative) Multi body simulation methodology — Examples ... 38
C.1 General ... 38
C.2 Multi body simulation by Siemens ... 38
C.3 Multi body simulation by SNCF ... 48
Annex D (informative) Notice to the buffer head geometry and buffer overlap ... 55
Bibliography ... 59

European foreword

This document (FprCEN/TR 17373:2019) 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 Vote on TR.

Introduction

During CEN/TC 256/SC 2/WG 33/SG 2 meetings for the writing of European Standard EN 15551, SNCF presented its experience about derailments in the space of time from 1976 to 1982 due to insufficient buffer overlap and proposed to modify the equations written in EN 15551:2009, Annex J to make greater the width of buffer heads sufficient for safety operation service. The equations SNCF proposed, based on the former assumptions acc. UIC-leaflet from January 1964, simply takes into account the maximal own play of the vehicles, instead of the 5 mm value given in UIC 527-1:2005, 3.2.2 and EN 15551:2009, K.6. Indeed, this 5 mm value is a realistic value for freight wagons but not for other types of vehicles. Regarding the modification of the equations proposed by SNCF the other members of W 33 pointed out that:

— it is not possible to increase the internal half width of the buffer head over the limits specified by UIC 527-1:2005, Apendix A and EN 15551:2009, 6.2.2;

— since 1965 there are two language versions of UIC 527-1, a French version and a German version, and they have a following discrepancy in formulae for calculation of the width of buffer head:

  — UIC 527-1 in French version: calculate the half width of buffer head with different formulae for vehicles with running bogies (e.g. coaches, wagons) or with power bogies (e.g. locomotives, power heads and motor vehicles). Thus, the width of the buffer head calculated for vehicles with power bogies should be greater than the width of the buffer head calculated for vehicles with running (non-power) bogies;

  — UIC 527-1 in German version: calculate the half width of buffer head with the same formulae for all types of bogie vehicles, namely: for vehicles with running bogies as well as for vehicles with power bogies.

— No cases of buffer locking due to an insufficient dimensioning of buffer width (with consequently insufficient buffer overlap) were really noticed in Germany, whereas also in German speaking countries the UIC 527-1 equations in German version have been used for decades to dimension the buffer heads width.

— The geometry of the outside half width of buffer heads (opposite to vehicle centre line) of SNCF derailed coaches have had a circular shape geometry that reduced the buffing surface in Geometry specified in UIC 527-1:2005, Apendix A).

To elaborate a uniform methodology for the calculation of the width of buffer heads, WG 33 decided to create an ad hoc group whose mission was to analyse, by means of realistic simulations, realized with the multi body Software SIMPACK, if the equations, written in the standard EN 15551:2009, Annex J, provide the width of buffer head enough for required minimum buffer overlap and what the domain of use of these equations was.

This document presents the work made by the WG 33 Ad hoc group and the conclusion of this group.

Investigation is conducted for specified vehicles in different vehicle combinations (train sets) for defined running cases in curves.

The purpose of this investigation is evaluation of following parameters:

— lateral displacement of coupled vehicles on the track;

— lateral displacement of coupled vehicles to each other;

— buffer overlap between two specified coupled vehicles with given buffers.

For this purpose, the types of vehicles defining the train sets and different operational conditions are specified. Position of the vehicles on the track at the moment of maximum lateral displacement to each other (minimum buffer overlap) is recorded.

The worst cases of lateral displacement and buffer overlap between two coupled vehicles as well as relation to UIC 527-1 and EN 15551 equations are analysed.

1 Scope

The purpose of this document is to analyse the conducted investigation and evaluation of lateral displacement and buffer overlap between each two specified vehicles of different train sets for defined running cases in curves.

For this purpose, the types of vehicles defining the train sets and different operating conditions are specified. Position of the vehicles on the track at the moment of maximum lateral displacement (minimum buffer overlap) is recorded during the calculation.

The worst cases of lateral displacement and buffer overlap between two coupled vehicles as well as relation to equations in EN 15551:2009 are analysed.

2 Normative references

There are no normative references in this document.

3 Terms and Definitions

No terms and definitions are listed 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

4 Symbols and abbreviations

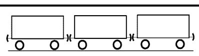
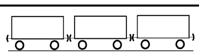
Symbol	Designation	Unit
a	Distance between end wheel sets of vehicles not fitted with bogies or between bogie centres	mm
dg_a	Geometric overthrow of the vehicle on the outside of the curve	mm
dg_i	Geometric overthrow of the vehicle on the inside of the curve	mm
dy_i	Distance from the centre line of the buffer to the contact point at the buffer head, index 1, 2 in accordance to the vehicle number	mm
dy_p	Distance between the centre lines of the 2 buffers	mm
F	Geometric overthrow of the vehicle on the outside of the curve for car body pivots on the track centre line	mm
F_{BC}	Compressive force buffers in contact	kN
F_{LC}	Compressive force simulates the forces with occur on the vehicles during braking or pushing operation	kN
$j1$	own lateral play (internal lateral displacement) of the vehicle ($j1$) in secondary suspension	mm
$j2$	Lateral play in primary suspension	mm
$j3$	Lateral play of the wheel set in a track	mm

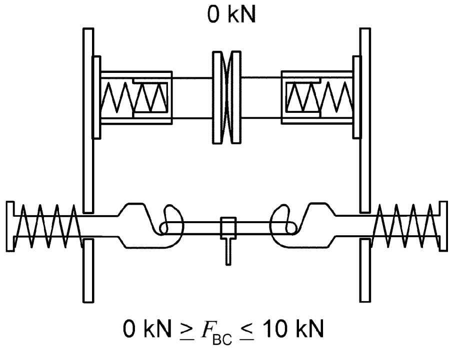
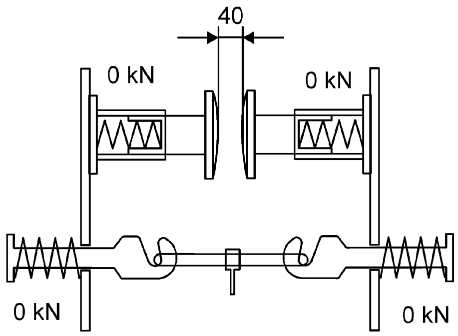
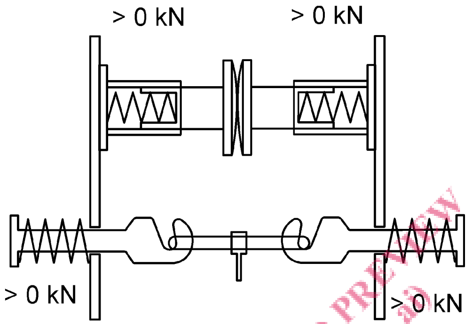
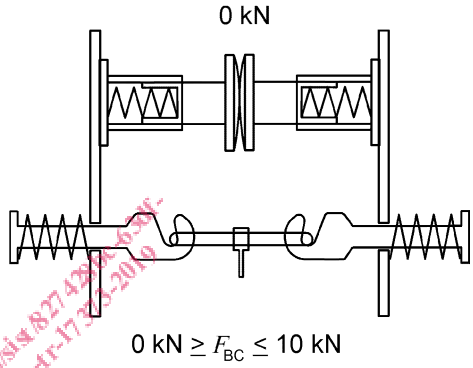
Symbol	Designation	Unit
k	coefficient of lateral displacement of the vehicle in the track	—
l	Track gauge, distance between the rail running edges	mm
l_{nom}	Nominal track gauge	mm
LoB	Length over buffer	mm or m
n	Distance from the section under consideration to the adjacent end wheel set or the closest bogie centre or bogie pivot	mm
n_a	Overhang, distance from buffer face to the closest singular wheel set or closest bogie centre	mm
n_i	n for the sections between the wheel sets or bogie centres	mm
p	Bogie wheelbase	mm
R	Horizontal curve radius	mm or m
R_{LC}	Horizontal curve radius, left curve	mm or m
R_{RC}	Horizontal curve radius, right curve	mm or m
v	Vehicle speed	m/s or km/h

5 Boundary conditions

The configurations and scenarios studied by each participant are described in Table 1 and Table 2.

Table 1 — Boundary conditions

Velocity	v = 30 km/h	constant	for R = 150 m
	v = 40 km/h	**constant**	**for R = 190 m**
Track	***R*150m — 6,79 m — *R*150m**	**gauge**	**1 470 mm**
	***R*190m — 0 m — *R*190m**	**gauge**	**1 458 mm**
Number of vehicles	**3**		
Vehicle configuration	**DB**	**1st class intercity "Avmz" Avmz – Avmz - Avmz**	**3 times the same type**
	SNCF 1	**VTU coaches VTU – VTU – VTU**	**3 times the same type**
	SNCF 2	**Loco BB 27000 + 2 freight wagons (FW) (FW, length over buffers, LoB = 18 m, a = 12 m) Loco + Loco + coach**	
	Siemens	**2 Loco (Vectron) + coach (UIC-type) Loco + Loco + coach**	
Compressive force between vehicles[a]	**F_{LC} = 0 kN**  **= const**		
	F_{LC} = 200 kN  **= const**		

Screw coupler tightening	**nominal case (*N*)**	**degraded case (*D*)**
— for locomotives or wagons		**Dimension in millimeter** 
— for coaches		
	Buffers in contact	
	— 2 rounds before contact with nuts	
	— Specific rules (SNCF)	
a The compressive force simulates the forces with occur on the vehicles during braking or pushing operation		

In Table 2, the studied configurations of the coupled vehicles are indicated by the sign “X”. The scenarios additional indicated by a footnote “a” for “worst case” are the “special” cases where it is assumed that higher requirements might occur and the calculation of the buffer head width in accordance to the specified formulas are not valid for all vehicles.

Table 2 — Configuration of coupling vehicles

Operator/ Manufacturer	Vehicle configuration	Screw coupler tightening	0 kN *R* 150 m *v* = 30 km/h	0 kN *R* 190 m *v* = 40 km/h	200 kN *R* 150 m *v* = 30 km/h	200 kN *R* 190 m *v* = 40 km/h
DB	3 coaches "Avmz"	*N*	X	X	X	X
		D			X[a]	
Siemens	2 Locomotive + 1 UIC coach Locomotive = Siemens Vectron	*N*	X		X	
		D			X[a]	
SNCF 1	3 coaches "VTU"	*N*	X	X	X	X
		D			X[a]	
SNCF 2	1 Locomotive + 2 freight wagons Locomotive = BB27000	*N*			X	
		D			X[a]	

Key
N = nominal case, see Table 1, Screw coupler tightening
D = degraded case, see Table 1, Screw coupler tightening
X = configuration to be calculated/simulated

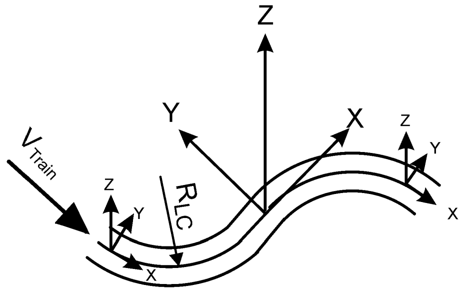
[a] Classified as "worst case"

As specified by the previous tables (Table 1 and Table 2), the two following parameters are taken into account, because they are considered as the most influent ones:

— Screw coupler tightening;

— Compressive force (as reaction of braking or pushing mode).

In order to compare the results between the calculations from the group members, a uniform coordinate system for the analysis of output data was determined. This coordinate system is defined in accordance with 3-finger rule of the right hand, where “x” follows the track in running direction of the train set, and is shown in Figure 1.



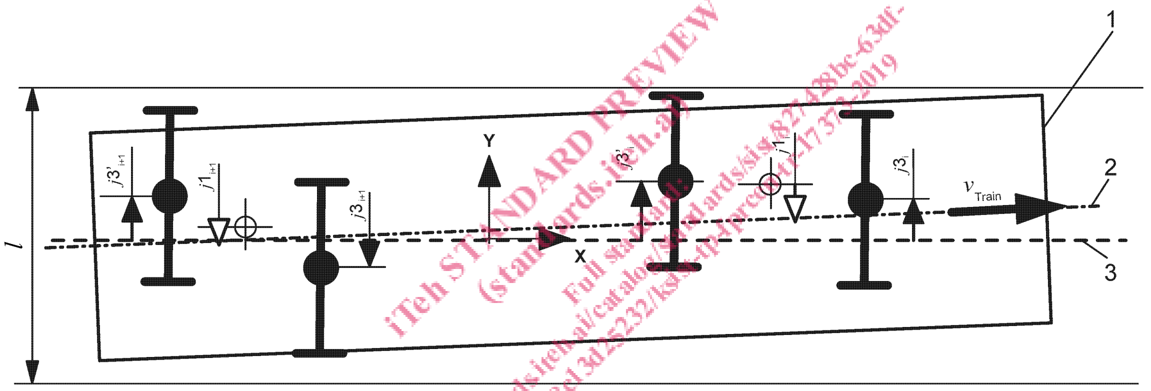
Key

v_{Train} velocity of the train set

R_{LC} radius, left curve

Figure 1 — Coordinate system

It is also necessary to fix of the variables to be registered. The following scheme presents the variable names for vehicle 1 (i is the position of the bogies: i = 1 is the first bogie entering in the S-curve).



Key

v_{Train} velocity of the train set **track centre line**

l track gauge: 1 470 mm R_{LC} radius, left curve

vehicle body x, y axis of the coordinate system

vehicle body centre line

wheel set

bogie pivot

own play of the vehicle body on the bogie ($j1$): Example: $j1_i$, $j1_{i+1}$,

play of the wheel sets in a track ($j3$): Example: $j3_i$, $j3'_i$, $j3_{i+1}$, $j3'_{i+1}$

NOTE 1 i is the position of the bogie: i = 1 is the first bogie entering in the S-curve

NOTE 2 ' indicates the second wheel set of the bogie

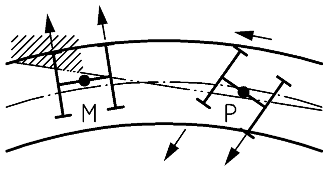
NOTE 3 The play $j2$ (bogie internal to primary spring) is neglected.

Figure 2 — Visualization of the names of analysed parameters

6 Vehicle dynamic

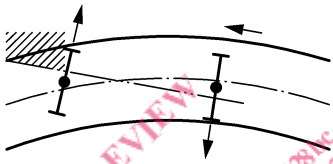
6.1 Coefficient of displacement *k*

The lateral displacement of the wheel sets in the track (*j*3) is different for the bogie vehicles and other vehicles. Thus, there are two equations for the calculation of the coefficient "*k*" for the position of the wheel sets of the bogies in the curve, see Figure 3.



$$k = \frac{n_a + a}{a} \quad (1)$$

a) bogie vehicles



$$k = \frac{2 \cdot n_a + a}{a} \quad (2)$$

b) all other vehicles

where:

a is the distance, in mm, between end wheel sets or bogie pivots of the vehicle concerned;

n_a is the overhang, in mm, of the buffer face in relation to the end wheel sets or bogie pivot;

k is the coefficient of displacement of the vehicle in the track.

Figure 3 — Coefficient *k* for bogie vehicles and other vehicles