RBR GAUGE STUDY TECHNICAL NOTE

RBDL-SOD-ZZ-ZZ-NTF-R-00001

Revision Number:	2.0	**Effective From:**	2025-03-25

Document owner	Railway Track Expert	[redacted]
Prepared by	Railway Track Expert	[redacted]
Reviewed by	Position	Name Surname
	Position	Name Surname

Approved by	Position	Name Surname

THIS DOCUMENT IS REVIEWED AND APPROVED ELECTRONICALLY IN EDMS

DOCUMENT UNCONTROLLED WHEN PRINTED

Co-funded by
the European Union

DOCUMENT HISTORY

This document has been issued and amended as follows:

Revision	Effective from	Author	Description of changes
1.0	2024-10-31	[redacted]	First issue
2.0	2025-03-25	[redacted]	Document update according to comments received from the verification party

CONTENTS

ACRONYMS AND ABBREVIATIONS

A full list of acronyms and abbreviations can be found in RBR Glossary of Abbreviations. The following acronyms and abbreviations are used throughout this document:

Symbol	Designation	Unit
b_{lim}	Semi-width of the installation limit gauge.	m (meters)
$b_{structure}$	Semi-width of the uniform gauge.	m
b_{RP} (or b_{CR})	Semi-width of the reference profile	m
b_Q	Semi-width of the point Q (or PT)	m
$\Delta b_{\delta D}$	Effect of cant difference on distance between tracks	m
D	Cant	m
D_0	Fixed cant value taken into account by agreement between the vehicle and the infrastructure	m
EA	Distance between track centers	m
h	Height in relation to the running surface	m
h_{c0}	Value of hc used for the agreement between the vehicle and the infrastructure	m
h_{RP} (or h_{CR})	Height of the reference profile	m
$h_{structure}$	Height of the uniform gauge	m
Δh	Height variation h	m
I	Cant deficiency	m
I_0	Fixed cant deficiency value taken into account by agreement between the vehicle and the infrastructure with regard to the kinematic gauge	m
k	Security coefficient to take into account track irregularities	m
L	Standard distance between the centerlines of the rails of the same track	m
l_{max}	Maximum track gauge	m
l_{nom}	Nominal track gauge	m
$M3b$	Additional Infrastructure traverse allowance	m
$M3h$	Additional Infrastructure vertical allowance	m
P	Upper point of the reference profile lateral face which is the determining factor for the distance between centers	m
Q or PT	End lateral point of the reference profile upper face	m
q_s	Quasi-static effect	m
q_{sa}	Displacement due to the quasi-static roll taken into account by the infrastructure outside the reference profile on the outside of the curve	m
q_{si}	Displacement due to the quasi-static roll taken into account by the infrastructure outside the reference profile on the inside of the curve	m
R	Displacement due to the quasi-static roll taken into account by the infrastructure outside the reference profile on the inside of the curve	m

R_V	Vertical transition radius in longitudinal section	m
s_0	Flexibility coefficient taken into account in the agreement between the vehicle and the infrastructure	m
S	Allowed additional overthrow	m
S_a	Allowed additional overthrow on the outside of the curve	m
S_i	Allowed additional overthrow on the inside of the curve	m
T_{load}	Angle of dissymmetry, considered as in $\eta 0r$ for poor load distribution	° (degree)
T_D	Track crosslevel errors between two maintenance periods	m
T_N	Track vertical tolerance	m
T_{osc}	Crosslevel track irregularities causing random oscillations	m
T_{susp}	Angle of dissymmetry, considered as in $\eta 0r$ for poor suspension adjustment	°
T_{track}	Transverse displacement of the track between two periods of maintenance	m
Σ_j	Sum of the (horizontal) safety allowances for the structure gauge covering certain random phenomena (j = 1, 2 or 3)	m
Σ_V	Sum of the values of the allowances taken into account by the infrastructure in the vertical direction	m
Σ_{EAj}	Sum of the safety allowances for the distance between centres covering certain random phenomena (j = 1, 2 or 3)	m
η_0	Angle of dissymmetry of a vehicle due to construction tolerances, to suspension adjustment and to unequal load distributions	°
η_{0r}	Reference angle η_0 taken into account in the agreement	°
i/a	"on the inside/outside of the curve"	
B	Distance between the center of the tracks and the gauge outer surface at the level of a 760mm platform (Mixed traffic)	mm
U_i	Additional overthrow added to the gauge at the inner side of the curve (Mixed traffic)	m
U_y	Additional overthrow added to the gauge at the outer side of the curve (Mixed traffic)	m
a	Deviation of the gauge from the vertical position, when there is applied cant on the track (Mixed traffic)	mm
h_a	Applied cant (Mixed traffic)	mm
y	Height above TOR level till the point of the gauge that the deviation a is calculated (Mixed traffic)	mm

DEFINITIONS

The following terms are used throughout this document:

Term	Definition
Reference profile	Line specific to each gauge, representing the cross-section shape and used as a common basis to work out the sizing rules of the infrastructure and of the rolling stock (EN15273-1)

Quasi-static roll	Corresponds to the roll movements of the vehicle due to roll of the sprung weight under the effect of the transverse accelerations due to gravity or to centrifugal force not compensated by the cant. Defined on the basis of the reference profile by applying the associated rules (EN15273-1)
Structure gauge	Defines the space, relative to the track used called the reference track, to be cleared of all objects or structures and relative to the traffic or adjacent track in order to permit safe operation on this reference track (EN15273-3)

1. INTRODUCTION

The structure gauge is the area where no track-side equipment shall be located (signals, catenary masts etc).

The design shall be done considering the following reference profiles on Rail Baltica tracks with 1435 mm track gauge system:

a) GC for all the line as defined in EN15273-1, EN15273-2, EN15273-3.

b) Considering the use of low floor wagons, additional requirements to be followed are defined for the lower part of the structure gauge in EN15273-3 (scheme for GI3 kinematic profile).

c) For the Mixed Traffic Line sections, wider and higher structure gauge must be considered to allow over gauge exceptional transport and operation under exceptional procedures of dynamic reference profile SEC (As defined in Swedish Infrastructure Manager Trafikverket document TRVINFRA-00398).

d) The lower parts of the structure gauges for Passenger only and Light Freight traffic and Mixed traffic, are compatible with GI3. The lower gauge according to the Swedish standard TRVINFRA-00398 for the free space up to 50mm above TOR is not considered for RB network.

The design shall be done considering the following gauge on 1520 mm track gauge system:

a) Structure gauge S as defined in the Commission Regulation (EU) No 1299/2023.

In the present document the gauges resulting from the reference profiles mentioned in point 2 are studied and the orthonormal gauge enveloping these gauges is presented. The structure gauge S from point 3 is analyzed as well.

It shall be marked that according to TEN-T 2024/1679, due to Russia's war of aggression against Ukraine, "Member States with a network with a track gauge different from that of the European standard nominal track gauge of 1435 mm should assess the migration of existing lines of the European Transport Corridors to the European standard nominal track gauge of 1435 mm".

All measurements shall be in meters unless otherwise indicated.

1.1. PURPOSE

The purpose of this document is to provide justification regarding the definition of structural gauges presented in Design Guideline RBDG-MAN-012 in force (DG012 version in force), explain, justify and support with respective calculations the update proposal of chapter 4.1 Gauges and 4.2 Structure Gauges of the same Design Guidelines (DG012 update proposal). To provide examples of application of the basic calculations of platform offset, location of shunting limits and distance between track centres.

To be used for designing the railway system, ensuring the compatibility of subsystems and interoperability constituents, in accordance with Directive 2008/57/EC and Directive 2016/797/EU. To ensure interoperability between the Rail Baltica Global project and the European railway network.

To demonstrate the process of application of requirements of the Commission regulation (EU) No 1299/2023 and updates of 2019/776 and 2023/1694 on the technical specifications for interoperability relating to the 'infrastructure' subsystem of the rail system in European Union with reference to EN15273-3:2013, EN15273-2:2013 and EN15273-1:2013.

This document is based on IDOM's Gauge Study version 12.

1.2. APPLICATION

The document acts as an aid, providing general examples and guidance to the consultants to perform themselves the relevant detailed calculations for their design along RB network, For stations, according to the local horizontal and vertical alignment characteristics in each case. Values shall not be copied directly from this document.

2. GC AND GI3 GAUGE

2.1. UNIFORM GC AND GI3 GAUGE

Uniform GC and GI3 gauge are calculated in accordance with standards EN15273-1, EN15273- 2, EN15273-3.

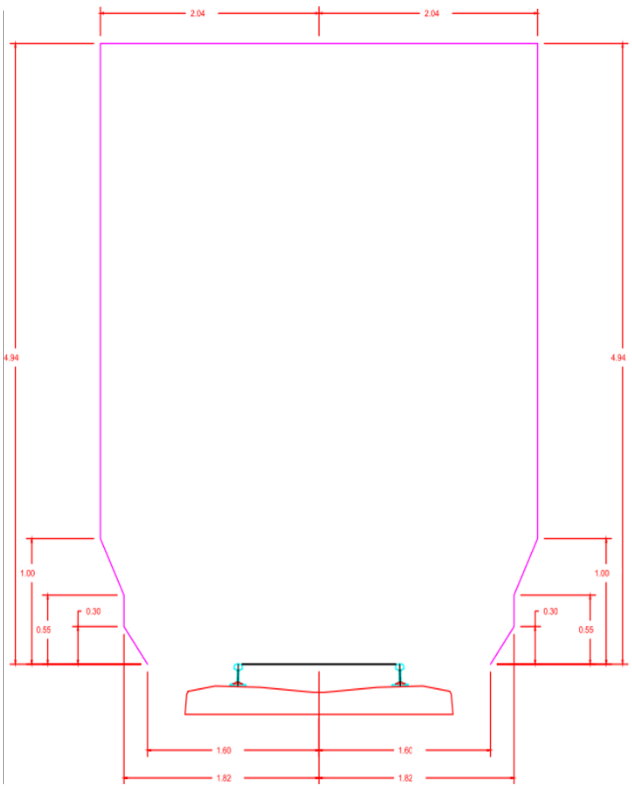
The parameters used to generate the uniform GC and GI3 gauge profiles for DG012 version in force and for DG012 update proposal can be found in Annex 1 and Annex 3 respectively.

2.1.1. DG012 version in force

The differences in the calculated gauge parameters between the mixed traffic lines and the passenger only and light freight traffic lines due to speed and cant allowances, is negligible (1cm horizontally and 3 cm vertically), therefore, the worst case is considered (passenger only lines).

The uniform gauge resulting from these calculations is the following.

Figure 1: Uniform gauge on straight or curved track and no cant



In Annex 1 additional information on the calculation of the uniform gauge is presented.

2.1.2. DG012 update proposal

The reasons for proposing an update in the structure gauge for passenger only and light freight sections where GC and GI3 kinematic reference profiles are considered, are listed below:

a) Implementation of the pantograph gauge for pantograph space reservation.

b) Implementation of space reservation in the structure gauge for passenger platform.

c) Adjustment of the structure gauge width and height in platform area.

d) Provide details for the lower parts of the gauge, using the same approach as for the mixed traffic.

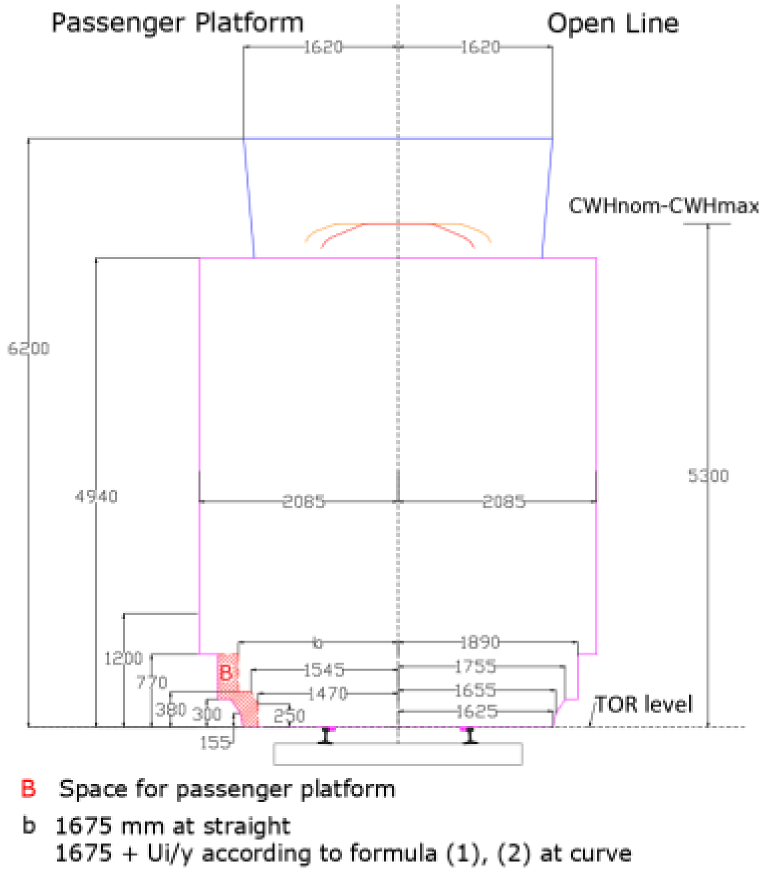
e) Adjustment of Passenger only and Light freight traffic uniform gauge considering the worst case scenario of combinations of curves with small radius and high applied cant sections, according to EN15273-1,2,3 kinematic method.

f) The proposed dimensions (4.5cm wider and lower part details) are the result of testing different radii and cant scenarios and applying the wider combination.

g) Orthonormal gauge removal and lower part adjustment in order to provide space for dwarf signals along the line.

h) Space B reservation for passenger platform, width b will be 1675 on a straight and 1675+Ui/y widening on the inner/outer side of curves. Ui=4100/R (1) and Uy=31000/R (2).

Figure 2: Proposal for Uniform gauge update on straight or curved track and no cant



2.2. DISPLACEMENT OF THE GAUGE PROFILE AT CANTED SECTIONS

The uniform gauge results from a numerical application officially comprising the maximum additional overthrows, maximum quasi-static effects and the infrastructure allowances. It is a nominal gauge to which the infrastructure does not add any additional overthrow or quasi-static effect.

As a result, when the track section has cant, the uniform gauge shall be rotated to consider the inclination of the track but no widening is applied (except from the platform area as described in 2.1.2). The displacement in horizontal (H) and vertical (V) are calculated according to the formulas:

$$H = D * \frac{h}{1.5}$$

In the inside of the curve

$$V = \frac{B \pm 0.75}{1.5} * D$$

Where:

H: horizontal displacement of the gauge profile at a certain point (m)

V: vertical displacement of the gauge profile at a certain point (m)

D: cant (m)

h: height of the calculation point (m)

B: horizontal distance from the central axis of the gauge to the calculation point (m)

3. SEC GAUGE

3.1. NORMAL SECTION STRUCTURE GAUGE

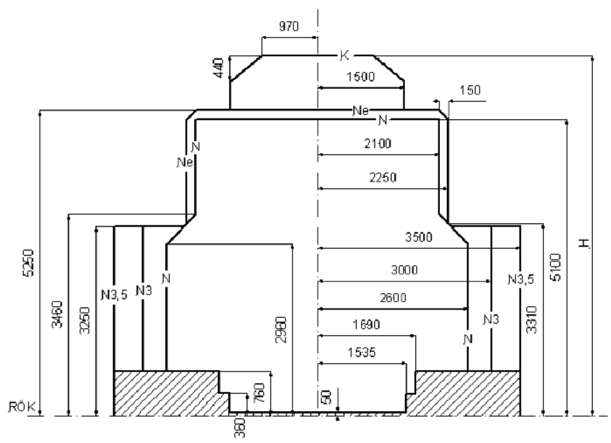
SEc gauge as defined in Swedish Infrastructure Manager Trafikverket document TDOK: 2014- 0555 (current version TRVINFRA-00398 v1.0) is studied for mixed traffic section.

3.1.1. DG012 version in force

The normal section is considered, as indicated in the mentioned standard for new lines. The normal section is a profile calculated for a straight track with no cant. Additions are calculated for tracks on curve and with cant.

The applicable profile on straight track with no cant has the measurements shown in the Figure bellow:

Figure 3: Normal section on straight track and no cant TRVINFRA-0398



3.1.2. DG012 update proposal

The reasons for proposing an update in the structure gauge for mixed traffic sections where Sec dynamic and GI3 kinematic reference profiles are considered, are listed below:

a) Implementation of the pantograph gauge for pantograph space reservation.

b) Implementation of space reservation in the structure gauge for passenger platform.

c) Provide details for the lower parts of the gauge, applying the requirements for GI3 and Sec upper and middle parts according to TDOK: 2014- 0555 (current version TRVINFRA-00398 v2.0,).

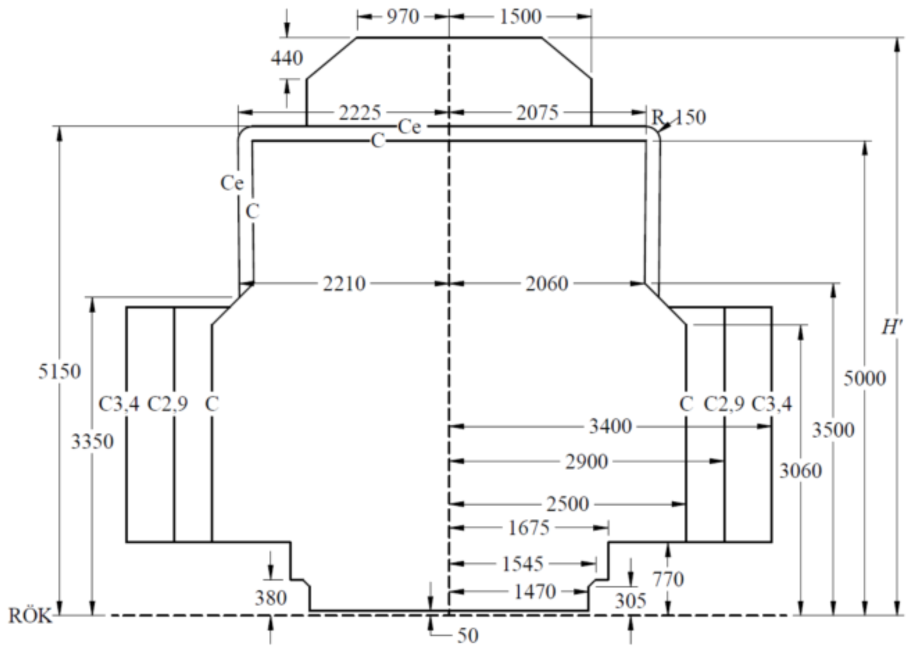
d) Orthonormal gauge removal and lower part adjustment to provide space for dwarf signals along the line.

e) Adjustment of the mixed traffic gauge, considering the worst-case scenario of combinations of curves with small radius and high applied cant sections, according to EN15273-1,2,3 dynamic method.

f) Space B reservation for passenger platform, width b will be 1675 on a straight and 1675+Ui/y widening on the inner/outer side of curves. Ui=41000/R (1) and Uy=31000/R (2).

g) Adjustment of the structure gauge width and height in platform area. The characteristics for the platform area and lower parts of gauge below 770mm height from Minsta Sektion C (TRVINFRA00398, K30184) are applied instead of Normalsektion wider parameters below 760mm height (TRVINFRA00398, K30153) as in the DG012 version in force. The purpose is to secure large space and safety clearance along the open line and achieve larger allowances for the transfer of over gauge transport (see chapter 10.2). Minsta section C is the minimum section possible for applying Sec gauge according to the Swedish standards.

Figure 4: Minsta Sektion C (Minimum Section) according to TRVINFRA0398 v2 K3086



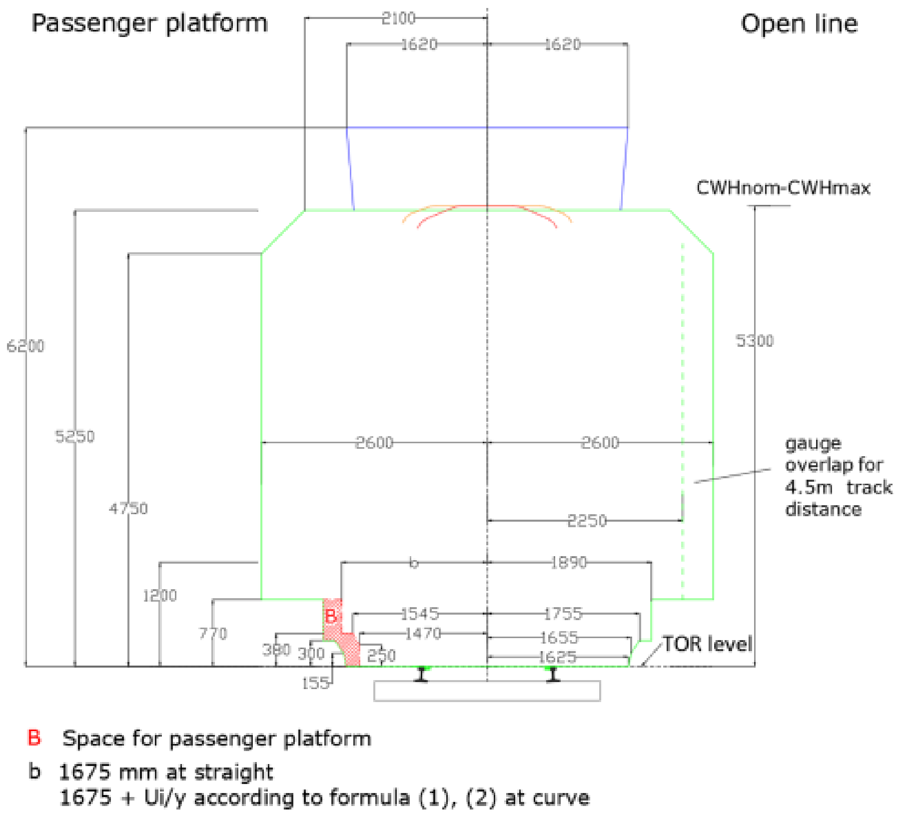
h)

i) It shall be marked that the Normalsektion N, Minsta Sektion C and in result the proposed gauge in Figure 4, shall not be considered for the platform installation. The reference profile Sec and GC shall always be clear from conflict with platforms instead. Additional operational rules shall be in place by the Infrastructure Manager, regarding over gauge transport above platforms with high cant and sharp curve radius.

j) The Normal Section N is defined in the Swedish standards for special transfers, mostly the move of transformers in the Swedish network after receiving the relevant approval of movement from the respective responsible authority. They are considered for extra safety when transferring over gauge transport along the network.

k) The specific rules defining what shall be considered as special transport in Rail Baltica Network is not part of this study. Operational rules for over gauge transport of exceptional consignments exceeding Sec/GC dimensions will be defined in a DG update. Further analysis is provided in chapter 10.

Figure 5: Proposal for Mixed traffic gauge update on track on straight section



3.2. EXTENSION IN CURVES

In curves, the normal section shall be expanded. The width dimensions on the inside (Ui) and the outside (Uy) are increased according to the formulas:

Equation 1: Normal extension in horizontal curve (Equation 2 § TDOK 2014:0555)

$$U_i = \frac{41}{R}$$

$$U_y = \frac{31}{R}$$

Where:

R : horizontal radius (m)

3.3. DISPLACEMENT FOR CANTED SECTIONS

In the canted sections, the normal section is inclined. Centre of rotation is the centre and top of the inner rail. The additions in horizontal (H) and vertical (V) are increased according to the formulas:

$$H = \frac{\mathrm{D} * \mathrm{h}}{1.5}$$

$$V = \frac{\mathrm{D}(\mathrm{B} \pm 0.75)}{1.5}$$

Where:

H: horizontal displacement of the gauge profile at a certain point (m)

V: vertical displacement of the gauge profile at a certain point (m)

D: cant (m)

h: height of the calculation point (m)

B: horizontal distance from the central axis of the gauge to the calculation point (m)

4. RBR STRUCTURE GAUGE

4.1. DG012 VERSION IN FORCE

To consider the GC, GI3 and SEc gauges independently from curves in an orthonormal coordinate system the following structure gauges for Passenger only and light freight traffic in section 4.1 and for Mixed traffic in section 4.2 is used.

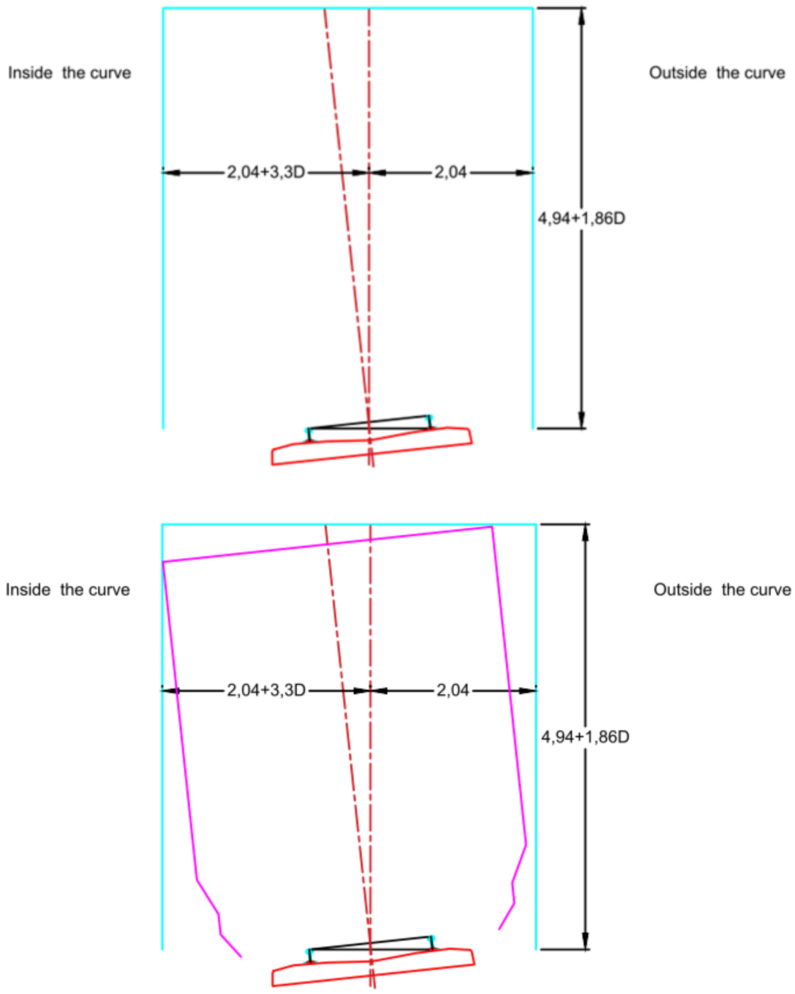
Platforms can be installed inside the structure gauges.

4.1.1. Passenger only and light freight traffic

The structure gauge for passenger only and light freight traffic sections shall only consider the GC uniform gauge.

The profile is adjusted to the GC uniform profile in sections with no cant and is increased in the canted sections to consider the additional space needed to rotate the gauge vertically and inside the curve.

Figure 6: Passengers only and light freight traffic sections Orthonormal structure gauge (RBDG-MAN-012-0110 figure 3)



Where:

D: cant (m)

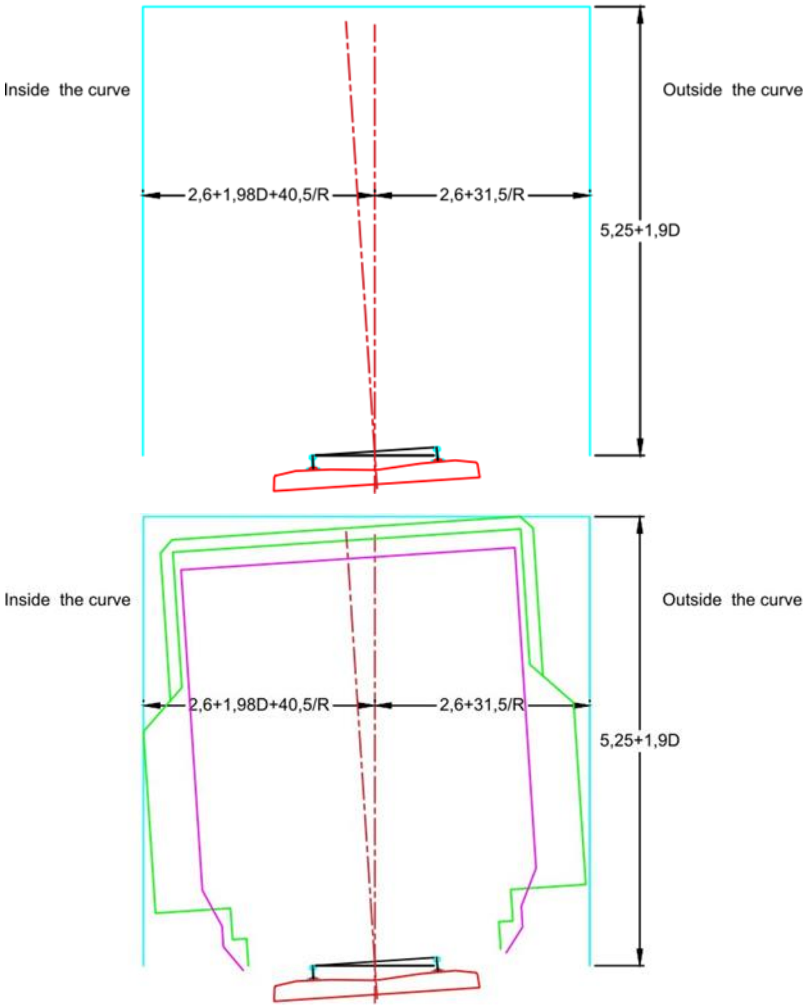
4.1.2. Mixed traffic

The structure gauge for mixed traffic sections shall consider the GC uniform gauge and SEc gauges.

The orthonormal gauge is adjusted to the SEc gauge, as it envelops the GC uniform gauge regardless of the alignment conditions.

Considering the normal section, the extension in curves and cant rotation the orthonormal gauge is as follows:

Figure 7: Mixed traffic sections Orthonormal structure gauge (RBDG-MAN-012-0110 figure 2)



Where:

D: cant (m)

R: horizontal radius (m)

4.2. DG012 UPDATE PROPOSAL

The orthonormal structure gauge is removed at the DG012 update proposal. The purpose is to create gauges that would take into account the space needed to be reserved for platforms and/or dwarf signals in the open track. Pantograph gauge is added.

A unified approach for the area below 0.77m height is applied, for the structure gauges of mixed and passenger only and light freight traffic.

Detailed calculations and justification for the proposed structure gauges' dimensions are presented in Annex 3 both for Passenger only and light freight traffic sections (GC+GI3 reference profiles) and for Mixed traffic sections (Sec+GI3 reference profile).

4.2.1. Passenger only and light freight traffic

The uniform structure gauge proposed is presented in section 2.1.2. No additional widenings due to track geometry are taken into account. The rules for displacement for canted sections in chapter 2.2 apply.

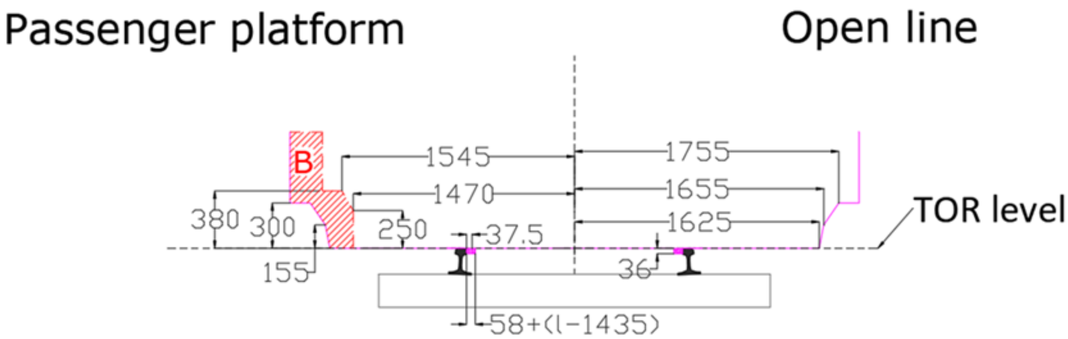
4.2.2. Mixed traffic

The structure gauge proposed is presented in chapter 3.1.2. The rules for extension in curves and displacement for canted sections in chapter 3.2 and 3.3 respectively apply.

4.2.3. Lower parts

The lower part of the gauge is unified for both Mixed and Passenger and Light freight traffic sections, considering GI3 kinematic reference profile, without considering the free space up to 50mm above TOR as they are defined in the Swedish standard TRVINFRA00398. According to the calculations for the uniform gauge for Passenger and light freight traffic, the lower part is at TOR level for the worst case scenario tested for the network. The same lower part is applied for the Mixed traffic structure gauge. For specific locations on the network, the kinematic method according to EN15273-1, 2, 3 shall be applied for obtaining the exact dimensions for the respective horizontal and vertical geometry.

Figure 8: Proposal for lower part of the structure gauges for passenger only and light freight traffic and mixed traffic sections (dimensions in mm)



4.2.4. Dual gauge for gauntlet 1435/1520 track

Dual structure gauge is defined for both traffic types by the superimposition of the respective 1520 and 1435 structure gauges. The rules for additional widenings and displacement due to the track geometry for each side apply as described in sections 2.2, 3.2 and 3.3 for 1435 and according to the respective national standards for 1520 (see chapter 5).

Figure 9: Gauntlet track structure gauge for 1520 and 1435 passenger only and light freight traffic sections

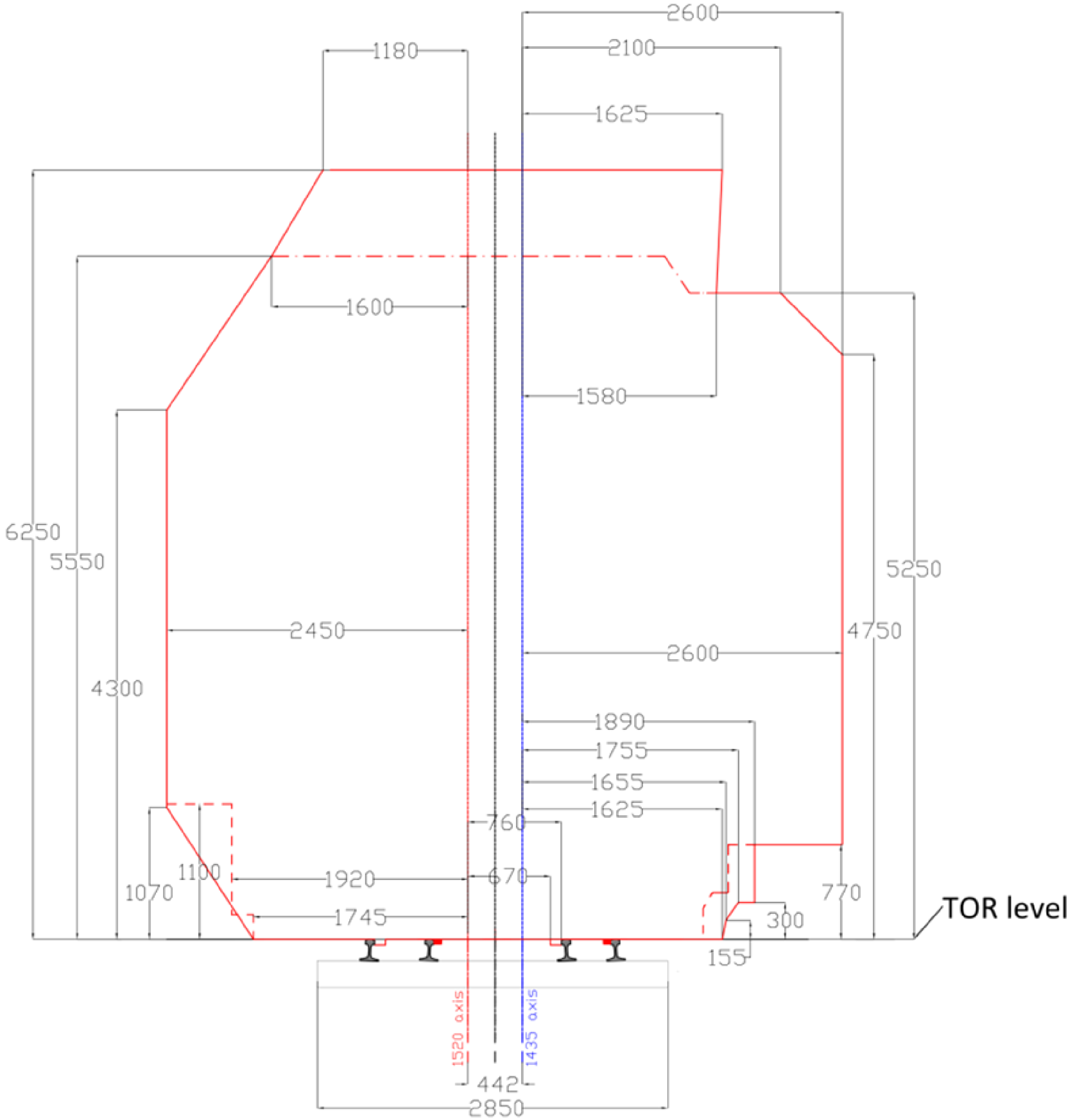
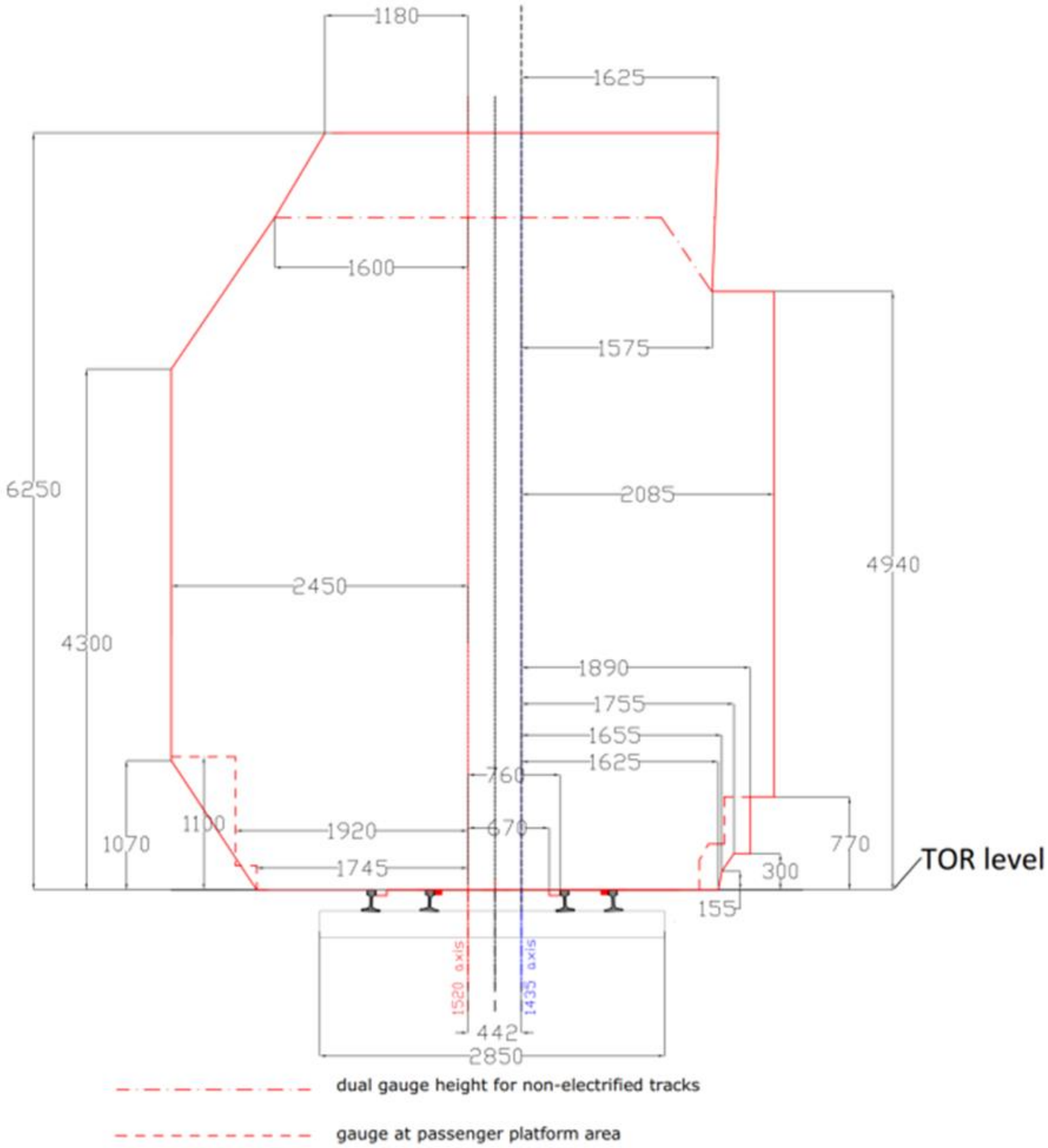

2600
2100
1180
1625
1600
1580
6250
5550
5250
4300
2450
2600
4750
1890
1755
1655
1625
760
670
1920
1745
1100
1070
770
300
155
TOR level
1520 axis
1435 axis
442
2850

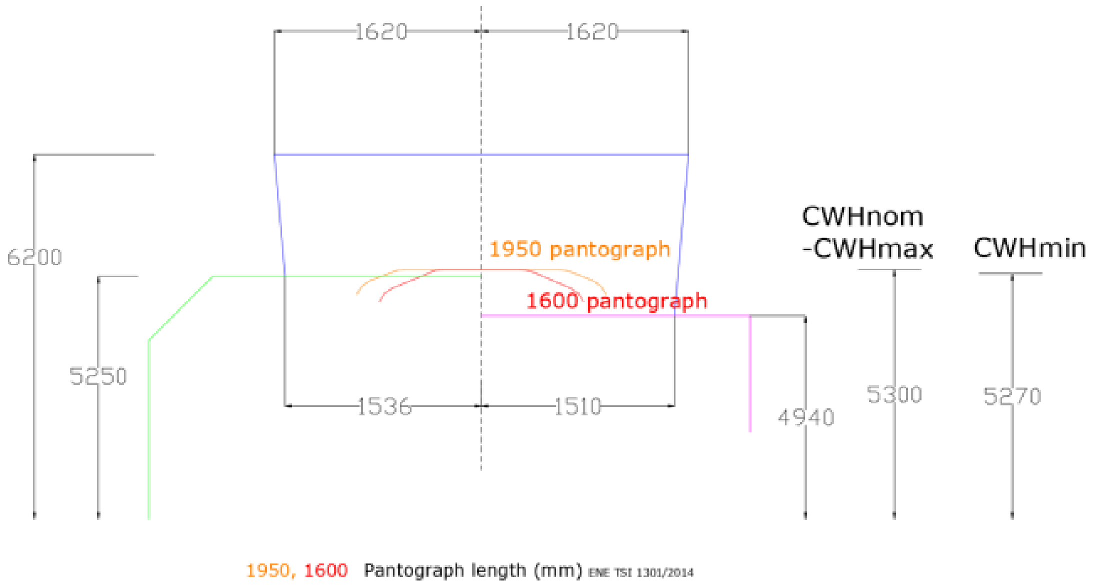
Figure 10: Gauntlet track structure gauge for 1520 and 1435 mixed traffic sections (dimensions in mm)



4.2.5. Pantograph gauge

No additional widenings are applied on the pantograph structure gauge due to the geometry of the section.

Figure 11: Proposal for pantograph structure gauge for Mixed and Passenger only and light freight traffic sections (dimensions in mm)



TRAFFIC	min CWH	nom CWH	max CWH
MIXED	5.27 m	5.30 m	5.30 m
PASSENGER -LIGHT FREIGHT	5.27 m	5.30 m	5.30 m

Figure 12: Proposed pantograph gauge for gauntlet 1520 and 1435 passenger only and light freight traffic sections (dimensions in mm)

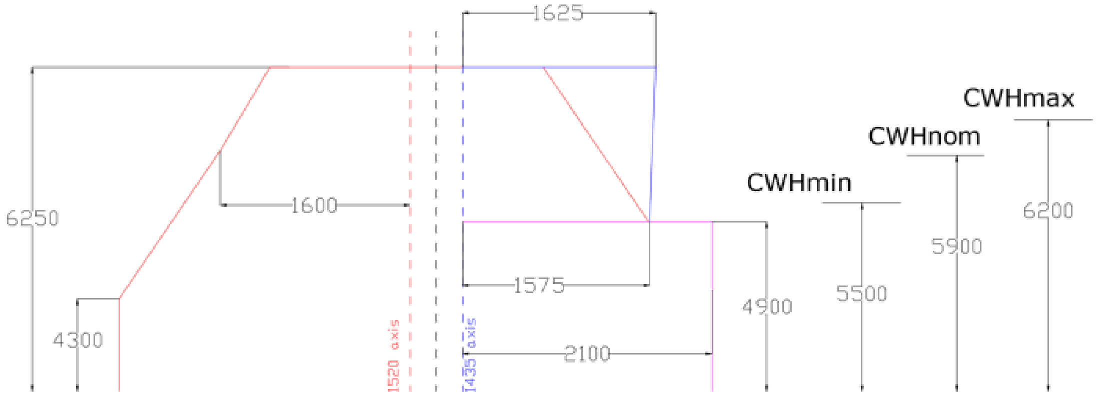
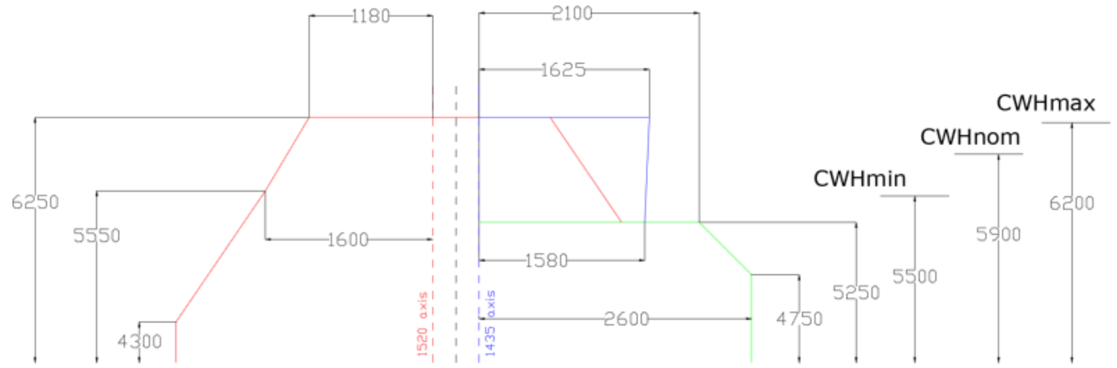


Figure 13: Proposed pantograph gauge for gauntlet 1520 and 1435 mixed traffic sections (dimensions in mm)

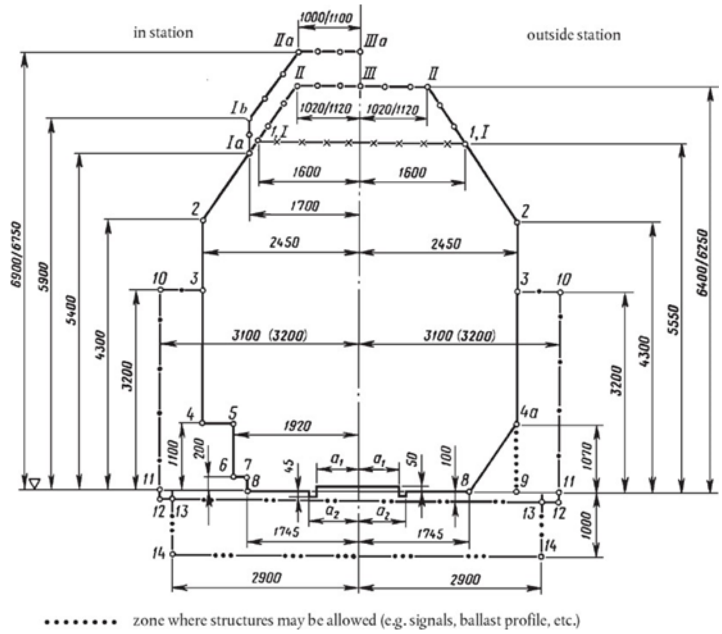


5. STRUCTURE GAUGE S FOR THE 1520 MM TRACK GAUGE SYSTEM

The S gauge follows an orthonormal coordinate system as defined in Annex H § Commission regulation (EU) No 1299/2023.

Considering the normal section, the extension in curves and cant rotation the orthonormal gauge is followed.

Figure 14: Structure gauge S for the 1520 mm track gauge system



The structural gauge for curved tracks with radius below 4000 m, suffer a gauge widening of $b_{RI} = b_{RA} = 36000/R\ m$ (b_{RI} for the internal side of the curve, b_{RA} for the external side of the curve) according to Table B.1 § GOST 9238-2013.

6. CONCLUSIONS

Currently applied orthonormal structure gauges and structure gauges' update proposals for mixed traffic sections (considering GC and SEC gauges) and for passenger only and light freight traffic sections (considering only GC gauge) have been presented.

If compliant with the RBR structure gauge the design is also compliant with GC and SEc requirements.

Orthonormal structure gauge S for the 1520 mm track gauge system have been presented.

7. DISTANCE BETWEEN TRACK CENTRES

Distance between track centres shall be checked in accordance with the studied gauges.

7.1. PASSENGER ONLY AND LIGHT FREIGHT TRAFFIC

For passenger only lines the GC gauge is required. The requirements are as follows:

Table 1: Distance between track centres requirements for passenger lines

Standard	Required distance between track centres
Infrastructure TSI. Table 4 (200 < v ≤ 250)	4.00 m
EN 15273-3. Limit distance between track centres for GC gauge	3.832 m

As can be seen the 4.0m distance between track centres is compliant with the requirements of the passenger traffic lines.

7.2. MIXED TRAFFIC LINES

For mixed traffic lines in addition to GC gauge the SEc gauge shall be considered. Requirements are as follows:

Table 2: Distance between track centres requirements for mixed lines

Standard	Required distance between track centres
Infrastructure TSI. Table 4 (200 < v ≤ 250)	4.00 m
EN 15273-3. Limit distance between track centres for GC gauge	3.555 m
TRV INFRA00398. Limit for distance between tracks for SEc gauge	4.44 m, not less than 4.5m
EN 15273-3. Limit distance between track centres for SEc gauge	4.387 m

As can be seen the 4.5m distance between track centers is compliant with the requirements of the mixed traffic lines. For curves with radius lower than 300m additional widening is needed, see Annex 2 chapter 5.

7.3. 1520 MM TRACK GAUGE SYSTEM

For 1520 mm track gauge system the "T" gauge shall be considered, the required centre line distance according to "T" uniform gauge contour geometry with a separation of 150 mm between vehicle gauges sufficient for dynamic effects and wear conditions is 4.1 m on straight section with an increase of $b_R = 72\ 000/R$ in case of the same radius in both tracks according to E.2.8.3 § GOST 9238-2013:

Table 3: Distance between track centres requirements for 1520 mm track gauge system, according to GOST 9238-2013 [m]

Straight	R=4000 m	R=3000 m	R=2000 m	R=1000 m	R=500 m	R=150 m
4.100 m	4.118 m	4.124 m	4.136 m	4.172 m	4.244 m	4.58 m

Dimensions of structure gauge and increase of distance between track centres, calculated on different alignment parameters with and without cant are calculated according to tables E.5 (for railway network tracks) and E.6 (for access tracks) of annex E § GOST 9238-2013.

National regulations apply on the calculation of the distance between track centres on 1520 mm gauge tracks on the different countries:

a) For Lithuania, the requirements on the distance between track centres for 1520 mm track gauge are defined in the clause 61 in the standard 15/LG for arrival and departure and cumulative (departure) tracks. In curved sections of station tracks, the distance between track axis shall be increased taking into account the requirements of the Table 3.6 § 163/K.

Table 4: Distance between track centres requirements on straight and curved sections for 1520 mm track gauge system, according to 15/LG and 163/K

Horizontal radius (m)		Straight	R=4000 m	R=3000 m	R=2000 m	R=1000 m	R=500 m	R=150 m
Cant (mm)		D=0 mm	D=0 mm	D=0 mm	D=0 mm	D=0 mm	D=0 mm	D=0 mm
Required distance between track centres (m)	Normal requirement	5.3	5.32	5.32	5.34	5.37	5.59	5.83
	Minimum requirement	4.8	4.82	4.82	4.84	4.87	5.09	5.33

b) For Latvia, the requirements on the distance between track centres for 1520 mm track gauge are defined in the Annex in the standard LVS 282:2015.

When carrying out the construction of stations, changes and overtaking points or reconstruction of existing distribution points, the following distances must be observed:

Table 5: Distance between track centres requirements for 1520 mm track gauge system, according to LVS 282:2015

Track description:	The distance between the axes of side tracks at stations, changes and overtaking points, mm	
	normal	minimum
1. Main tracks	5300	4800
2. Main track and side track: 2.1. in one-way and two-ways sections with train speed up to 120 km/h 2.2. in stations with two tracks with speed greater than 120 km/h	5300	5300
3. Receiving and departure tracks	6500	6500*
4. Less important station tracks: rolling stock parking tracks, cargo area tracks, etc.	5300	4800
5. Tracks for arrivals and departure which wagons are repaired.	4800	4800

For every other track	5600 and 5300	5600 and 5300

* When designing second tracks and modernizing (reconstructing) existing lines, the distance may be reduced, but it should not be less than 5300 mm.

For Estonia, requirements on the track centreline distance are based on the standard GOST 9238-2013.

8. PLATFORM OFFSET

8.1. INTRODUCTION

The following requirements/conditions are taken into account in the calculation of the platform offset:

a) Platforms in RBR shall be located at a height of 0.760m above the running surface (h_q).

b) The platform offset is the distance between track centre and platform edge (b_q). It is measured parallel to the running plane.

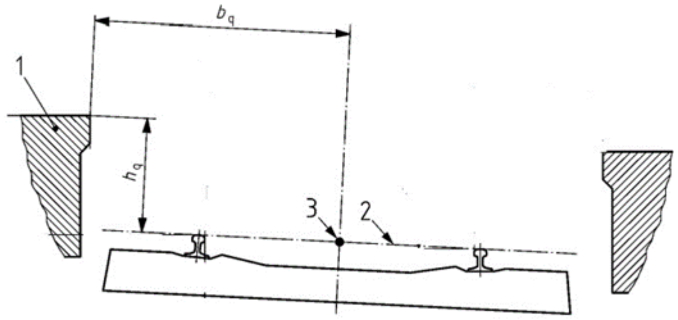
c) The minimum radius allowed for the alignment along a passenger platform is of 1000m and the cant is limited to 70mm.

d) It is assumed that the platform is a vertical wall. For other geometries of the platform the study could be adapted to the chosen option.

e) In accordance with Infrastructure TSI b_q is set on the basis of the installation limit gauge as defined in EN15273-3.

f) For mixed traffic lines SEc gauge is checked to confirm the platform offset is compliant with the SEc gauge profile.

Figure 15: Platform position relative to the track



1: Platform

2: Running plane

3: Track axis

8.2. INFRASTRUCTURE TSI REQUIREMENTS

The platform shall be built close to the installation limit gauge within a maximum tolerance of 50mm, as indicated in the Infrastructure TSI. The value for b_q shall therefore respond to:

$$b_{qlim} \leq b_q \leq b_{qlim} + 50mm$$

Different b_{qlim} are calculated for different possible alignment conditions and the corresponding maximum and minimum platform offsets are determined.

Table 6: Platform offsets in accordance with GC installation limit gauge (Infrastructure TSI requirement) and no coping

R (m)	D (mm)	Platform offset for GC installation limit gauge (h=0.76 m)	
		inside of the curve	outside of the curve
Str	0	1.667m < bq < 1.717m	1.667m < bq < 1.717m
4000	70	1.668m < bq < 1.719m	1.689m < bq < 1.74m
3600	70	1.668m < bq < 1.719m	1.690m < bq < 1.741m
2000	70	1.669m < bq < 1.720m	1.690m < bq < 1.741m
1000	70	1.671m < bq < 1.722m	1.693m < bq < 1.744m

In Annex 1 additional information on the calculation of the platform offset on the basis of the installation limit gauge is presented.

8.3. SEC GAUGE CHECK

8.3.1. DG012 version in force

In mixed traffic lines the SEc gauge profile must be checked to avoid any interference between the train and the platform edge. The passenger platform can never invade the SEc profile. The minimum platform offset for the SEc gauge depending on the different alignment conditions is the following according to the current version of DG012:

Table 7: Platform offsets for Sec reference profile according to TRVINFRA-00398 according to the current version of DG012

R (m)	D (mm)	Minimum platform offset for SEc gauge (h=0.76m)	
		inside of the curve	outside of the curve
Str	0	1.690m < bq	1.690m < bq
4000	70	1.700m < bq	1.716m < bq
3600	70	1.701m < bq	1.717m < bq
2000	70	1.711m < bq	1.724m < bq
1000	70	1.731m < bq	1.734m < bq

8.3.2. DG012 update proposal

The minimum platform offset for the SEc gauge depending on the different alignment conditions is the following according to the proposal for DG012 proposal:

Table 8: Platform offsets for Sec reference profile according to TRVINFRA-00398 according to the proposal for DG012 update

R (m)	D (mm)	Minimum platform offset for SEc gauge (h=0.76m)	
		inside of the curve	outside of the curve
Str	0	1.675m < *bq*	1.675m < *bq*
4000	70	1.685m < *bq*	1.702m < *bq*
3600	70	1.686m < *bq*	1.703m < *bq*
2000	70	1.696m < *bq*	1.710m < *bq*
1000	70	1.716m < *bq*	1.725m < *bq*

8.4. RESULTING PLATFORM OFFSET

8.4.1. DG012 version in force

After considering the requirements of the Infrastructure TSI and the compliance between GC and SEc gauge to prevent interferences, the conclusion is the following:

*Table 9: Passenger platform offset in mixed traffic lines according to the DG012 version in force**

R (m)	D (mm)	Platform offset in mixed traffic lines	
		inside of the curve	outside of the curve
Str	0	1.690m < *bq* < 1.717m	1.690m < *bq* < 1.717m
4000	70	1.700m < *bq* < 1.719m	1.716m < *bq* < 1.74m
3600	70	1.701m < *bq* < 1.719m	1.717m < *bq* < 1.741m
2000	70	1.711m < *bq* < 1.720m	1.724m < *bq* < 1.741m
1000	70	No *bq* margin available*	1.740m < *bq* < 1.744m

* additional request to the National Safety Authority will be needed in case b_q tolerance is not feasible for construction/maintenance

Table 10: Passenger platform offset in passenger only traffic lines

R (m)	D (mm)	Platform offset in passenger only and light freight traffic lines	
		inside of the curve	outside of the curve
Str	0	1.667m < *bq* < 1.717m	1.667m < *bq* < 1.717m
4000	70	1.669m < *bq* < 1.719m	1.690m < *bq* < 1.74m
3600	70	1.669m < *bq* < 1.719m	1.691m < *bq* < 1.741m
2000	70	1.670m < *bq* < 1.720m	1.691m < *bq* < 1.741m

1000	70	1.672m $< bq <$ 1.722m	1.694m $< bq <$ 1.744m

** The resulting platform offset is a reference value for predetermined radius, cant and cant deficiency values. Further platform offset calculation will be required on the platform design for the actual track geometry following the TSI INFRA and EN15273 methodology described in Annex 1 for GC gauge and Annex 2 for Sec gauge.

Table 11: Summary table for platform offset and available tolerance according to the DG012 version in force

			TSI-EN15273-GC				Sec (Normal Section) (TRVINFRA00389) -from the tilted track axis		Overlap				available margin for tolerance		Gauge overlap with platform 2.5% (mm)				
	V	100	inner		outer		inner	outer	inner		outer		inner	outer		Gauge width			
* outer values for δ with coping hnez=0.347	Radius	Cant	Bqlim	Bqlim +50mm	Bqlim	Bqlim +50mm	B+Ui B=1690	B+Uy+δ δ=347*D/1500	B+Ui	Bqlim +50mm	B+Uy+δ δ=347*D/1500	Bqlim +50mm				Bi	By	check inner	check outer
Station platforms on side tracks (100km/h)	(straight)	0	1666	1716	1666	1716	1690	1690	1690	1716	1690	1716	26	26	0	1690	1690	ok	ok
	1000	70	1671	1721	1686	1736	1731	1737	1731	1721	1737	1736	-10	-1	19	1731	1721	ok	ok
	2000	70	1669	1719	1685	1735	1711	1722	1711	1719	1722	1735	9	13	19	1711	1706	ok	ok
	3000	45	1667	1717	1678	1728	1704	1711	1704	1717	1711	1728	13	17	5	1704	1700	ok	ok
	4000	35	1667	1717	1676	1726	1700	1706	1700	1717	1706	1726	17	20	0	1700	1698	ok	ok
Halts (249 km/h)	3100	90	1668	1718	1689	1739	1703	1721	1703	1718	1721	1739	15	18	31	1703	1700	ok	ok
	4400	70	1668	1718	1687	1737	1699	1713	1699	1718	1713	1737	19	24	19	1699	1697	ok	ok

8.4.2. DG012 update proposal

After considering the requirements of the Infrastructure TSI and the compliance between GC and SEc gauge to prevent interferences, the conclusion is the following:

Table 12: Passenger platform offset in mixed traffic lines according to the DG012 proposal for update

R (m)	D (mm)	Platform offset in mixed traffic lines	
		inside of the curve	outside of the curve
Str	0	1.675m < bq < 1.717m	1.675m < bq < 1.717m
4000	70	1.685m < bq < 1.719m	1.702m < bq < 1.74m
3600	70	1.686m < bq < 1.719m	1.703m < bq < 1.741m
2000	70	1.696m < bq < 1.720m	1.710m < bq < 1.741m
1000	70	1.716m < bq < 1.722m	1.725m < bq < 1.744m

Table 13: Passenger platform offset in passenger only traffic lines

R (m)	D (mm)	Platform offset in passenger only and light freight traffic lines	
		inside of the curve	outside of the curve
Str	0	1.667m < bq < 1.717m	1.667m < bq < 1.717m
4000	70	1.669m < bq < 1.719m	1.690m < bq < 1.74m
3600	70	1.669m < bq < 1.719m	1.691m < bq < 1.741m
2000	70	1.670m < bq < 1.720m	1.691m < bq < 1.741m
1000	70	1.672m < bq < 1.722m	1.694m < bq < 1.744m

** The resulting platform offset is a reference value for predetermined radius, cant and cant deficiency values. Further platform offset calculation will be required on the platform design for the actual track geometry following the TSI INFRA and EN15273 methodology described in Annex 1 for GC gauge and Annex 2 for Sec gauge.

Table 14: Summary table for platform offset and available tolerance according to the DG012 proposal for update

			TSI-EN15273-GC				Sec (Minimum Section/New gauge) (TRVINFRA00389)-from the tilted track axis		Overlap				available margin for tolerance		Gauge overlap with platform 2.5% (mm)					
	V	100	inner		outer		inner	outer			outer		inner	outer		Gauge width				
* outer values for δ with coping hnez=0.347	Radius	Cant	Bqlim	Bqlim+50mm	Bqlim	Bqlim+50mm	B+Ui B=1675	B+Uy+δ δ=347*D/1500	B+Ui	Bqlim+50mm	B+Uy+δ δ=347*D/1500	Bqlim+50mm				Bi	By	By	check inner	check outer
Station platforms on side tracks (100km/h)	(straight)	0	1666	1716	1666	1716	1675	1675	1675	1716	1675	1716	41	41	0	1675	1675	ok	ok	ok
	1000	70	1671	1721	1686	1736	1716	1722	1716	1721	1722	1736	5	14	9	1716	1706	ok	ok	ok
	2000	70	1669	1719	1685	1735	1696	1707	1696	1719	1707	1735	24	28	9	1696	1691	ok	ok	ok
	3000	45	1667	1717	1678	1728	1689	1696	1689	1717	1696	1728	28	32	0	1689	1685	ok	ok	ok
	4000	35	1667	1717	1676	1726	1685	1691	1685	1717	1691	1726	32	35	0	1685	1683	ok	ok	ok
Halts (249 km/h)	3100	90	1668	1718	1689	1739	1688	1706	1688	1718	1706	1739	30	33	21	1688	1685	ok	ok	ok
	4400	70	1668	1718	1687	1737	1684	1698	1684	1718	1698	1737	34	39	9	1684	1682	ok	ok	ok

8.4.3. Construction and maintenance tolerance

Considering the results of the platform offset analysis for GC and Sec gauge according to the rules of DG012 that is currently in force (Table 11) and rules of the proposal for DG012 update (Table 14), it is derived that the available margin for platform offset tolerance is more favourable with the proposal for DG012 update.

For all radii values from R 2000m, it is possible to have tolerance of at least +/-10mm compared to +/-5 available with the current DG012 rules, when applying the mean value between the upper and lower limits.

For horizontal radius of 1000m, there is a small available margin of +/-3mm for the inner and +/-7mm for the outer side of the curve following the DG012 proposal for update, while according to the DG012 version in force there was no available platform offset that would secure the passage of both GC and SEc gauge.

9. SHUNTING LIMITS

9.1. INTRODUCTION

The shunting limit is the limit where the head of the train must stop in front of a turnout on the heel side, so that its position is compatible with the movement of the train on the other track.

9.2. 1435 MM TRACK GAUGE

9.2.1. Passenger only and light freight traffic sections according to EN15273-3

According to EN15273-3:2013, chapter 10.2, when a vehicle is located at the beginning of a curve, the front of it has already an overthrow relative to the track centerline before the first bogie or wheel set has re-entered the curve.

The outside additional overthrows are to be partially taken into account from a distance n_a+a from the layout transition. The geometric overthrow appears fully when the vehicle is located entirely in the curve, therefore the rear of the vehicle is at a distance n_a from the start of the curve. A smooth change is created between these two extreme solutions.

A similar solution arises on the inside of the curve. As the critical points are located between two bogies, the change in the additional overthrows begins at a distance a from the start of the transition zone to end at a distance a/2 in the curve.

Table 15: Shunting limit calculation methodology according to EN15273-3

Reference vehicle number	$A_{i/a}$	$B_{i/a}$	B_{Ve}	a	n_a (a=5 m)	n_a (a=20 m)	$S_{i/a}$
1i	3,75	0	$B_{cr}+B_{i/a}$	$\sqrt{(8*A_{i/a})}$	-	-	$A_{i/a}/R-B_{i/a}$
2a	3,75	0	$B_{cr}+B_{i/a}$	-	$\frac{-a+\sqrt{+8Aa}}{2}$	$\frac{-a+\sqrt{+8Aa}}{2}$	$A_{i/a}/R-B_{i/a}$
3i	50	0,185	$B_{cr}-B_{i/a}$	$\sqrt{((A_{i/a}/R)*(8*R))}$	-	-	$A_{i/a}/R-B_{i/a}$
4a	60	0,225	$B_{cr}-B_{i/a}$	-	$\frac{-a+\sqrt{+8Aa}}{2}$	$\frac{-a+\sqrt{+8Aa}}{2}$	$A_{i/a}/R-B_{i/a}$
Note: the vehicles numbers 1 and 3 determines the additional deviations for the interior side of the curve and the vehicles n°2 and 4 for the exterior side of the curve. Some values are purely theoretics and not usable in practise for other reasons.							

a-vehicle wheelbase

n_a - overhang

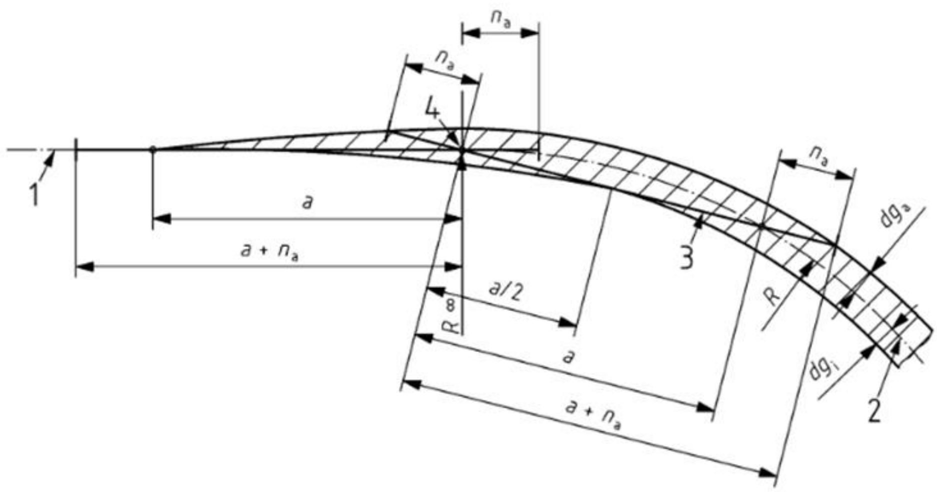
B_{cr} = 1.645 m for GC gauge

Additional overthrows:

$dg_{i/a} = B_{cr} + S_{i/a} + qs_{i/a} + \Sigma_{1,i/a}$

See Annex 1 chapter 9 for additional overthrows calculation formulas.

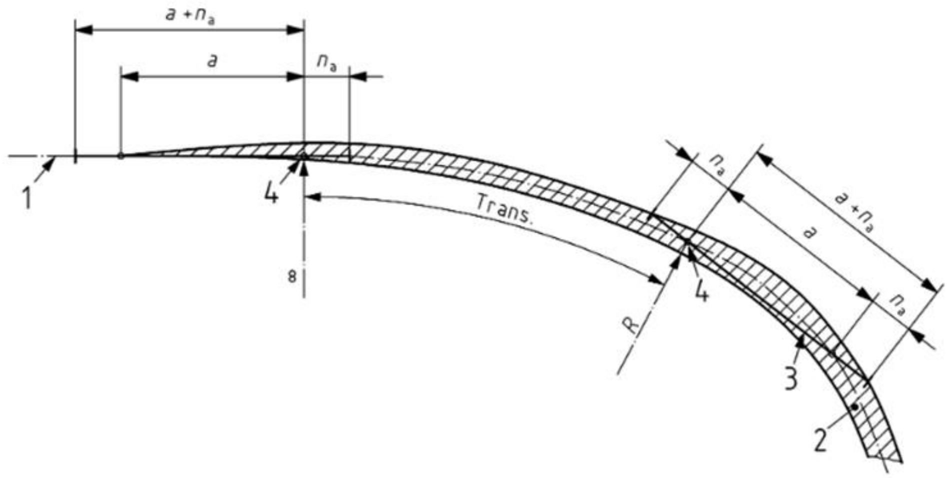
Figure 16: Effects of sudden change of curvature 15273-3:2013



Key

1	element of straight layout
2	element of curved layour of radius *R*
3	reference vehicle
4	transition point

Figure 17: Effects of a progressive transition 15273-3:2013



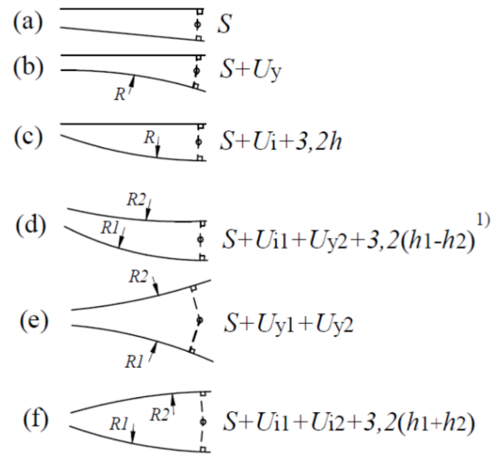
Key

1	element of straight layout
2	element of curved layout of radius *R*
3	reference vehicle
4	transition point (beginning of curve)
Trans.	Transition

9.2.2. Mixed traffic sections and passenger only and light freight traffic sections according to RBDG-MAN-013

At mixed traffic sections designed to Sec gauge, the obstacle clearance point is calculated considering the widening due to horizontal radius and cant shall be added according to the rules set below as they are defined by RBDG-MAN-013.

Figure 18: Calculation of obstacle-free point in RBDG-MAN-013, according to the methodology from TRVINFRA-00398



Where:

S = basic distance as below:

For GC gauge sections, S=3.60 m (See Annex 1 chapter 9 for value compliance with EN15273-3 calculations for GC gauge-Passenger only and light freight traffic sections)

For Sec gauge sections:

Between main tracks and between main track and side track, S=4.10 m

Between side tracks, S=3.90 m

and,

Internal overthrow Ui=41/R (Radius R in meter)

External overthrow Uy=31/R (Radius R in meter)

and,

h – cant

h1 – cant in curve R1

h2 – cant in curve R2

[1)] The term (h1 – h2) is used only when h1 > h2

9.3. 1520 MM TRACK GAUGE

Shunting limit is calculated in tracks with 1520 mm gauge by use of the minimum requirement between track centrelines defined by the uniform gauges "T" with a separation of 150 mm between vehicle gauges sufficient for dynamic effects and wear conditions with the additional increase of $bR = 72\,000/R$ depending on the turnout radius according to E.2.8.3 § GOST 9238-2013. The applicable semi distance in the positioning of the shunting limit is shown in the following table:

Table 16: Semi distance between track centres requirements for 1520 mm track gauge system, according to GOST 9238-2013 [m]

Straight	R=4000 m	R=3000 m	R=2000 m	R=1000 m	R=500 m	R=150 m
2.050 m	2.059 m	2.062 m	2.068 m	2.086 m	2.122 m	2.290 m

10. OPERATIONAL CONDITIONS

10.1. HALTS

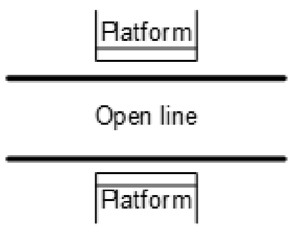
Along Rail Baltica network, there are stops designed on open line without any side tracks for serving passenger trains. The two platforms are located right next to the main tracks where trains may pass by with full speed 249 km/h.

A Halt's main purpose is to allow stops of regional passenger services with a platform length of 210 m.

Halts shall be used as emergency stops for international passenger services if planned on Rail Baltica mainline and if needed from operational point of view.

For safety reasons, gates will be located on halts' platforms, 2m from the platform edge.

Figure 19: Halts, stopping point where platforms are located on the open line next to the main tracks



10.2. OVER GAUGE TRANSPORT

Sec dynamic reference profile and the respective Normal Section N/Minimum Section C, as described in chapter 3, are applied on Mixed traffic lines for the upper and middle parts of the reference profile and structure gauge. The lower part of the gauge is compatible with GI3 kinematic reference profile. The purpose is to reserve enough space along the line in order to serve higher and wider shipments on Rail Baltica network and the possibility to secure over gauge transport.

In general, at platform areas, GC kinematic and Sec dynamic reference profiles clear passage shall be secured for all stations, serving cases of stations with platforms on sharp curves and/or with high applied cant value. The structure gauge (resulting from Normal section N/Minimum Section C) shall not be expected to be cleared for passage in all cases, as due to the large width of 2.6m and low height of 0.76-0.77m at the platform area, there is incompatibility with platforms in the inner side of curves where the applied cant is higher than 37.5mm (practically 40mm). Such cases appear often in halts designed on curves where due to high operation speed, the cant may be 70mm or even more in exceptional cases.

In Figure 19 below, an example for horizontal radius 4400, applied cant D70mm, speed V249km/h and coping hnez347mm is demonstrated. Calculations for passenger platform in mixed traffic section, according to TSI INFRA, EN15273-1, 2, 3 and TRVINFRA00398 (formulas and parameters provided in Annex 1 and 2) result in platform offset for the inner side of the curve 1.699m ≤ bq,i ≤ 1.719m and the outer side of the curve 1.715m ≤ bq,a ≤ 1.738m.

Figure 20: Platform installation for horizontal radius 4400, applied cant D70mm, speed V249km/h and coping h_{nez}347mm

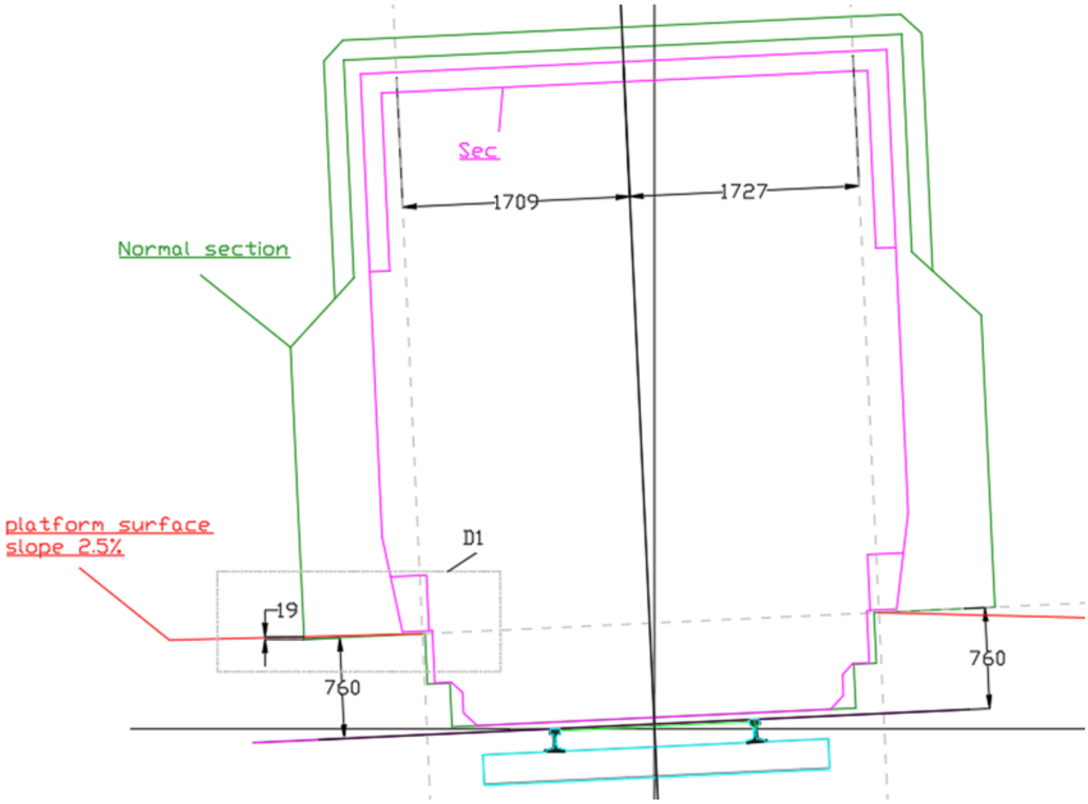
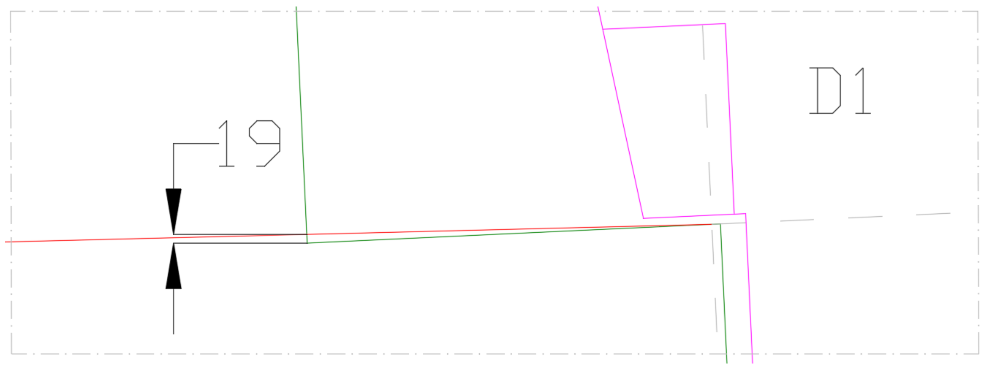


Figure 21: Detail 1 of Figure 19, Normal Section overlap with platform surface of 2.5% slope



Sec dynamic reference profile and GC kinematic reference profile is cleared above the platform. Normal Section overlaps with the platform top surface of 2.5% slope for 19mm. Special operational rules are to be introduced by the infrastructure manager above platforms, for the over gauge transport enclosed in the Normal Section dimensions (or Minimum section according to the proposal for update of DG012).

10.3. SEC GAUGE TRAFFIC IN RB NETWORK

Operational rules have to be defined by the infrastructure manager for allowing Sec gauge traffic in the network.

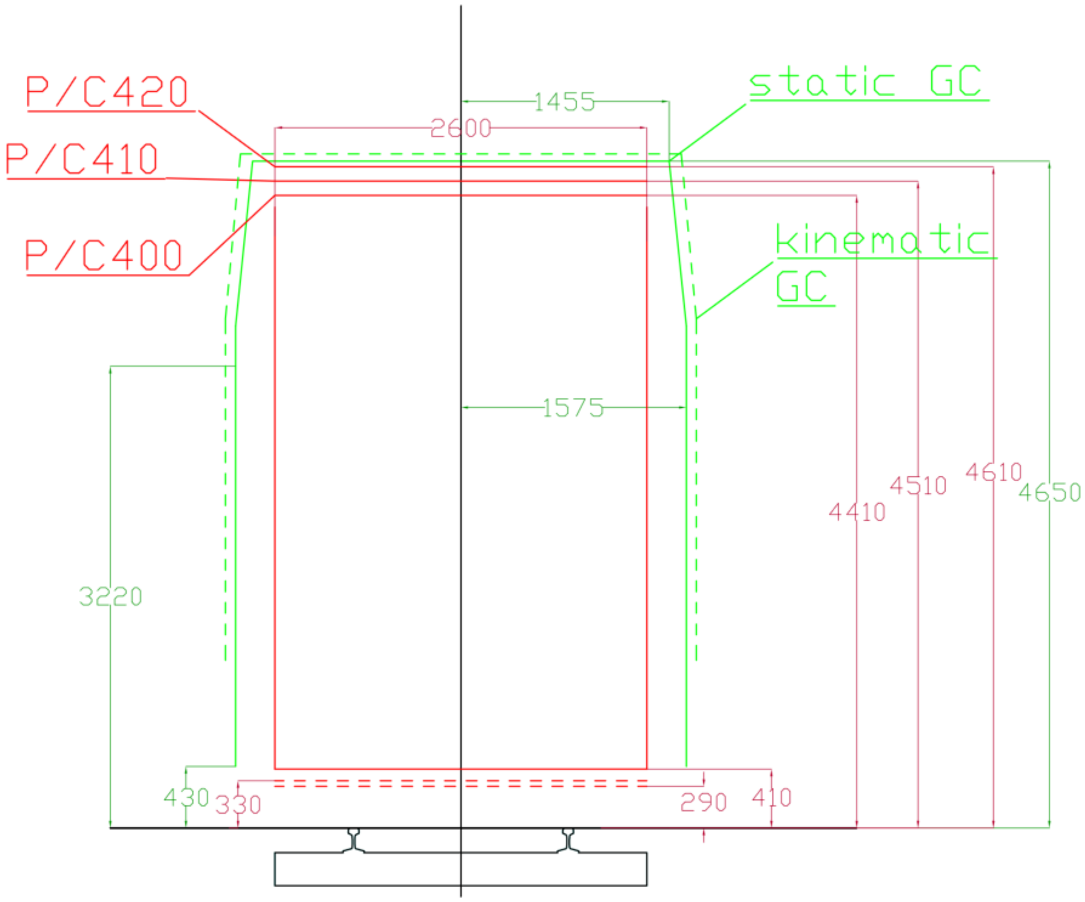
The upper and middle parts of the SEc gauge are implemented in RB gauge. Clear passage in height and width on open line and clear offset for passage above platform areas are secured by the design according to chapter 8.

The lower parts of Sec gauge are not taken into account in RB network, since GI3 kinematic reference profile if applied for gauge heights between 0-400mm above TOR height. Sec dynamic reference profile lower parts is lower than GI3 kinematic reference profile by 30mm. Sec gauge clearance for the lower parts shall not be assumed by definition in RB network, but checks shall be performed on the infrastructure before granting passage.

10.4. P/C WAGONS

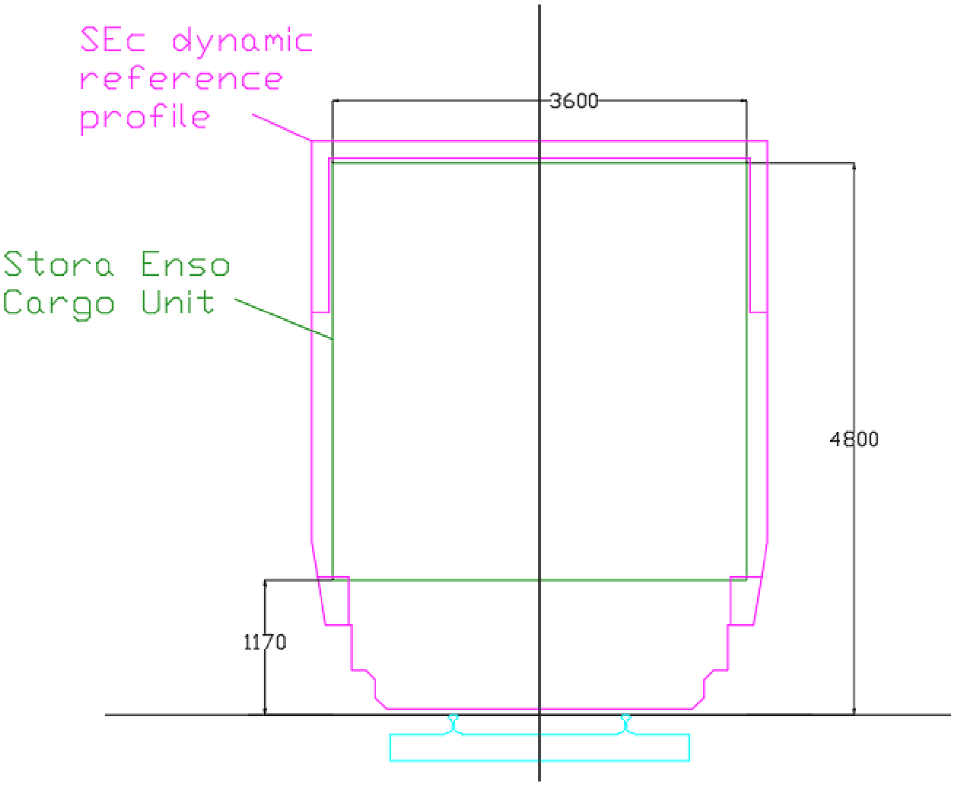
The pocket wagons (freight wagons that have been specially designed for the transport of truck semi-trailers) are typically between 210 and 330mm height above TOR and RoLa wagons 316-410mm above TOR. Thus, the total height for a P/C 400 on such wagons would vary between 4.210m and 4.410m. This results in worst case to heights 4.410, 4.510, 4.610 above TOR for P/C400, P/C410 and P/C420 respectively, dimensions enclosed in GC static and kinematic reference profiles.

Figure 22: PC/400, P/C410 and PC/420 dimensions in comparison to GC static and kinematic reference profile



Stora Enso Cargo Unit (SECU) are loaded on wagons with loading height (load surface) of 1.17m. The container would have a loading height (top of container above rails) of 4.3m. The dimensions of the container loaded on the wagon are enclosed by the SEc dynamic reference profile.

Figure 23: Stora Enso Cargo Unit enclosed by Sec dynamic reference profile



PROCESS CONTROL

Document Creation: The Operation and Maintenance Team is responsible for creating and updating the document.

Document Revision: For documents revisions the Guide RBGL-DMT-QRG-Z-00003 (Revision and Version Management) to be followed. Revisions to be registered in the "Document History".

Document Obsoleting: When new revision is published, previous version became obsolete.

REVIEW AND UPDATE OF THE DOCUMENT

The document will be reviewed and revised whenever it is deemed necessary.

REFERENCES

Ref:	Document Number:	Document Title:
1.	**Internal Referenced Documents**	
1.1	RBDG-MAN-012-0110	General Requirements
2.	**External Referenced Documents**	
2.1	EN 15273-1	Railway Applications-Gauges-Part 1: General-Common rules for infrastructure and rolling stock
2.2	EN 15273-2	Railway Applications-Gauges-Part 2: Rolling Stock
2.3	EN 15273-3	Railway Applications-Gauges-Part 3: Structure Gauges

2.4	TSI 1299/2023	COMMISSION REGULATION on the technical specifications for interoperability relating to the 'infrastructure' subsystem of the rail system in the European Union
2.5	TSI 1299/2023	COMMISSION REGULATION on the technical specifications for interoperability relating to the 'infrastructure' subsystem of the rail system in the European Union
2.6	TDOK2014:0555	BVS 1586.20-Track super structure-Infrastructure profiles "Trackside clearance requirements" (Banöverbyggnad - Infrastrukturprofiler "Krav på fritt utrymme utmed banan")
2.6	TRVINFRA00398	Ban och Stationsutformning Version 1.0 2023-10-09

ANNEX 1. GC AND GI3 GAUGE CALCULATIONS

1. INTRODUCTION

2. In the present Annex the justification of the calculations carried out to study the compliance of the Rail Baltica Railway lines with the GC and GI3 gauges in accordance with standards EN 15273-1, EN 15273-2 and EN 15273-3 are presented.

3. As indicated in EN 15273-3, when the infrastructure manager has sufficient space available, he can define a non-variable gauge with a design that permits easier management for the maintenance managers. This gauge, which generally incorporates additional allowances, is a nominal type structure gauge called a uniform gauge.

4. GC and GI3 gauges are kinematic gauges, therefore, from the reference profiles and associated rules of calculation of the installation nominal gauge for kinematic gauges (EN15273-3 18a,b and EN15273-2we can obtain a uniform gauge profile.

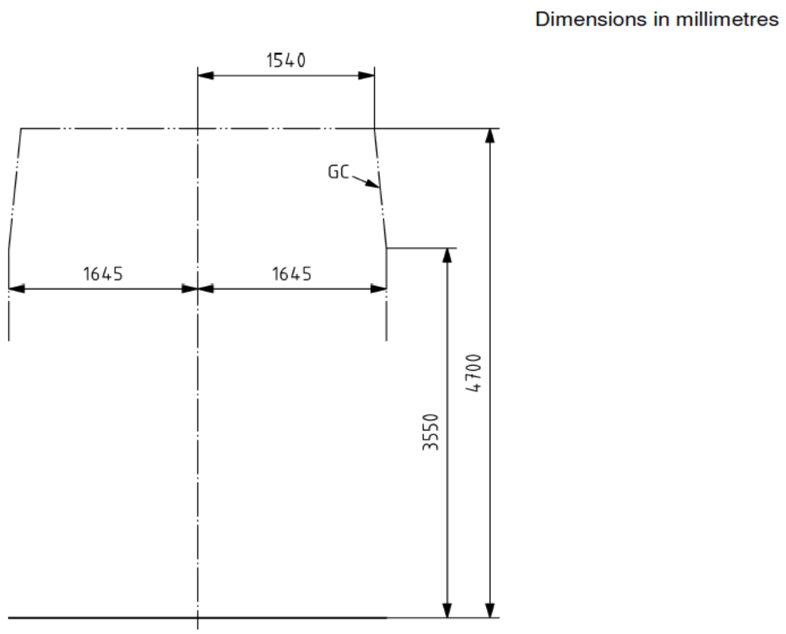
5. The reference profiles and associated rules shall be presented, and the results obtained from the calculations. From these, a uniform gauge is elaborated to be included in the typical cross sections to check the compliance of the infrastructure with the gauge requirements.

6. The standards EN 15273-1, EN 15273-2 and EN 15273-3 are also used to determine the limit distance between track centres and the platform offset with the installation limit gauge.

2. REFERENCE PROFILES

7. The following figure shows the GC reference profile.

Figure 24: Kinematic reference profile of gauge GC (Annex C EN-15273-3)



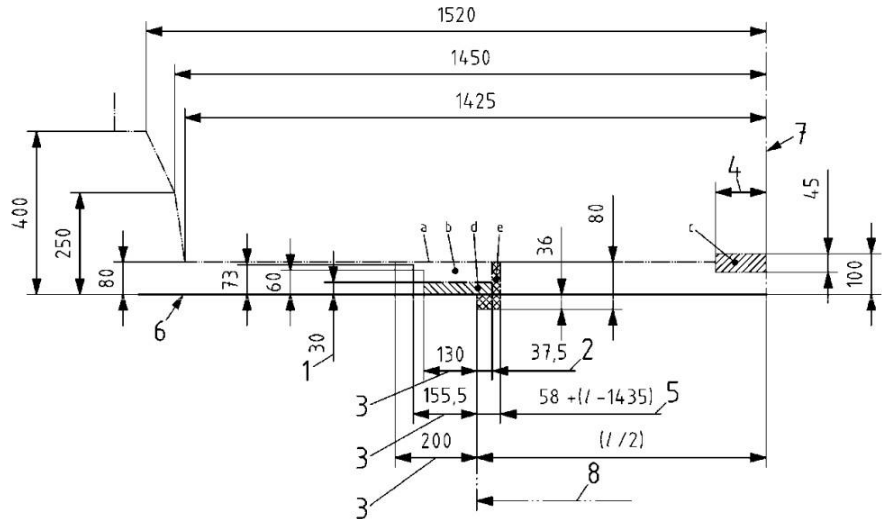
8. The following rules apply to the GC gauge whatever the height.

Table 17: Formulae for S of gauge GC (Annex C EN-15273-3). Dimensions in meters

	Radius R	On the inside of the curve	On the outside of the curve
Additional overthrows S	$\infty \geq R \geq 250$	$\frac{3.75}{R} + \frac{l_{max} - 1.435}{2}$	
	$250 > R \geq 150$	$\frac{50}{R} - 0.185 + \frac{l_{max} - 1.435}{2}$	$\frac{60}{R} - 0.225 + \frac{l_{max} - 1.435}{2}$
Quasi-static effect q_s	All	$\frac{0.4}{1.5}[D - 0.05]_{>0}[h - 0.5]_{>0}$	$\frac{0.4}{1.5}[I - 0.05]_{>0}[h - 0.5]_{>0}$

9. For the lower parts the following figure shows the GI3 reference profile

Figure 25: Kinematic reference profile of GI3 (Annex C EN-15273-1). Dimensions in mm



Legend:

a. Area for the parts away from the wheels.

b. Area for parts in the immediate vicinity of the wheels

c. Brush area for fixed ramp contact

d. Area for wheels and other equipment that comes in contact with the rails

e. Area occupied exclusively by the wheels

1. Limit, which must not be exceeded, of the organs located outside the extreme axes for passage over the detonators. However, this limit need not be respected by the organs located between the wheels as long as the latter remains within the wheel's path.
2. Maximum theoretical width of the flange profile in the case of check rails
3. Effective limit position of the outer face of the wheel and of the parts associated with the wheel
4. When the vehicle is on the track with radius curve R =250 m (the minimum radius for the installation of the fixed ramp contact), and with a track width of 1.465 m, no part of the vehicle that can fall below 0.100 m above the road surface, except the contact brushes, must be less than 0.125 m from the centre line of the track. For the parts or organs between the bogies, this dimension is 0.150 m.
5. Effective limit position of the inner surface of the wheel when the opposite wheel has its flange in contact. This dimension varies with the extension of the track gauge

6. Rolling plane
7. Reference profile axis
8. Inner face of the rail

9. The following rules apply to the GI3 gauge according to Table C.7 in Annex C EN-15273-3.

Table 18: Additional deviations GI3 (Annex C EN-15273-3). Dimensions in meters

Height	Radius R	si(on the inside of the curve)	sa(on the outside of the curve)
$h = 0.400$	$\infty \geq R \geq 250$	$\frac{2.5}{R} + \frac{l_{max} - 1.435}{2}$	$\frac{2.5}{R} + \frac{l_{max} - 1.435}{2}$
	$250 > R \geq 150$	$\frac{50}{R} - 0.190 + \frac{l_{max} - 1.435}{2}$	$\frac{60}{R} - 0.230 + \frac{l_{max} - 1.435}{2}$
$0.250 < h < 0.400$	All	Point h=0.400 and point h=0.250 shall be connected by a straight line	
$h \leq 0.250$	$\infty \geq R \geq 250$	$\frac{2.5}{R} + \frac{l_{max} - 1.435}{2}$	$\frac{l_{max} - 1.435}{2}$
	$250 > R \geq 150$	$\frac{37.5}{R} - 0.140 + \frac{l_{max} - 1.435}{2}$	$\frac{40}{R} - 0.160 + \frac{l_{max} - 1.435}{2}$

The quasi-static effect does not play a role if h<0,5 m.

3. ASSOCIATED RULES FOR THE UNIFORM GAUGE

3.1. General

10. The reference profile is determined for a flat straight track, of nominal rail gauge without cant. The gauge shall be increased to account for cant, curve radius and rail gauge.

3.2. Horizontal

11. The position of the structure shall cover the sum:

$$b_{structure\ i/a} \geq b_{RP} + S_{i/a} + qs_{i/a} + \sum\nolimits_3$$

12. Allowances ($\sum_j$)are defined to take into account the random phenomena. The various phenomena are grouped according to their character.

13. M_1 includes the effects of certain random phenomena due to actual movements of the vehicles. This allowance determines the limit of the point reached by the vehicle. M_1 is determined on the basis of:

    13.1. Dissymmetry h_0 due to poor suspension adjustment and load distribution not exceeding 1°.

14. M_2 the random effects that make the best use of allowances to ensure track maintenance at the chosen frequencies and resources. M_2 is determined on the basis of:

    14.1. W idening in order to take account of the track displacements between two maintenance operations;

14.2. The geometric part only ($h\frac{T_D}{L}$) due to the crosslevel error of the track T_D (the quasi-static part shall be taken into account by the vehicle).

15. M_3 is an allowance that allows easy management of the gauge in the long term and offers additional possibilities for special consignments, temporary installations or others.

16. The sum of the allowances $\sum_j$ is determined on the basis of the following formulation (Annex A EN-15273-3):

Equation 2: Sum of margins (Equation A.2 § EN 15273-3)

$$\sum\nolimits_{3,i/a} = T_{track} + \frac{T_D}{L}h + s_0\frac{T_D}{L}[h - h_{c0}]_{>0} + \mathrm{tg}(T_{\mathrm{susp}})\,[h - h_{c0}]_{>0} + \mathrm{tg}(T_{load})\,[h - h_{c0}]_{>0} + \frac{s_0}{L}T_{osc}[h - h_{c0}]_{>0} + M3b$$

3.3. Vertical

17. In the height plane, the position of the structure shall ensure that:

Equation 3: Structure or obstacle position (Equations 18a § EN 15273-3)

$$h_{structure\ i/a} \geq h_{RP} + \Delta h_{R_V} + \Delta h_Q + \sum\nolimits_V$$

18. Where

Δh_{R_V} is the superelevation/lowering in the transition curve (Annex C EN-15273-3):

18.1. The superelevation of the upper parts (h≥3.25m) is given by:

Equation 4: Overelevation in upper parts (Equation C.1 § EN 15273-3)

$$\Delta h_{R_V} = \frac{50}{R_V}$$

18.2. For the lower parts (h≤1.17m), a lowering is applied, given by:

Equation 5: Overelevation in lower parts (Equation C.2 § EN 15273-3)

$$\Delta h_{R_V} = \frac{-50}{R_V}$$

The same lowering is applied for the point h=1.17m at the middle of the gauge since it is a breaking point facing downwards, which would behave similarly to the lower gauge parts.

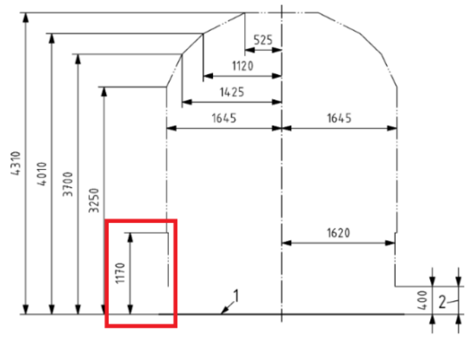


Figure 26: G1 (1.645, 1.17) point

18.3. Δh_Q is the superelevation of the upper parts due to the vertical effect of the roll.

$$\Delta h_{Qi/a} = b_Q sin(\alpha_{Qi/a}) - (h_Q - h_{c0})(1 - \cos(\alpha_{Qi/a}))$$

18.4. Equivalent to:

Equation 6: Overelevation resulting from the quasi-static effect (Equation 5 § EN 15273-3)

$$\Delta h_{Qi/a} \approx b_Q sin(\alpha_{Qi/a})$$

18.5. Where:

$\alpha_{Qi/a}$ is the rotation of the gauge due to the quasi-static effects.

h_Q, b_Q are the coordinates of the point considered *Q*.

18.6. n
this case:

$$sin(\alpha_{Qi/a}) = \frac{s_0}{L}(D - D_0, I - I_0)$$

18.7. I
n the lower parts:

Equation 7: Structure or obstacle position (Equations 18b § EN 15273-3)

$$h_{structure} \leq h_{RP} + \Delta h_{R_V} + \sum_V$$

19. Generally, the sum of the allowances $\sum_V$ is determined for point Q on the basis of the following formulation (Annex A EN-15273-3):

Equation 8: Sum of margins in the vertical direction for PT (Equations A.6 y A.7 § EN 15273-3)

$$\sum_{V,Q_a} = \left(b_Q + \frac{L}{2} + s_0 b_Q\right)\frac{T_D}{L} + b_Q\frac{s_0}{L}T_{osc} + b_Q tg(T_{load}) + b_Q tg(T_{susp}) + T_N + M3h$$

$$\sum_{V,Q_i} = \left(b_Q - \frac{L}{2} + s_0 b_Q\right)\frac{T_D}{L} + b_Q\frac{s_0}{L}T_{osc} + b_Q tg(T_{load}) + b_Q tg(T_{susp}) + T_N + M3h$$

20. For the other points of the upper parts and for the lower parts, the sum of the allowances $\sum_V$ is determined on the basis of the following formulation:

Equation 9: Sum of margins in the vertical direction for rest of points (Equations A.6 y A.7 § EN 15273-3)

$$\sum_V = T_N + M3h$$

4. PARAMETERS FOR THE UNIFORM GAUGE

4.1. DG012 version in force

21. The parameters used to generate the uniform GC and GI3 gauge profiles can be found in the following table.

Table 19: GC and GI3 parameters

Parameter	Value		Source	Description of parameter
	Mixed traffic	Passenger and light freight		
R	300 m	300 m	RBDG-MAN-013-0103 3.10 (mix) RBDG-MAN-013-0103 5.10 (pax)	Horizontal curve radius

Parameter	Value		Source	Description of parameter
	Mixed traffic	Passenger and light freight		
R_V	2000 m	2000 m	RBDG-MAN-013-0103 4.2 (mix) RBDG-MAN-013-0103 6.2 (pax)	Vertical curve radius of longitudinal profile
L	1.5 m	1.5 m	EN 15273-3 Annex C	Standard distance between the centrelines of the rails of the same track
$lmax$	1.463 m	1.463 m	INF TSI table 12	Maximum track gauge for all speeds
l_{nom}	1.435 m	1.435 m	RBDG-MAN-014-0104 3.4.1	Nominal track gauge
D	0.11 m	0.18 m	RBDG-MAN-013-0103 3.1 (mix) RBDG-MAN-013-0103 5.1 (pax)	Cant
D_0	005 m	0.05 m	EN 15273-3 Annex C	Fixed cant value taken into account by agreement between the rolling stock and the infrastructure with regard to the kinematic gauge
I	0.115 m	0.13 m	RBDG-MAN-013-0103 3.3 (mix) RBDG-MAN-013-0103 5.3 (pax)	Cant deficiency
I_0	005 m	0.05 m	EN 15273-3 Annex C	Fixed cant deficiency value taken into account by agreement between the rolling stock and the infrastructure with regard to the kinematic gauge
s_O	0.4	0.4	EN 15273-3 Annex C	Flexibility coefficient value taken into account in the agreement between the rolling stock and the infrastructure
h_{c0}	0.5 m	0.5 m	EN 15273-3 Annex C	Value of hc used for the agreement between the rolling stock and the infrastructure
T_{load}	0.77°	0.77°	EN 15273-3 Annex B	Angle of dissymmetry, considered in reference angle ηo, for poor load distribution

Parameter	Value		Source	Description of parameter
	Mixed traffic	Passenger and light freight		
T_{susp}	0.23°	0.23°	EN 15273-3 Annex B	Angle of dissymmetry, considered in reference angle ηo, for poor suspension adjustment degree
$T_{osc\ i}$	0.013 m	0.013 m	EN 15273-3 Annex B (other quality track)	Crosslevel difference selected for calculation of oscillations caused by track irregularities inside curve
$T_{osc\ a}$	0.065 m	0.065 m	EN 15273-3 Annex B (other quality track)	Crosslevel difference selected for calculation of oscillations caused by track irregularities outside curve
T_{track}	0.025 m	0.025 m	EN 15273-3 Annex B	Transverse displacement of the track between two periods of maintenance
T_D	0.015/0.020 m	0.015/0.020 m	EN 15273-3 Annex B	Track crosslevel difference between two maintenance periods (0.015 for V>80 km/h and 0.020 for V≤80 km/h)
$T_{N\ hight}$	0.021 m	0.021 m	EN 15273-3 Annex B	Vertical displacement of the track between two periods of maintenance towards the top
$T_{N\ low}$	0.021 / 0.005 m	0.021 / 0.005 m	EN 15273-3 Annex B	Vertical displacement of the track between two periods of maintenance towards the bottom
$M3b$	0.1 m	0.1 m	RBDG-MAN-017-0104	Additional Infrastructure traverse allowance
$M3h$	0.05 m	0.05 m	RBDG-MAN-017-0104	Additional Infrastructure vertical allowance
k	1.2	1.2	EN 15273-3 Annex B	Amplification coefficient for calculation of allowances
h_q	0.76 m	0.76 m	TSI INFRA 1299/2023	Platform height
hminCR Version in force	0.36 m for Sec (Normal Section) and 0.4 m for GC-GI3	0.4 m	EN 15273-3 Table 1	Height of the bottom corner of the reference profile

Parameter	Value		Source	Description of parameter
	Mixed traffic	Passenger and light freight		
hminCR Proposal for DG update	0.38 m for Sec (Minimum Section) 0.400 m for GC-GI3	0.400 for GC m	EN 15273-3 Table 1	Height of the bottom corner of the reference profile

5. UNIFORM GAUGE CALCULATIONS

22. In the following tables the associated rules for each of the points of the reference profiles are calculated.

5.1. Upper parts

Table 20: Gauge calculation. Upper parts passenger traffic lines

GC reference profile	b_{RP}	h_{RP}	Si	Sa	qsi	qsa	$\Sigma 3\ i$	$\Sigma 3\ a$	ΔhRV	$\Delta hQ\ i$	$\Delta hQ\ a$	$\Sigma V\ i$	$\Sigma V\ a$	$b_{structure\ i}$	$b_{structure\ a}$	$h_{structure\ i}$	$h_{structure\ a}$
Upper parts	1.62	0.4	0.028	0.028	0.000	0.000	0.129	0.129	0.025	0.000	0.000	0.071	0.071	1.777	1.777	0.496	0.496
Upper parts	1.62	1.17	0.028	0.028	0.023	0.014	0.153	0.163	0.025	0.000	0.000	0.071	0.071	1.824	1.824	1.266	1.266
Upper parts	1.645	1.17	0.028	0.028	0.023	0.014	0.153	0.163	0.025	0.000	0.000	0.071	0.071	1.849	1.849	1.266	1.266
Upper parts	1.645	3.25	0.028	0.028	0.095	0.059	0.226	0.264	0.025	0.000	0.000	0.071	0.071	1.994	1.995	3.346	3.346
Upper parts	1.645	3.55	0.028	0.028	0.106	0.065	0.237	0.279	0.025	0.000	0.000	0.071	0.071	2.015	2.016	3.646	3.646
Q point	1.54	4.7	0.028	0.028	0.146	0.090	0.277	0.335	0.025	0.033	0.053	0.117	0.154	1.990	1.992	4.875	4.932

Table 21: Gauge calculation. Upper parts mixed traffic lines

GC reference profile	b_{RP}	h_{RP}	Si	Sa	qsi	qsa	$\Sigma 3\ i$	$\Sigma 3\ a$	ΔhRV	$\Delta hQ\ i$	$\Delta hQ\ a$	$\Sigma V\ i$	$\Sigma V\ a$	$b_{structure\ i}$	$b_{structure\ a}$	$h_{structure\ i}$	$h_{structure\ a}$
Upper parts	1.62	0.4	0.028	0.028	0.000	0.000	0.129	0.129	0.025	0.000	0.000	0.071	0.071	1.777	1.777	0.496	0.496
Upper parts	1.62	1.17	0.028	0.028	0.011	0.012	0.153	0.163	0.025	0.000	0.000	0.071	0.071	1.812	1.822	1.266	1.266
Upper parts	1.645	1.17	0.028	0.028	0.011	0.012	0.153	0.163	0.025	0.000	0.000	0.071	0.071	1.837	1.847	1.266	1.266
Upper parts	1.645	3.25	0.028	0.028	0.044	0.048	0.226	0.264	0.025	0.000	0.000	0.071	0.071	1.943	1.984	3.346	3.346
Upper parts	1.645	3.55	0.028	0.028	0.049	0.053	0.237	0.279	0.025	0.000	0.000	0.071	0.071	1.958	2.004	3.646	3.646
Q point	1.54	4.7	0.028	0.028	0.067	0.073	0.277	0.335	0.025	0.027	0.025	0.117	0.154	1.911	1.975	4.869	4.903

5.2. Lower parts

23. In the following table the associated rules for each of the points of the GI3 reference profile is calculated.

Table 22: Gauge calculation. Lower parts any traffic

GC reference profile	b_{RP}	h_{RP}	*Si*	*Sa*	*qsi*	*qsa*	$\Sigma 3\ i$	$\Sigma 3\ a$	*ΔhRV*	$\Sigma V\ i$	$\Sigma V\ a$	$h_{structure\ i}$	$h_{structure\ a}$	$b_{structure\ i}$	$b_{structure\ a}$
Lower parts	1.52	0.4	0.023	0.023	0.0	0.0	0.129	0.129	-0.025	-0.071	-0.071	0.304	0.304	1.672	1.672
Lower parts	1.45	0.25	0.023	0.015	0.0	0.0	0.128	0.128	-0.025	-0.071	-0.071	0.154	0.154	1.601	1.593
Lower parts	1.425	0.08	0.023	0.015	0.0	0.0	0.126	0.126	-0.025	-0.071	-0.071	-0.016	-0.016	1.574	1.566
Lower parts	0.125	0.08	0.023	0.015	0.0	0.0	0.126	0.126	-0.025	-0.071	-0.071	-0.016	-0.016	0.274	0.266
Lower parts	0.125	0.1	0.023	0.015	0.0	0.0	0.126	0.126	-0.025	-0.071	-0.071	0.004	0.004	0.274	0.266
Lower parts	0.	0.1	0.023	0.015	0.0	0.0	0.126	0.126	-0.025	-0.071	-0.071	0.004	0.004	0.149	0.141

5.3. Uniform gauge profile in DG012 version in force

24. As the results obtained considering the parameters for mixed traffic lines and passenger traffic lines are so similar, the worst case shall be considered for all the lines.
25. The uniform gauge is adjusted to the calculated profile as shown in the following figure. The upper parts are adjusted and so are the lower parts.

Figure 27: GC and GI3 uniform gauge

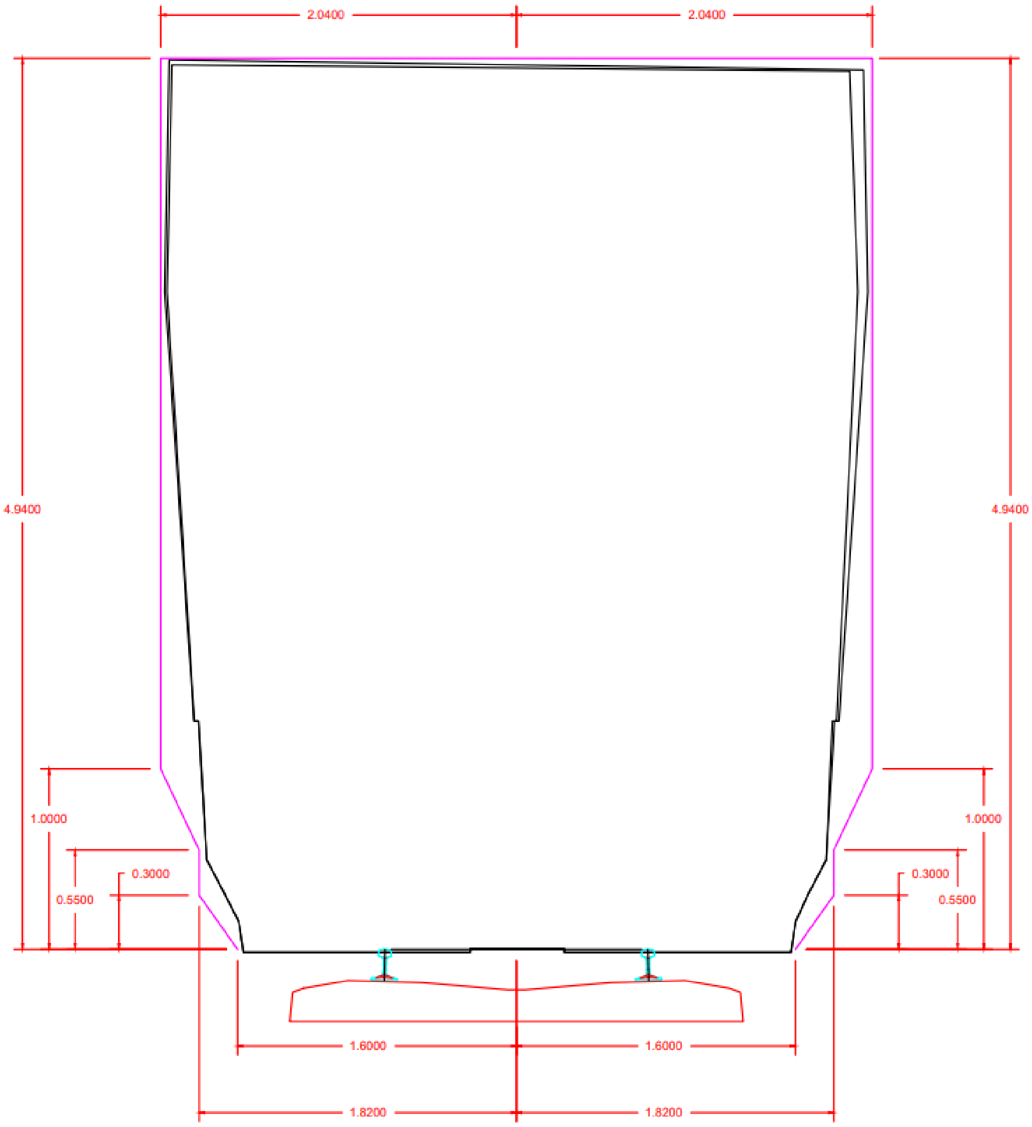
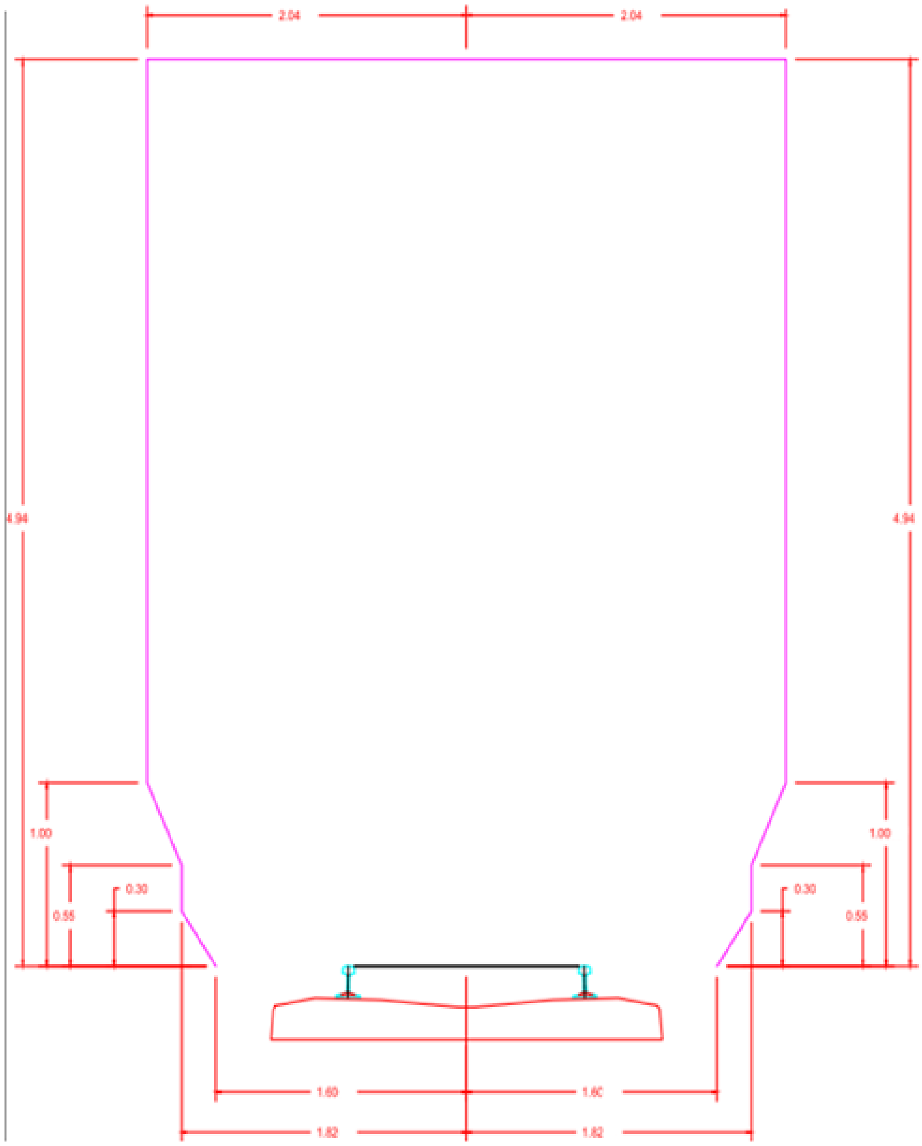


Figure 28: GC and GI3 uniform gauge



6. INSTALLATION LIMIT GAUGE FOR PLATFORM OFFSET

26. Platform position is determined by the installation limit gauge. The installation limit gauge is calculated in accordance with EN15273-3 using the following formulation.

Equation 10:Semi-wide, interior side of the curve (Equation A.10 § EN 15273-3)

$$b_{lim,i} = b_{RP} + S_i + max\left[\Sigma'_{2,i} + K * (D - D_0)_{>0}\ ;\ \Sigma''_2\ ;\ \left(\Sigma'_{2,a} - K * I_0\right)\right]$$

Equation 11: Semi-wide, exterior side of the curve (Equation A.13 § EN 15273-3)

$$b_{lim,a} = b_{RP} + S_a + max\left[\Sigma'_{2,a} + K * (I - I_0)_{>0}\ ;\ \Sigma''_2\right]$$

Where:

Equation 12: Margin Σ'(Equation A.8 § EN 15273-3)

$$\Sigma'_{2,i/a} = k\sqrt{T_{track}^2 + \left[\frac{T_D}{L}h + s_0\frac{T_D}{L}[h - h_{co}]_{>0}\right]^2 + \left[tg(T_{\text{susp}})[h - h_{co}]_{>0}\right]^2 + [tg(T_{\text{load}})[h - h_{co}]_{>0}]^2 + \left[\frac{s_0}{L}(T_{\text{osc}})[h - h_{co}]_{>0}\right]^2}$$

Equation 13: Margin Σ'' (Equation A.9 § EN 15273-3)

$$\Sigma''_2 = k\sqrt{T_{track}^2 + \left[\frac{T_D}{L}h\right]^2}$$

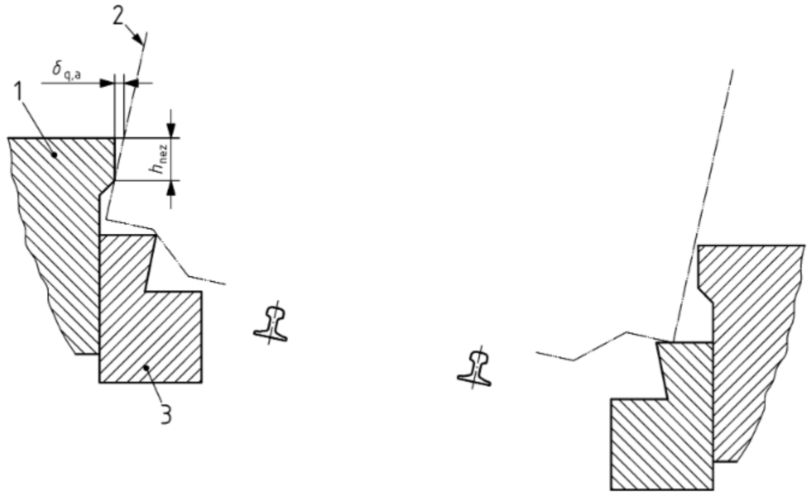
Equation 14: Coefficient K (Equation A.11 § EN 15273-3)

$$K = \frac{s_0}{L}[h - h_{co}]_{>0}$$

27. Different installation limit gauge possible in tracks with a passenger platform are calculated.
28. Other than the radius and gauge the rest of the parameters used are equal to the ones used in the uniform gauge calculation.
29. Platform edge shall take into account canted tracks according to EN15273-3 chapter 13.1. In order to allow the gauge to remain coincident with the platform edge, either an edge coping can be created or a sloping vertical face of the platform provided. The lower parts can then fit below the coping when the track is canted.
30. On the outside of the curve, additional value $\delta_{q,a}$ shall be added to the limit value $b_{lim\ a}$ according to the formation of the platform with or without coping.
31. If there is a coping:

$$\delta_{q,a} = \left(\frac{D}{L}\right) * h_{nez}$$

Figure 29: δq,a with platform coping



1 platform

2 gauge on canted track

3 safety steps for personnel

32. If there is no coping:

$$\delta_{q,a} = \left(\frac{D}{L}\right) * (h_q - h_{minCR})$$

Figure 30: δq,a with no platform coping

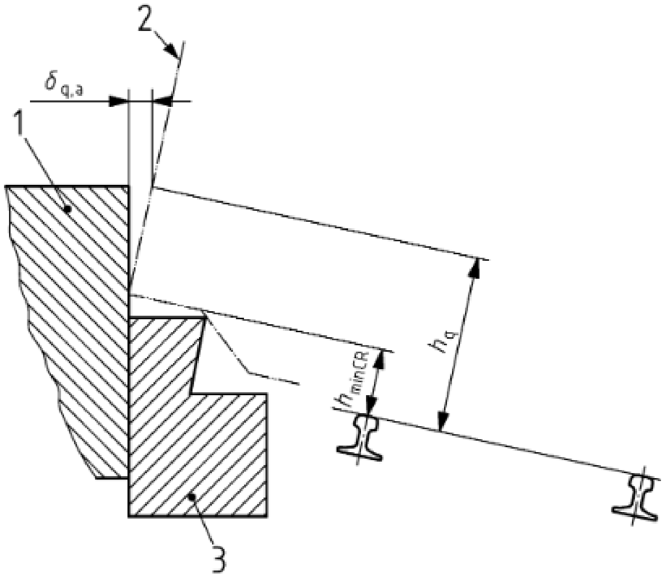


Table 23: Horizontal installation limit gauge straight track R=inf., I=0mm and D=0mm

b_{RP}	h_{RP}	Si	Sa	K	Σ'2,i	Σ'2,a	Σ''2	b lim i	b lim a
1.62	0.4	0.014	0.014	0.000	0.030	0.030	0.030	1.664	1.664
1.62	1.17	0.014	0.014	0.179	0.037	0.039	0.033	1.671	1.673
1.645	1.17	0.014	0.014	0.179	0.037	0.039	0.033	1.696	1.698
1.645	3.25	0.014	0.014	0.733	0.077	0.095	0.049	1.736	1.754
1.645	3.55	0.014	0.014	0.813	0.084	0.104	0.052	1.743	1.763
1.54	4.7	0.014	0.014	1.120	0.110	0.139	0.064	1.664	1.693

Table 24: Horizontal installation limit gauge R=4000m, V=249km/h, I=113mm and D=70mm

b_{RP}	h_{RP}	Si	Sa	K	Σ'2,i	Σ'2,a	Σ''2	b lim i	b lim a
1.62	0.4	0.015	0.015	0.000	0.030	0.030	0.030	1.666	1.666
1.62	1.17	0.015	0.015	0.179	0.037	0.039	0.033	1.675	1.685
1.645	1.17	0.015	0.015	0.179	0.037	0.039	0.033	1.700	1.710
1.645	3.25	0.015	0.015	0.733	0.077	0.095	0.049	1.751	1.801
1.645	3.55	0.015	0.015	0.813	0.084	0.104	0.052	1.760	1.815
1.54	4.7	0.015	0.015	1.120	0.110	0.139	0.064	1.687	1.765

Table 25: Horizontal installation limit gauge R=3600m, V=245km/h, I=127mm and D=70mm

b_{RP}	h_{RP}	Si	Sa	K	Σ'2,i	Σ'2,a	Σ''2	b lim i	b lim a
1.62	0.4	0.015	0.015	0.000	0.030	0.030	0.030	1.665	1.665
1.62	1.17	0.015	0.015	0.179	0.037	0.039	0.033	1.675	1.688
1.645	1.17	0.015	0.015	0.179	0.037	0.039	0.033	1.700	1.713
1.645	3.25	0.015	0.015	0.733	0.077	0.095	0.049	1.752	1.814
1.645	3.55	0.015	0.015	0.813	0.084	0.104	0.052	1.760	1.829
1.54	4.7	0.015	0.015	1.120	0.110	0.139	0.064	1.687	1.779

Table 26: Horizontal installation limit gauge R=2000m, V=180km/h, I=121mm and D=70mm

b_{RP}	h_{RP}	Si	Sa	K	Σ'2,i	Σ'2,a	Σ''2	b lim i	b lim a
1.62	0.4	0.016	0.016	0.000	0.030	0.030	0.030	1.666	1.666
1.62	1.17	0.016	0.016	0.179	0.037	0.039	0.033	1.676	1.686
1.645	1.17	0.016	0.016	0.179	0.037	0.039	0.033	1.701	1.713
1.645	3.25	0.016	0.016	0.733	0.077	0.095	0.049	1.752	1.808
1.645	3.55	0.016	0.016	0.813	0.084	0.104	0.052	1.761	1.823
1.54	4.7	0.016	0.016	1.120	0.110	0.139	0.064	1.688	1.774

Table 27: Horizontal installation limit gauge R=1000m, V=130km/h, I=129mm and D=70mm

b_{RP}	h_{RP}	Si	Sa	K	Σ'2,i	Σ'2,a	Σ''2	b lim i	b lim a
1.62	0.4	0.018	0.018	0.000	0.030	0.030	0.030	1.668	1.668
1.62	1.17	0.018	0.018	0.179	0.037	0.039	0.033	1.678	1.691
1.645	1.17	0.018	0.018	0.179	0.037	0.039	0.033	1.703	1.716
1.645	3.25	0.018	0.018	0.733	0.077	0.095	0.049	1.754	1.816
1.645	3.55	0.018	0.018	0.813	0.084	0.104	0.052	1.763	1.831
1.54	4.7	0.018	0.018	1.120	0.110	0.139	0.064	1.690	1.786

33. The resulting platform offsets for platform height of 0.76 m for the GC installation limit gauge on straight and curved segments are as calculated in accordance with EN15273-3 as it is shown in the following table:

Table 28: Horizontal installation limit gauge for straight (I=0mm and D=0 mm) and curved segments (D=70mm, Vmax, Imax for the respective radius R and no coping)

Radius	b_{RP}	h_{RP}	V	D	I	S_i	S_a	K	$\Sigma'_{2,i}$	$\Sigma'_{2,a}$	Σ''_2	$\delta_{q,a}$	$b_{lim\,i}$	$b_{lim\,a}$
Straight	1.62	0.76	249	0.00	0.00	0.015	0.015	0.069	0.032	0.032	0.031	0	1.667	1.667
4000	1.62	0.76	249	0.07	0.113	0.015	0.015	0.069	0.032	0.032	0.031	0.017	1.668	1.689
3600	1.62	0.76	245	0.07	0.127	0.015	0.015	0.069	0.032	0.032	0.031	0.017	1.668	1.690
2000	1.62	0.76	180	0.07	0.121	0.016	0.016	0.069	0.032	0.032	0.031	0.017	1.669	1.690
1000	1.62	0.76	130	0.07	0.129	0.018	0.018	0.069	0.032	0.032	0.031	0.017	1.671	1.693

7. LIMIT DISTANCE BETWEEN TRACK CENTRES

34. The limit installation distance between track centers is determined to prevent the gauge of one track from interfering with the gauge of the adjacent track while taking into account both the reference profiles and associated rules and also a sum of allowances.

35. This limit installation distance between track centres is calculated in accordance with EN 15273- 3 using the following formulation:

Equation 15: Limit distance between track centres (Equation A.27 § EN 15273-3)

$$EA_2 = 2b_{RP} + S_a + S_i + max[\Sigma'_{EA2} + K * (I - I_0)_{>0} + K * (D - D_0)_{>0} \,;\, \Sigma''_{EA2}] + \Delta b_{\delta D}$$

35.1. Where:

$\Delta b_{\delta D}$ is the effect of cant difference on distance between tracks.

K is as follows:

$$K = \frac{s_0}{L}[h - h_{co}]_{>0}$$

Σ'_{EA2} and Σ''_{EA2} are as follows:

Equation 16: Margins for the limit implementation distance between track centres (Equations A.25 and A.26 § EN 15273-3)

$$\Sigma'_{EA2} = \sqrt{(\Sigma'^{2}_{2,i/a})_{track\ 1} + (\Sigma'^{2}_{2,i/a})_{track\ 2}}$$

$$\Sigma''_{EA2} = \sqrt{(\Sigma''^{2}_{2,i/a})_{track\ 1} + (\Sigma''^{2}_{2,i/a})_{track\ 2}}$$

35.2. Where:

Equation 17: Margins for the limit implementation distance between track centres (Equations A.8 and A.9 § EN 15273-3)

$$\Sigma'_{2,i/a} = k\sqrt{T^2_{track} + \left[\frac{T_D}{L}h + s_0\frac{T_D}{L}[h - h_{co}]_{>0}\right]^2 + [tg(T_{susp})[h - h_{co}]_{>0}]^2 + [tg(T_{load})[h - h_{co}]_{>0}]^2 + \left[\frac{s_0}{L}(T_{osc})[h - h_{co}]_{>0}\right]^2}$$

$$\Sigma''_2 = k\sqrt{T^2_{track} + \left[\frac{T_D}{L}h\right]^2}$$

Equation 18: Effect of the difference of cant (Equation 26 § EN 15273-3)

$$\Delta b_{\delta D} = \frac{h_p}{L}[D_a - D_i]$$

36. The resulting limit distance between track centres assuming that $\Delta b_{\delta D} = 0$ is the following for tracks with passenger only and light freight traffic.

Table 29: Limit distance between track centres for main tracks with passenger only and light freight traffic

GC reference profile	b_{RP}	h_{RP}	*Si*	*Sa*	*K*	$\sum'_{EA2}$	$\sum''_{EA2}$	$\Delta b_{\delta D}$	Limit distance between track centres
Point P	1.645	3.55	0.017	0.017	0.813	0.133	0.074	0	3.623

37. The resulting limit distance between track centres considers the worst possible design situation for main tracks with maximum speed:

    37.1. Max D_a=180mm according to chapter 4.2.4.2 § TSI INF and chapter 5.1 § DG013 (for only passenger traffic)

    37.2. I=125mm<130mm max value according to chapter 5.3 § RBDG-MAN-013-0105

    37.3. R_H=2400m min possible radius for max D (180mm), I (125mm) and V (249km/h) values' combination according to chapter 5.4. § RBDG-MAN-013-0105.

    37.4. *Main tracks are parallel with the same applied cant. Only in areas such as triangles there might be applied cant difference between neighbouring main tracks. For D_i between 180mm and 25mm ($\Delta b_{\delta D}$ between 0 and 0.367) the limit distance between track centres is EA between 3.623 and 3.990 < 4 m (4 m is the min preferred track distance value for only passenger traffic sections with 200km/h maximum design speed, according to RBDG-MAN-013-0105 ch.5.10. 3.8m is not always possible). For D_i=0mm, EA= 4.049m.

38. The resulting limit distance between track centres is the following for main tracks with mixed traffic.

Table 30: Limit distance between track centres for main tracks with mixed traffic

GC reference profile	*bRP*	*hRP*	*Si*	*Sa*	*K*	*Σ'EA2*	*Σ"EA2*	*ΔbδD*	Limit distance between track centres
Point P	1.645	3.55	0.016	0.016	0.813	0.133	0.074	0	3.555

39. The resulting limit distance between track centres considers the worst possible design situation for main tracks with maximum speed:

    39.1. Da=110mm according to chapter 3.1 § RBDG-MAN-013-0105 (for mixed traffic)

    39.2. I=112mm<115mm max value according to chapter 3.3 RBDG-MAN-013-0105

    39.3. R_H=3300m min possible radius for max D (110mm), I (112mm) and V (249km/h) values according to chapter 3.4. § RBDG-MAN-013-0105

39.4. *Main tracks are parallel with the same applied cant. Only in areas such as triangles there might be applied cant difference between neighbouring main tracks. For Di between 110mm and 0mm (ΔbδD between 0 and 0.260) the limit distance between track centres is EA between 3.555m and 3.815m< 4.0m.

40. According to RBDG-MAN-013 ch.3.10, on mixed traffic section with 249km/h maximum design speed, the minimum distance between track centres is 4,5m. On section with only freight traffic, the minimum distance between track centres could be reduced to 4,0m. 4m track distance is feasible for GC gauge according to the calculations. See annex 2 for SEc gauge calculations.

41. The resulting limit distance between track centres is the following for side tracks with mixed/passenger traffic.

Table 31: Limit distance between track centres for side tracks with mixed/passenger traffic

GC reference profile	b_{RP}	h_{RP}	S_i	S_a	K	$\Sigma' EA2$	$\Sigma'' EA2$	$\Delta b \delta D$	Limit distance between track centres
Point P	1.645	3.55	0.163	0.190	0.813	0.151	0.091	0	3.832

42. The resulting limit distance between track centres considers the worst possible design situation for side tracks for passenger only and light freight traffic sections:

42.1. Da=0mm

42.2. I=96.4mm<110mm max value according to chapter 5.3 RBDG-MAN-013-0105

42.3. R_H=150m min possible radius only on side tracks according to chapter 5.4 § RBDG-MAN-013-0105

42.4. * For D_i between 0mm and 60mm ($\Delta b_{\delta D}$ between 0 and 0.142) the limit distance between track centres is EA between 3.832m and 3.843m <4.0 m while 3.8m is not possible in any case. According to RBDG-MAN-013 chapter 5.10, 3.8m track center distance is possible for passenger only sections with max speed 200km/h. Design guideline update is proposed: "*For very small radius i.e. less than 300m* ***and for neighbouring tracks with applied cant difference****, specific studies about track gauge and distance between track centers shall be prepared for RB Rail approval.*"

8. DETERMINATION OF PLATFORM OFFSET AT TURNOUTS

43. The turnout utilized in the calculation is an aggressive one, due to the following elements (example according to EN15273-3 Annex E):

43.1. The radius of high deviation (1°);

43.2. The small radius of curvature in the deviation track is 215 m;

43.3. An overwidth of the local track;

43.4. The turnout is located in a track with straight alignment;

44. The following table determines the characteristics of the vehicles of reference GC.

Table 32: Characteristics of the reference vehicles G1 according to Table F.2 § EN 15273-3:2014+A1

Reference vehicle number	$A_{i/a}$	$B_{i/a}$	B_{Ve}	a	n_a (a=5 m)	n_a (a=20 m)
1i	3,75	0	1,645	5,477	-	-
2a	3,75	0	1,645	-	1,208	0,368
3i	50	0,185	1,460	20	-	-
4a	60	0,225	1,420	-	8,736	4,832
Note: the vehicles numbers 1 and 3 determines the additional deviations for the interior side of the curve and the vehicles n°2 and 4 for the exterior side of the curve. Some values are purely theoretics and not usable in practise for other reasons.						

45. The turnout determines the over widening of the curve. When a vehicle occupies the deviated track, the extreme of the vehicle is going to penetrate the gauge in the straight track.

8.1. Widening of the curve

46. It is determined the maximum widening of the gauge, GC, influenced by the distance between axis and therefore the maximum widening of the gauge.

47. It is utilized the limit gauge of verification:

47.1. The additional deviations (widening of the curve and local overwidening):

47.1.1. Widening in the principal track

47.1.2. The track widening is determined by the reference vehicles 2 and 4 in Table 32.

47.1.3. Widening of the deviated track

47.1.4. The gauge widening in the deviated track is determined over the base of the reference vehicles 1 and 3, that determines the widening of the gauge in the interior side of the curve.

47.2. The quasi static effect:

47.2.1. In the exterior side of the curve, the cant deficiency is determined as following:

47.2.2. The switches are defined for a constant cant deficiency of 90 mm.

47.2.3. In consequence, the quasi-static effect is determined as:

Equation 19: Equation 8 § EN 15273-3:2014+A1

$$qs_a = \frac{s_0}{L}[I - I_0]_{>0}[h - h_{co}]_{>0} = \frac{0,4}{1,5}[0,09 - 0,05]_{>0}[h - 0,5]_{>0}$$

48. The margins are determined based on the following formulations:

Equation 20: Equation A.12 and A.14 § EN 15273-3:2014+A1, installation limit gauge allowance used for the calculation of the platform offset at turnouts

$$\Sigma_{2,i} = max\left[\Sigma'_{2,i} + K * (D - D_0)_{>0}\,;\ \Sigma''_2\,;\ \left(\Sigma'_{2,a} - K * I_0\right)\right]$$

$$\Sigma_{2,a} = max\left[\Sigma'_{2,a} + K * (I - I_0)_{>0}\,;\ \Sigma''_2\right]$$

49. The widening of the gauge is variable in the whole height. The supplement to be added over the gauge in straight widening is function of the height.
50. The two following cases request the particular attention when they are applied to these turnouts:
    50.1. The application of this type of turnout requests the enhancement of the limit distance between the track axis of (132 mm=) 138 mm, in comparison with the case of two tracks on straight alignment and in absence of this type of turnout.
    50.2. The application of this type of turnout along the platform edge request the liberation of the supplementary space of 90 mm along the platform.
51. The installation limit is calculated according to the following formulation (Equation A.10 § EN 15273-3:2014+A1) :

$$b_{lim} = b_{CR} + S_i + q_{si} + \Sigma_{2,i} = 1.62 + 0.054 + 0.034 + 0.003 = 1.710\ m$$

52. The platform shall be built close to the installation limit gauge within a maximum tolerance of 50mm, as indicated in the Infrastructure TSI. The value for bq shall therefore respond to:

$$b_{qlim} \leq b_q \leq b_{qlim} + 50mm$$

53. bqlim is calculated for the straight alignment condition and the corresponding maximum and minimum platform offsets.

Table 33: Platform offset of turnout in straight alignment according with GC installation limit gauge (Infrastructure TSI requirement)

Turnout alignment	Platform offset for mixed traffic line and passenger traffic line
Straight	1.710m < b_q < 1.760m

9. SHUNTING LIMIT METHODOLOGY COMPARISON BETWEEN EN15273-3 AND RBDG-MAN-013 FOR GC GAUGE

54. RBDG-MAN-013 defines the basic distance S to be S=3.60 m for GC gauge.
55. Following the methodology provided in section 9.2.1 and the formulas below, the following table is calculated.

Equation 211: Equation A.19b and A.20b § EN 15273-3:2014+A1, verification limit gauge allowance used for the calculation of the shunting limit

$$\Sigma_{1,i} = max\left[\Sigma'_{1,i} + K * (D - D_0)_{>0}\ ;\ \Sigma''_1\ ;\ (\Sigma'_{1,a} - K * I_0)\right]$$

Equation 22: Equation A.17.§ EN 15273-3:2014+A1

$$\Sigma'_{1,i/a} = k\sqrt{\begin{matrix}[tg(T_{susp})[h - h_{co}]_{>0}]^2 + \\ [tg(T_{load})[h - h_{co}]_{>0}]^2 + \left[\frac{S_0}{L}(T_{osc})[h - h_{co}]_{>0}\right]^2\end{matrix}}$$

Equation 23: Equation A.18 .§ EN 15273-3:2014+A1

$$\Sigma''_1 = k\sqrt{\begin{matrix}[tg(T_{susp})[h - h_{co}]_{>0}]^2 + \\ [tg(T_{load})[h - h_{co}]_{>0}]^2\end{matrix}}$$

Equation 24: Equations A.19a and A.20a.§ EN 15273-3:2014+A1

$$b_{ver,i/a} = b_{CR} + S_i + \Sigma_{1,i/a} + q_{s,i/a}$$

Table 34: Input and calculated parameters for a straight section

Parameter	Value
V (km/h)	249
I (mm)	0.0
R (m)	-
qsa	0.000
qsi	0.000
Point P GC h (m)	3.55
D	0
Point P GC bcR	1.645
Σ'1i	0.053
Σ'1a	0.082
Σ"1	0.051
K	0.813
Σ1,i	0.053
Σ1,a	0.082

Table 35: Calculations for different reference vehicle parameters according to EN15273

Reference vehicle	Ai/a	Bi/a	Bveh	a	na		na+a		Sa	Si	bver,a	bver,i
				a=	5	20					1 (EN15273-3:2013)	1 (EN15273-3:2013)
1i	3.75	0	1.645	5.477	-	-				0.00		1.698
2a	3.75	0	1.645	-	1.208	0.368	6.208	20.368	0.00		1.727	
3i	50	0.185	1.46	20	-	-				-0.185		1.513
4a	60	0.225	1.42	-	8.736	4.832	13.736	5.201	-0.225		1.502	

56. In a straight section the most restrictive scenario is vehicle 2a for the outer side calculations. This results to a basic distance S = 1.727*2= 3.454 m < 3.6 m as defined in RBDG-MAN-013 for GC gauge.

Table 36: Comparison between results for shunting limit distance according to different methodology, for different geometry cases

			bver,a		bver,i	
radius	cant	Speed	1 (EN15273-3:2013) verification gauge	DG013	1 (EN15273-3:2013) verification gauge	DG013
straight	-	249	1.727	1.800	1.698	1.800
190	0	40	1.858	1.966	1.776	2.013
190	50	50	1.862	1.966	1.776	2.173
200	160	70	1.866	1.958	1.852	2.003
300	0	50	1.778	1.905	1.710	1.935
300	110	70	1.766	1.905	1.759	1.935
500	110	100	1.796	1.863	1.754	1.881
760	180	140	1.792	1.841	1.809	1.853
1000	180	160	1.789	1.832	1.807	1.841
1200	180	170	1.774	1.826	1.807	1.834
2000	180	200	1.733	1.816	1.805	1.820
3600	180	249	1.728	1.809	1.805	1.811

57. The shunting limit distance value calculated according to RBDG-MAN-013 methodology is more conservative compared to that calculated according to EN15273-3 for all cases.

ANNEX 2: SEC GAUGE CALCULATIONS

1. INTRODUCTION

58. Limit for the distance between track centres shall be calculated for the SEc gauge in accordance with standard TRVINFRA00398 and EN 15273 to ensure its compliance with the chosen 4.5m distance between track centres for lines with mixed traffic.

59. Unless otherwise indicated, symbols, abbreviations and parameter values shall be equal to those used in the GC and GI3 calculations (refer to Annex 1).

2. PLATFORM OFFSET IN ACCORDANCE WITH TSI INFRA AND TRVINFRA00398

2.1. DG012 version in force

60. Platform position is determined by the installation limit gauge. According to TSI INFRA 1299:2023 chapter 7.7.16.2, the platform offset parallel to the running plane is calculated in accordance with SEc and the additional overthrows. Using the rules for additions to the gauge due to cant and radius from TRVINFRA-00398 7.1.6 and 7.1.5 respectively, the adapted platform offset rules for offset calculated parallel to the running surface are formed as follows:

$$bqlim\ i = \mathrm{B} + U_i$$
$$bqlim\ a = \mathrm{B} + U_y + \delta$$

60.1. B = 1690mm for platform with height 760mm. The width of the normal section at height 760mm where the platform is located ,is 1690 mm (see TRVINFRA-00398 K7.1).

60.2. Ui and Uy are (Table K7.3 in TRVINFRA-00398):

Equation 25: K30301 § TRVINFRA-00398

$$U_i = \frac{41}{R}$$

$$U_y = \frac{31}{R}$$

60.3. δ is replacing the a value (Equation 7.5 in TRVINFRA-00398), taking into account the existence or not of platform coping to define the offset of the platform from the tilted track axis securing safe passage for the gauge tested:

Equation 26: K30237 § TRVINFRA-00398 for platform with coping

$$\delta_{q,a} = \left(\frac{D}{L}\right) * h_{nez}$$

Equation 27: for platform with no coping

$$\delta_{q,a} = \left(\frac{D}{L}\right) * (h_q - h_{minCR})$$

60.4. y = 360 mm from normal section height, to consider additional distance for the low corner of the tilted gauge. Even though GI3 is applied for the lower parts of the gauge where 400mm from TOR height is the limiting dimension instead of 360mm, the 360mm is used for the calculations of the SEc compatible platform offset in order to secure the proper offset for passage of SEc trains next to the platforms.

Figure 31: Normal section dimensions at platform level

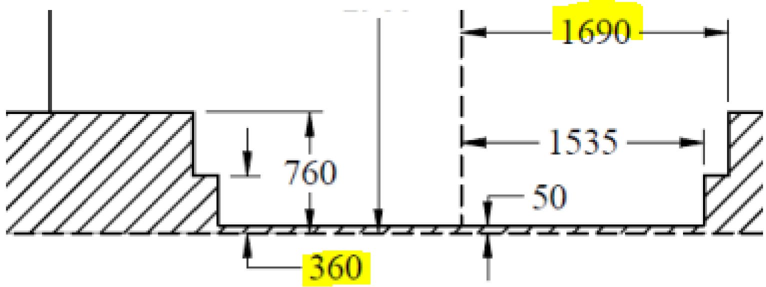


Table 37: Installation limit gauge for platform offset for SEc gauge (TRVINFRA-00398) for platform height of 0.76 m and no coping and Normal Section (DG in force version)

R (m)	*D (mm)*	*U_i (m)*	*U_y (m)*	*δ (mm)*	*Platform offset (inside of the curve)*	*Platform offset (outside of the curve)*
Str	0	0.000	0.000	0.000	1.690	1.690
4000	70	0.010	0.008	0.019	1.700	1.716
3600	70	0.011	0.009	0.019	1.701	1.717
2000	70	0.021	0.016	0.019	1.711	1.724
1000	70	0.041	0.031	0.019	1.731	1.740

2.2. DG012 update proposal

61. The same rules apply as for DG012 version in force. Values resulting from the minimum section are y=0.38m and B=1.675m.

Figure 32: Minimum section dimensions at platform level

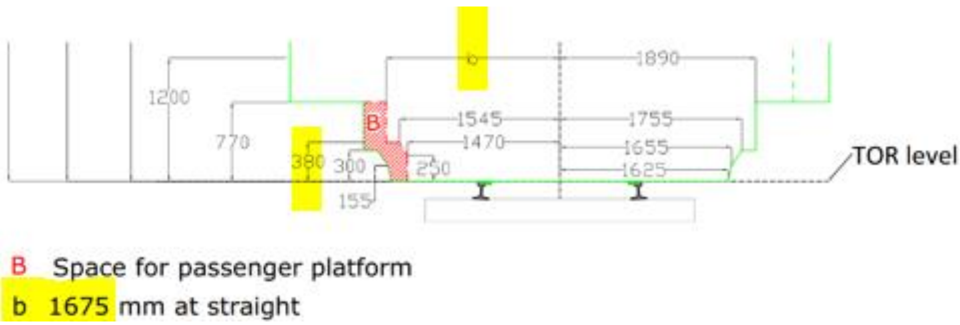


Table 38: Installation limit gauge for platform offset for SEc gauge (TRVINFRA-00398) for platform height of 0.76 m and Minimum section (DG update proposal)

R (m)	*D (mm)*	*U_i (m)*	*U_y (m)*	*a (mm)*	*Platform offset (inside of the curve)*	*Platform offset (outside of the curve)*
Str	0	0.000	0.000	0.000	1.675	1.675
4000	70	0.010	0.008	0.019	1.685	1.702
3600	70	0.011	0.009	0.019	1.686	1.703
2000	70	0.021	0.016	0.019	1.696	1.710
1000	70	0.041	0.031	0.019	1.716	1.725

3. INSTALLATION LIMIT GAUGE FOR PLATFORM OFFSET IN ACCORDANCE WITH EN15273-3

62. The values for parameters applied in the calculations are defined in table 39 . . Brp, hrp, D, I, and R tested are presented in table 45.

Table 39: Parameters for Sec gauge calculations

Parameter	Mixed traffic	Source	Description of parameter
R	300 m	RBDG-MAN-013-0103 3.10 (mix)	Horizontal curve radius
R_V	2000 m	RBDG-MAN-013-0103 4.2 (mix)	Vertical curve radius of longitudinal profile
L	1.5 m	EN 15273-3 Annex C	Standard distance between the centrelines of the rails of the same track
$lmax$	1.463 m	INF TSI Table 12	Maximum track gauge for all speeds
l_{nom}	1.435 m	RBDG-MAN-014-0104 3.4.1	Nominal track gauge
D	0.11 m	RBDG-MAN-013-0103 3.1 (mix)	Cant
D_0	0 m	EN 15273-1 Table C.6 chapter C.2.3.3 & chapter 4, table 1	Fixed cant value taken into account by agreement between the rolling stock and the infrastructure with regard to the kinematic gauge
I	0.115 m	RBDG-MAN-013-0103 3.3 (mix)	Cant deficiency
I_0	0 m	EN 15273-1 Table C.6 chapter C.2.3.3 & chapter 4, table 1	Fixed cant deficiency value taken into account by agreement between the rolling stock and the infrastructure with regard to the kinematic gauge
s_0	0.4	EN 15273-3 Annex C	Flexibility coefficient value taken into account in the agreement between the rolling stock and the infrastructure
h_{c0}	0.77 m	EN 15273-1 Table C.6 chapter C.2.3.3 & chapter 4, table 1	Value of hc used for the agreement between the rolling stock and the infrastructure
τ_{load}	0.77°	EN 15273-3 Annex B	Angle of dissymmetry, considered in reference angle ηo, for poor load distribution

Parameter	Mixed traffic	Source	Description of parameter
T_{susp}	0.23°	EN 15273-3 Annex B	Angle of dissymmetry, considered in reference angle ηo, for poor suspension adjustment degree
$T_{osc\ i}$	0.013 m	EN 15273-3 Annex B (other quality track)	Crosslevel difference selected for calculation of oscillations caused by track irregularities inside curve
$T_{osc\ a}$	0.065 m	EN 15273-3 Annex B (other quality track)	Crosslevel difference selected for calculation of oscillations caused by track irregularities outside curve
T_{track}	0.025 m	EN 15273-3 Annex B	Transverse displacement of the track between two periods of maintenance
T_D	0.015/0.020 m	EN 15273-3 Annex B	Track crosslevel difference between two maintenance periods (0.015 for V>80 km/h and 0.020 for V≤80 km/h)
$T_{N\ hight}$	0.021 m	EN 15273-3 Annex B	Vertical displacement of the track between two periods of maintenance towards the top
$T_{N\ low}$	0.021 / 0.005 m	EN 15273-3 Annex B	Vertical displacement of the track between two periods of maintenance towards the bottom
$M3b$	0.1 m	RBDG-MAN-017-0104	Additional Infrastructure traverse allowance
$M3h$	0.05 m	RBDG-MAN-017-0104	Additional Infrastructure vertical allowance
k	1.2	EN 15273-3 Annex B	Amplification coefficient for calculation of allowances
h_q	0.76 m	TSI INFRA 1299/2023	Platform height
hminCR Version in force	0.360 m	EN 15273-3 Table 1	Height of the bottom corner of the reference profile, adjusted to TRVINFRA normal section geometry
hminCR Proposal for DG update	0.380 m	EN 15273-3 Table 1	Height of the bottom corner of the reference profile, adjusted to TRVINFRA minsta section and proposed gauge for mixed traffic geometry

Parameter	Mixed traffic	Source	Description of parameter
hminCR Sec Reference profile	0.385 m	EN 15273-3 Table 1	EN 15273-3 Table 1

Equation 28: Equation 49 § EN15273-3:2013

$$b_{q,lim,i/a} \geq b_{CR} + S_{i/a} + \Sigma_{2,i/\alpha}$$

$$\Sigma_{2,i/a} = k\sqrt{T_{track}^2 + \left[\frac{T_D}{L}h\right]^2 + \left[tg(T_{susp})[h - h_{co}]_{>0}\right]^2 + [tg(T_{load})[h - h_{co}]_{>0}]^2}$$

63. Coping calculated for dynamic reference profile Sec, with $h_{CRmin} = 0.385$ m

Table 40: Installation limit gauge for platform offset for SEc gauge (EN15273) for platform height of 0.76, V=249km/h and no coping

Radius	bRP	hRP	D	I	Si	Sa	Σ2,i	Σ2,a	δq,a	bq lim i	bq lim a
Straight	1.635	0.76	0.00	0.00	0.015	0.015	0.031	0.031	0	1.681	1.681
4000	1.635	0.76	0.07	0.113	0.025	0.023	0.031	0.031	0.018	1.692	1.707
3600	1.635	0.76	0.07	0.127	0.026	0.024	0.031	0.031	0.018	1.693	1.707
2000	1.635	0.76	0.07	0.121	0.036	0.031	0.031	0.031	0.018	1.702	1.714
1000	1.635	0.76	0.07	0.129	0.056	0.046	0.031	0.031	0.018	1.722	1.730

64. Comparing the results of Table 40 with the proposed method from Table 38, it is noticed that the proposed method is more conservative regarding the proposed offset values. Nevertheless, since Sec is a dynamic gauge and has already considered additional parameters, it is decided that EN15273 method will not be used for the platform offset, but instead the one proposed in this chapter.

4. LIMIT DISTANCE BETWEEN TRACK CENTRES IN ACCORDANCE WITH TRVINFRA-00398

65. For the distance between track centers, we shall use the following formulation from section 5.10, as the tracks are parallel to each other, having the same radius and cant:

$$EA = S + U_i + U_y + 3.2(h_1 - h_2)$$

Where:

S is 4.2 m for main tracks

Ui and Uy are:

Equation 29: Equations 5.23 TRVINFRA-00398

$$U_i = \frac{41}{R}$$

$$U_y = \frac{31}{R}$$

$h1$ and $h2$ are cant in track 1 and cant in track 2.

66. The resulting limit distance between track centers at the P point, assuming that $h_1 - h_2 = 0$, is the following.

Table 41: Limit distance between track centres for SEc gauge (TDOK 2014-0555)

S	U_i	U_y	Limit distance between track centres
4.2	0.137	0.103	4.44

67. The resulting limit distance between track centres considers the worst design situation:

67.1. R_H=300m according to chapter 3.4. § RBDG-MAN-013-0105 (absolute minimum values of radius)The resulting value is

67.2. S=4.44 < 4.5. Decreased distance below 4.5 for freight only traffic is not possible.

67.3. For neighboring main (R400m) and side (R300m) tracks with cant difference h1-h2=110-0=110mm), the required track distance shall be widened to 4.2+0.103+0.103+3.2*0.110 = 4.758 m.

68. According to TRVINFRA0398 v2 K30628 the track distance shall be at least 4.5m wide even if the calculation result is less. For radii below 300m, calculations have to be made. According to RBDG-MAN-013, track center distance of 4.0 m is possible for freight only sections. Design guideline update is needed according to the calculations, adjusting the min distance between track centers to 4.5m.

5. LIMIT DISTANCE BETWEEN TRACK CENTRES IN ACCORDANCE WITH EN 15273

69. The limit installation distance between track centers is determined to prevent the gauge of one track from interfering with the gauge of the adjacent track while taking into account both the reference profiles and associated rules and also a sum of allowances.

70. This limit installation distance between track centers is calculated in accordance with EN 15273- 3 using the following formulation:

Equation 30: Equation A.49 § EN 15273-3:2014+A1

$$EA_2 = 2b_{RP} + S_a + S_i + \sum_{EA2} + \Delta b_{\delta D}$$

70.1. W
here:

$\Delta b\delta D$ is the effect of cant difference on distance between tracks.

Sa is as follows:

Equation 31: Equation from table D.19 § EN 15273-3

$$S_a = \frac{31}{R} + \frac{\boldsymbol{l_{max}} - 1.435}{2}$$

Si is as follows:

Equation 32: Equation from table D.19 § EN 15273-3

$$S_i = \frac{41}{R} + \frac{\boldsymbol{l_{max}} - 1.435}{2}$$

$\sum_{EA2}$ is as follows:

Equation 33: Equation A.48 § EN 15273-3

$$\Sigma_{EA2} = \sqrt{(\Sigma^2_{2,i/a})_{track\ 1} + (\Sigma^2_{2,i/a})_{track\ 2}}$$

71. Where:

Equation 34: Equation A.36 § EN 15273-3

$$\Sigma_{2,i/a} = k\sqrt{T^2_{track} + \left[\frac{T_D}{L}h\right]^2 + \left[tg(T_{\text{susp}})[h - h_{co}]_{>0}\right]^2 + [tg(T_{\text{load}})[h - h_{co}]_{>0}]^2}$$

72. Where:

$$h_{co} = 0.77m$$

Equation 35: Effect of the difference of cant (Equations 26 § EN 15273-3)

$$\Delta b_{\delta D} = \frac{h_p}{L}[D_a - D_i]$$

73. The resulting limit distance between track centres is the following.

Table 42: Limit distance between track centres for SEc gauge for main tracks (EN 15273)

SEc reference profile	b_{RP}	h_{RP}	S_i	S_a	Σ_{EA2}	$\Delta b_{\delta D}$	Limit distance between track centres
Point P	1.98	4.99	0.027	0.024	0.138	0	4.15

74. The resulting limit distance between track centres considers the worst design situation:
    74.1. Da=110mm according to chapter 3.1 § RBDG-MAN-013-0105 (for mixed traffic)
    74.2. Di=110mm (limiting value on the effect of the cant difference between exterior and interior tracks)
    74.3. I=112mm, 115mm is the maximum allowed value according to chapter 3.3 § RBDG-MAN-013-0105 (for freight traffic)
    74.4. RH=3300m according to chapter 3.4. § RBDG-MAN-013-0105

Table 43: Limit distance between track centres for SEc gauge for side tracks (EN 15273)

SEc reference profile	b_{RP}	h_{RP}	S_i	S_a	Σ_{EA2}	$\Delta b_{\delta D}$	Limit distance between track centres
Point P	1.98	4.99	0.288	0.222	0.157	0	4.627

75. The resulting limit distance between track centers considers the worst design situation:
    75.1. Da=0mm according to chapter 3.1 § RBDG-MAN-013-0105 (for mixed traffic)
    75.2. Di=0mm (limiting value on the effect of the cant difference between exterior and interior tracks)
    75.3. I=96.4mm, 115mm is the maximum allowed value according to chapter 3.3 § RBDG-MAN-013-0105 (for freight traffic)
    75.4. RH=150m according to chapter 3.4. § RBDG-MAN-013-0105
76. The distance between tracks needs additional widening than 4.5m for curve radius as low as 150m.

Table 44: Limit distance between track centres for SEc gauge for side tracks (EN 15273)

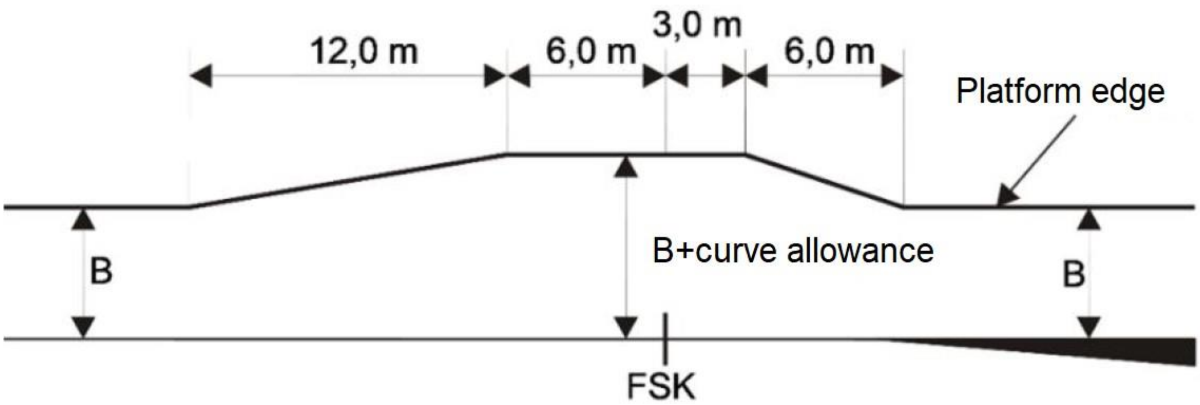
SEc reference profile	b_{RP}	h_{RP}	S_i	S_a	$\Sigma EA2$	$\Delta b_{\delta D}$	*Limit distance between track centres*
Point P	1.98	4.99	0.152	0.118	0.157	0	4.387

77. The resulting limit distance between track centres considers the worst design situation:
    77.1. Da=0mm according to chapter 3.1 § RBDG-MAN-013-0105 (for mixed traffic)
    77.2. Di=0mm (limiting value on the effect of the cant difference between exterior and interior tracks)
    77.3. I=63mm, 115mm is the maximum allowed value according to chapter 3.3 § RBDG-MAN-013-0105 (for freight traffic)
    77.4. RH=300m according to chapter 3.4. § RBDG-MAN-013-0105

6. DETERMINATION OF PLATFORM OFFSET AT TURNOUTS

78. The placement of the platform edge to the track centerline at the switch location shall offset a distance of curve allowance [mm] = 31000/R, as R [m] is the curve radius of the turnout, according to requirement K30302 in TVINFRA-00398 . Where parameter B is defined as 1690 mm in §59.1 for DG version in force and as 1675 mm in§60 for DG proposal for update.

Figure 33: Placement of platform, distance from track center at switch according to Figure K7.3 § TRVINFRA-0004



ANNEX 3. GAUGES' PROPOSAL FOR UPDATE-CALCULATIONS

1. GC AND GI3 GAUGE CALCULATIONS

79. Associated rules and parameters for the uniform gauge are used for the calculations as they are presented in Annex 1 chapter 3 and 4.

80. Regarding the speed, cant, and radius resulting in the gauge dimensions, the most restricting combinations where tested and the maximum values for the upper parts and the minimum values for the lower parts of the gauge where applied. Detailed results are presented in the tables below.

Table 45: GC and GI3 parameters for D180mm, R2360m, V249km/h, Rv10000m, I130mm (Passenger and light freight traffic)

h_{RP}	4.7	3.55	3.25	1.17	1.17	0.4	0.4	0.25	0.08	0.08	0.1	0.1
b_{RP}	1.54	1.645	1.645	1.645	1.62	1.62	1.52	1.45	1.425	0.125	0.125	0
$h_{structure\ i}$	4.876	3.626	3.326	1.094	1.094	0.324	0.324	0.174	0.004	0.004	0.024	0.024
$b_{structure\ i}$	1.979	2.004	1.983	1.838	1.813	1.766	1.665	1.594	1.567	0.267	0.267	0.142
$h_{structure\ a}$	4.891	3.626	3.326	1.094	1.094	0.324	0.324	0.174	0.004	0.004	0.024	0.024
$b_{structure\ a}$	1.981	2.005	1.984	1.839	1.814	1.766	1.665	1.593	1.566	0.266	0.266	0.141

Table 46: GC and GI3 parameters for D0mm, R190m, V40km/h, Rv2000m, I99mm (Passenger and light freight traffic)

h_{RP}	4.7	3.55	3.25	1.17	1.17	0.4	0.4	0.25	0.08	0.08	0.1	0.1
b_{RP}	1.54	1.645	1.645	1.645	1.62	1.62	1.52	1.45	1.425	0.125	0.125	0
$h_{structure\ i}$	4.847	3.646	3.346	1.074	1.074	0.304	0.304	0.154	-0.016	-0.016	0.004	0.004
$b_{structure\ i}$	1.931	1.991	1.979	1.896	1.871	1.843	1.738	1.651	1.623	0.323	0.324	0.199
$h_{structure\ a}$	4.908	3.646	3.346	1.074	1.074	0.304	0.304	0.154	-0.016	-0.016	0.004	0.004
$b_{structure\ a}$	2.057	2.085	2.065	1.927	1.902	1.856	1.751	1.644	1.617	0.317	0.317	0.192

Table 47: GC and GI3 parameters for D110mm, R200m, V60km/h, Rv2000m, I102mm (Mixed traffic)

h_{RP}	4.7	3.55	3.25	1.17	1.17	0.4	0.4	0.25	0.08	0.08	0.1	0.1
b_{RP}	1.54	1.645	1.645	1.645	1.62	1.62	1.52	1.45	1.425	0.125	0.125	0
$h_{structure\ i}$	4.872	3.646	3.346	1.074	1.074	0.304	0.304	0.154	-0.016	-0.016	0.004	0.004
$b_{structure\ i}$	1.985	2.026	2.010	1.894	1.869	1.830	1.725	1.641	1.614	0.314	0.314	0.189
$h_{structure\ a}$	4.910	3.646	3.346	1.074	1.074	0.304	0.304	0.154	-0.016	-0.016	0.004	0.004
$b_{structure\ a}$	2.044	2.072	2.052	1.912	1.887	1.840	1.735	1.633	1.606	0.306	0.306	0.181

Table 48: GC and GI3 parameters for the most restrictive combination of alignment characteristics

hRP	*4.7*	*3.55*	*3.25*	*1.17*	*1.17*	*0.4*	*0.4*	*0.25*	*0.08*	*0.08*	*0.1*	*0.1*
bRP	*1.54*	*1.645*	*1.645*	*1.645*	*1.62*	*1.62*	*1.52*	*1.45*	*1.425*	*0.125*	*0.125*	*0*
$h_{structure\ i}$	4.876	3.646	3.346	1.074	1.074	0.304	0.304	0.154	-0.016	-0.016	0.004	0.004
$b_{structure\ i}$	1.985	2.026	2.010	1.896	1.871	1.843	1.738	1.651	1.623	0.323	0.324	0.199
$h_{structure\ a}$	4.910	3.646	3.346	1.074	1.074	0.304	0.304	0.154	-0.016	-0.016	0.004	0.004
$b_{structure\ a}$	2.057	2.085	2.065	1.927	1.902	1.856	1.751	1.644	1.617	0.317	0.317	0.192

81. According to the results of table 54, the outline of the min uniform gauge is designed.

Figure 34: Uniform gauge resulting from the combination of the most restrictive alignment characteristics. The dimensions are indicative, according to Table 48

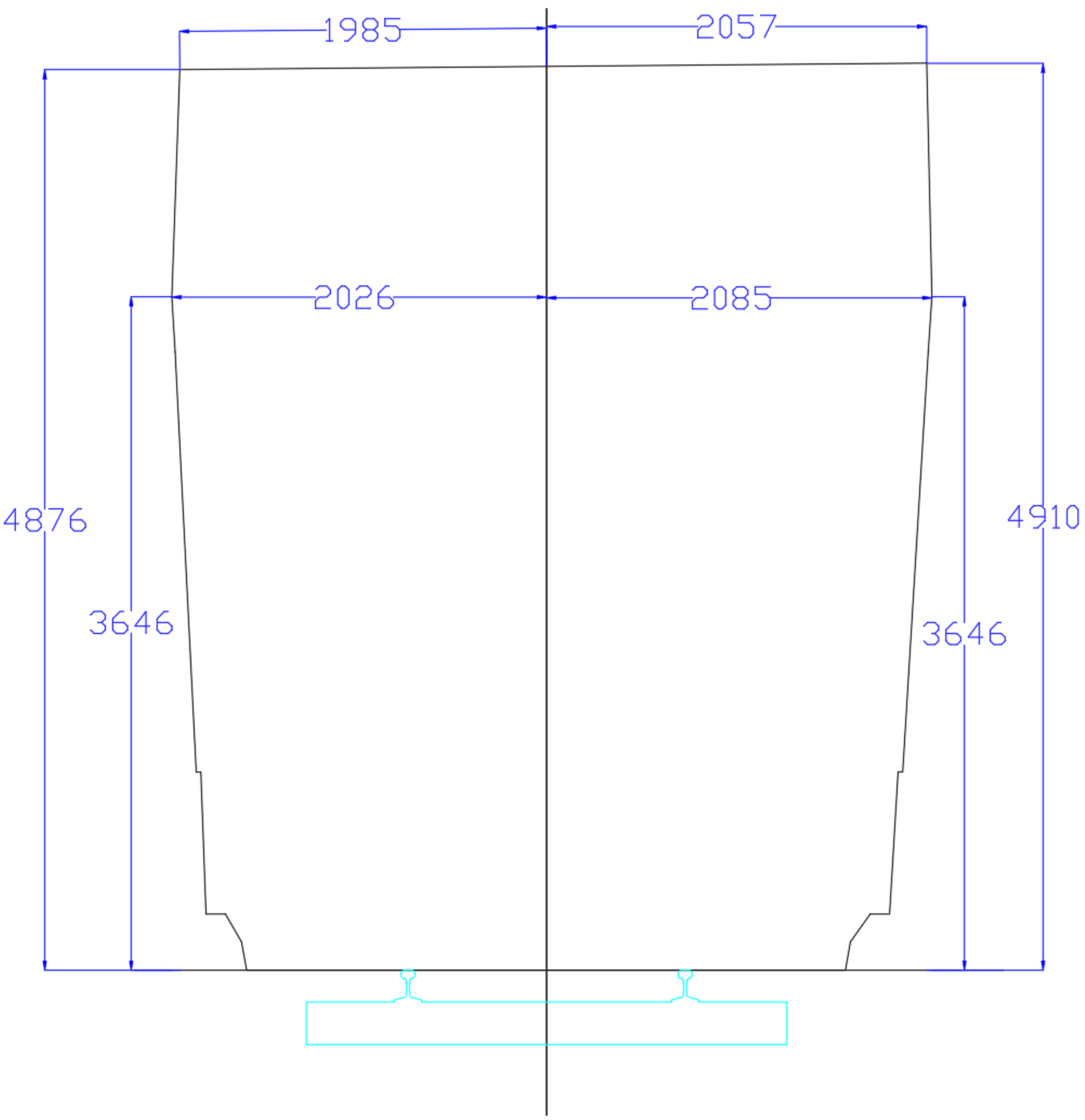
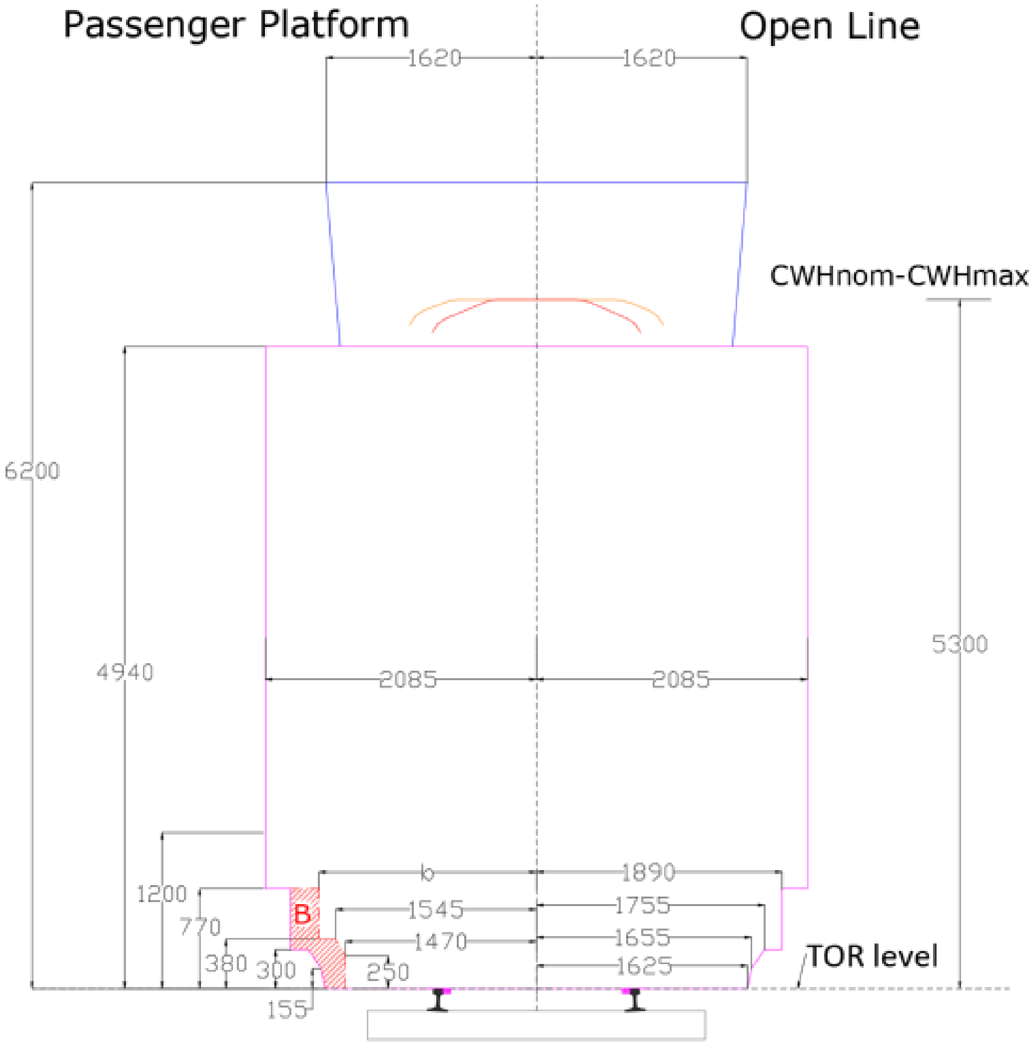


Figure 35: GC and CI3 uniform gauge proposal for DG012 update



2. SEC GAUGE CALCULATIONS

2.1. Associated rules

82. According to EN15273-3 chapter 8, the position of the structure for the horizontal shall cover the sum:

Equation 36: Structure or obstacle position (Equation 22 § EN 15273-3)

$$b_{structure\ i/a} \geq b_{RP} + S_{i/a} + \textstyle\sum_3$$

83. b_{RP} is the semi-width of the dynamic reference profile

84. $S_{i/a}$ are the additional overthrows for the inner and outer side of the curve and are:

Equation 37: Additional overthrows (Equation D.1 and D.2 § EN 15273-1)

$$S_i = \frac{41}{R} + \frac{l - 1.435}{2}$$

$$S_a = \frac{31}{R} + \frac{l - 1.435}{2}$$

85. Allowances ($\sum_j$)are defined to take into account the random phenomena. The various phenomena are grouped according to their character.

86. M_1 includes the effects of certain random phenomena due to actual movements of the vehicles. This allowance determines the limit of the point reached by the vehicle. M_1 is determined on the basis of:

86.1.

Dissymmetry h0 due to poor suspension adjustment and load distribution not exceeding 1°.

87. M_2 the random effects that make the best use of allowances to ensure track maintenance at the chosen frequencies and resources. M_2 is determined on the basis of:

87.1.

Widening in order to take account of the track displacements between two maintenance operations;

87.2. The geometric part only ($h\frac{T_D}{L}$) due to the crosslevel error of the track T_D (the quasi-static part shall be taken into account by the vehicle).

88. S_{upl} is to be determined on the basis of the values that the infrastructure manager wishes to take into account.

89. The sum of the allowances $\sum_j$ is determined on the basis of the following formulation (Annex A EN-15273-3):

Equation 38: Sum of margins (Equation A.31 § EN 15273-3)

$$\sum\nolimits_{3,i/a} = T_{track} + \frac{T_D}{L}h + \mathrm{tg}(T_{\mathrm{susp}})\,[h - h_{c0}]_{>0} + \mathrm{tg}(T_{load})\,[h - h_{c0}]_{>0} + Supl$$

90. On the upper parts the position of the structure shall ensure that:

Equation 39: Structure or obstacle position (Equation 23a § EN 15273-3)

91. $h_{structure\ i/a} \geq h_{RP} + \Delta h_{Rv} + \sum_{3v}$

92. According to EN15273-3 chapter 8, the position of the structure on the lower parts shall cover the sum:

Equation 40: Structure or obstacle position (Equation 23b § EN 15273-3)

$$h_{structure} \leq h_{RP} + \Delta h_{R_V} - \sum\nolimits_{3V}$$

93. In the vertical direction the sum of the allowances is determined for the point Q on the basis of the following formulation:

Equation 41: Sum of allowances in the vertical direction (Equation A.34 and A.35 § EN 15273-3)

$$\sum\nolimits_{v3,a} = \frac{T_D}{L}\left(bQ + \frac{L}{2}\right) + bQ * \mathrm{tg}(T_{\mathrm{susp}}) + bQ * \mathrm{tg}(T_{load}) + Tn + Supl$$

$$\sum\nolimits_{v3,i} = \frac{T_D}{L}\left(bQ - \frac{L}{2}\right) + bQ * \mathrm{tg}(T_{\mathrm{susp}}) + bQ * \mathrm{tg}(T_{load}) + Tn + Supl$$

94. For the other points of the upper parts and for the lower parts, the first four phenomena are not to be considered. Therefore, the allowances are usually determined on the basis of a fixed value as explained above.

95. Regarding the speed, cant, and radius resulting in the gauge dimensions, the most restricting combinations where tested and the maximum values for the upper parts and the minimum values for the lower parts of the gauge where applied. Detailed results are presented in the tables below.

96. For the lower parts, GI3 kinematic gauge is taken into account below 400mm, according to the rules from Annex 1.

Table 49: Dynamic SEc and kinematic GI3 gauge parameters for D0mm, R190m, V40km/h, Rv40000m, I56mm (Mixed traffic)

h_{RP}	4.99	1.5	1.2	0.78	0.78	0.78	0.385	0.385	0.4	0.25	0.08	0.08	0.1	0.1
b_{RP}	1.98	1.98	1.66	1.86	1.66	1.635	1.635	1.51	1.52	1.45	1.425	0.125	0.125	0
$h_{structure\ i}$	5.113	1.428	1.128	0.708	0.708	0.708	0.313	0.313	0.328	0.178	0.008	0.008	0.028	0.028
$b_{structure\ i}$	2.476	2.369	2.039	2.226	2.026	2.001	1.996	1.871	1.738	1.651	1.623	0.323	0.324	0.199
$h_{structure\ a}$	5.133	1.428	1.128	0.708	0.708	0.708	0.313	0.313	0.328	0.178	0.008	0.008	0.028	0.028
$b_{structure\ a}$	2.423	2.316	1.987	2.174	1.974	1.949	1.943	1.818	1.751	1.644	1.617	0.317	0.317	0.192

Table 50: Dynamic SEc and kinematic GI3 gauge parameters for D110mm, R200m, V60km/h, Rv2000m, I102mm (Mixed traffic)

h_{RP}	4.99	1.5	1.2	0.78	0.78	0.78	0.385	0.385	0.4	0.25	0.08	0.08	0.1	0.1
b_{RP}	1.98	1.98	1.66	1.86	1.66	1.635	1.635	1.51	1.52	1.45	1.425	0.125	0.125	0
$h_{structure\ i}$	5.137	1.404	1.104	0.684	0.684	0.684	0.289	0.289	0.304	0.154	-0.016	-0.016	0.004	0.004
$b_{structure\ i}$	2.465	2.358	2.029	2.216	2.016	1.991	1.985	1.860	1.725	1.641	1.614	0.314	0.314	0.189
$h_{structure\ a}$	5.157	1.404	1.104	0.684	0.684	0.684	0.289	0.289	0.304	0.154	-0.016	-0.016	0.004	0.004
$b_{structure\ a}$	2.415	2.308	1.979	2.166	1.966	1.941	1.935	1.810	1.735	1.633	1.606	0.306	0.306	0.181

Table 51: Dynamic SEc and kinematic GI3 gauge parameters for D110mm, R3300m, V249km/h, Rv10000m, I112mm (Mixed traffic)

h_{RP}	4.99	1.5	1.2	0.78	0.78	0.78	0.385	0.385	0.4	0.25	0.08	0.08	0.1	0.1
b_{RP}	1.98	1.98	1.66	1.86	1.66	1.635	1.635	1.51	1.52	1.45	1.425	0.125	0.125	0
$h_{structure\ i}$	5.113	1.424	1.124	0.704	0.704	0.704	0.309	0.309	0.324	0.174	0.004	0.004	0.024	0.024
$b_{structure\ i}$	2.256	2.160	1.832	2.020	1.820	1.795	1.791	1.666	1.665	1.593	1.567	0.267	0.267	0.142
$h_{structure\ a}$	5.128	1.424	1.124	0.704	0.704	0.704	0.309	0.309	0.324	0.174	0.004	0.004	0.024	0.024

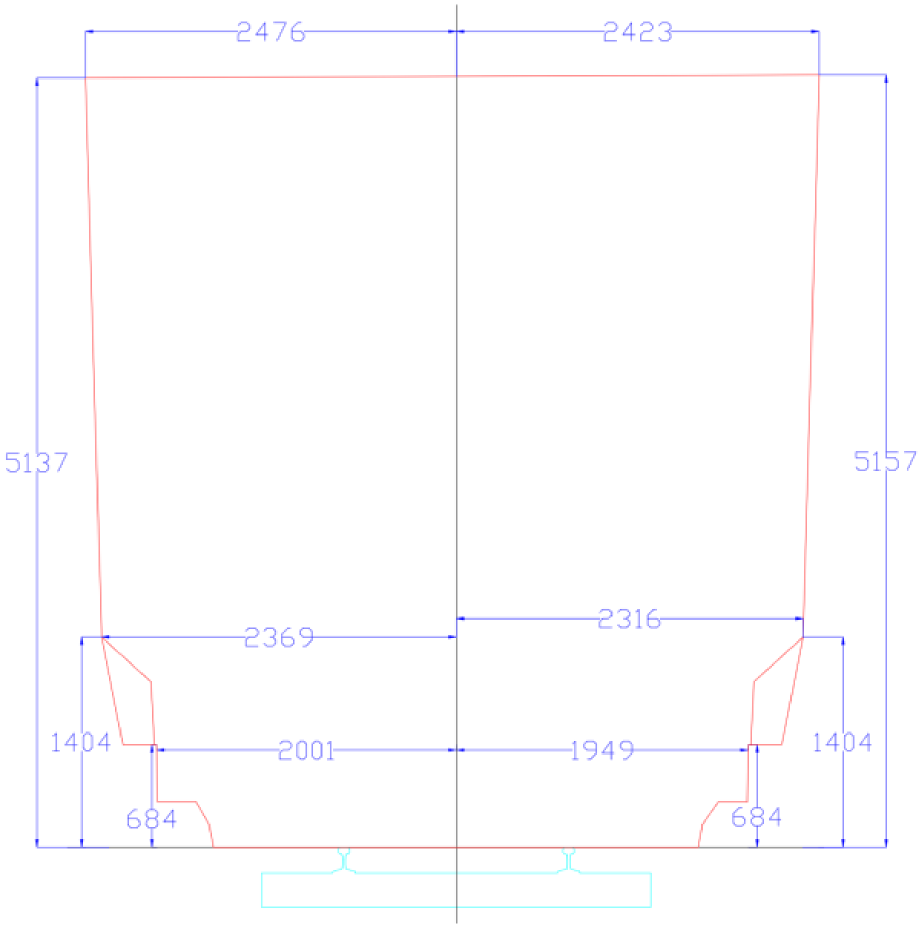
$b_{structure\ a}$	2.253	2.157	1.829	2.017	1.817	1.792	1.788	1.663	1.665	1.593	1.566	0.266	0.266	0.141

Table 52: Dynamic SEc and kinematic GI3 gauge parameters for the most restrictive combination of alignment characteristics

hRP	***4.99***	***1.5***	***1.2***	***0.78***	***0.78***	***0.78***	***0.385***	***0.385***	***0.4***	***0.25***	***0.08***	***0.08***	***0.1***	***0.1***
bRP	***1.98***	***1.98***	***1.66***	***1.86***	***1.66***	***1.635***	***1.635***	***1.51***	***1.52***	***1.45***	***1.425***	***0.125***	***0.125***	***0***
$h_{structure\ i}$	5.137	1.404	1.104	0.684	0.684	0.684	0.289	0.289	0.304	0.154	-0.016	-0.016	0.004	0.004
$b_{structure\ i}$	2.476	2.369	2.039	2.226	2.026	2.001	1.996	1.871	1.738	1.651	1.623	0.323	0.324	0.199
$h_{structure\ a}$	5.157	1.404	1.104	0.684	0.684	0.684	0.289	0.289	0.304	0.154	-0.016	-0.016	0.004	0.004
$b_{structure\ a}$	2.423	2.316	1.987	2.174	1.974	1.949	1.943	1.818	1.751	1.644	1.617	0.317	0.317	0.192

97. According to the results of table 59, the outline of the installation nominal dynamic gauge is designed.

Figure 36: Outline of the installation nominal for the dynamic gauge



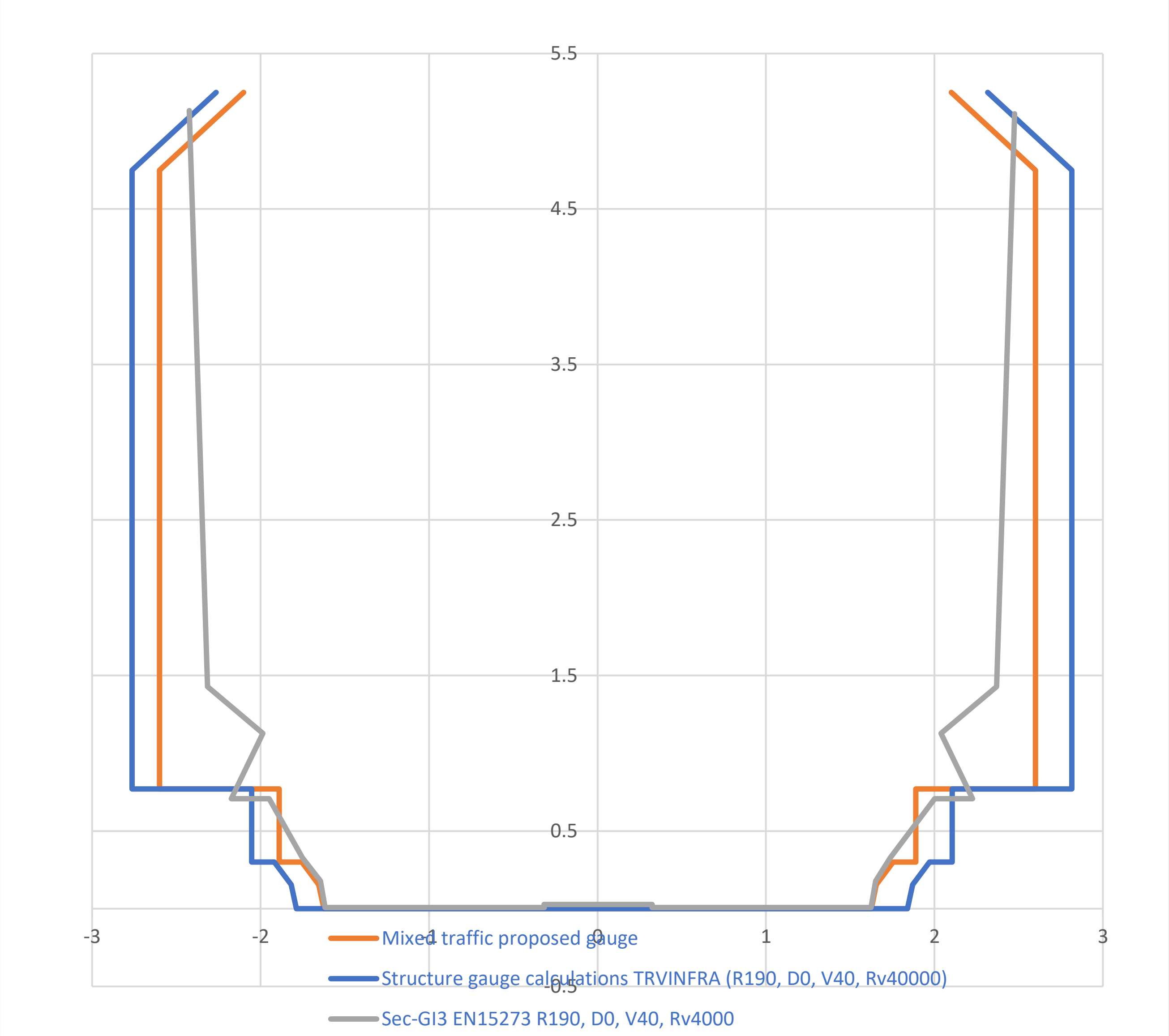


Figure 37 Comparative diagram between different methods for R190, D0, V40, Rv40000

Table 53 Structure gauge calculations TRVINFRA00398 (R190, D0, V40, Rv40000)

	h1	5.25	4.75	0.77	0.77	0.3	0.3	0.155	0
	b1	2.1	2.6	2.6	1.89	1.89	1.755	1.655	1.625
inner	h1+V	5.250	4.750	0.770	0.770	0.300	0.300	0.155	0.000
	b1+H+U	2.316	2.816	2.816	2.106	2.106	1.971	1.871	1.841
outer	h1+V	5.250	4.750	0.770	0.770	0.300	0.300	0.155	0.000
	b1+H+U	2.263	2.763	2.763	2.053	2.053	1.918	1.818	1.788

Figure 38 Comparative diagram between different methods for R200, D110, V60, Rv2000

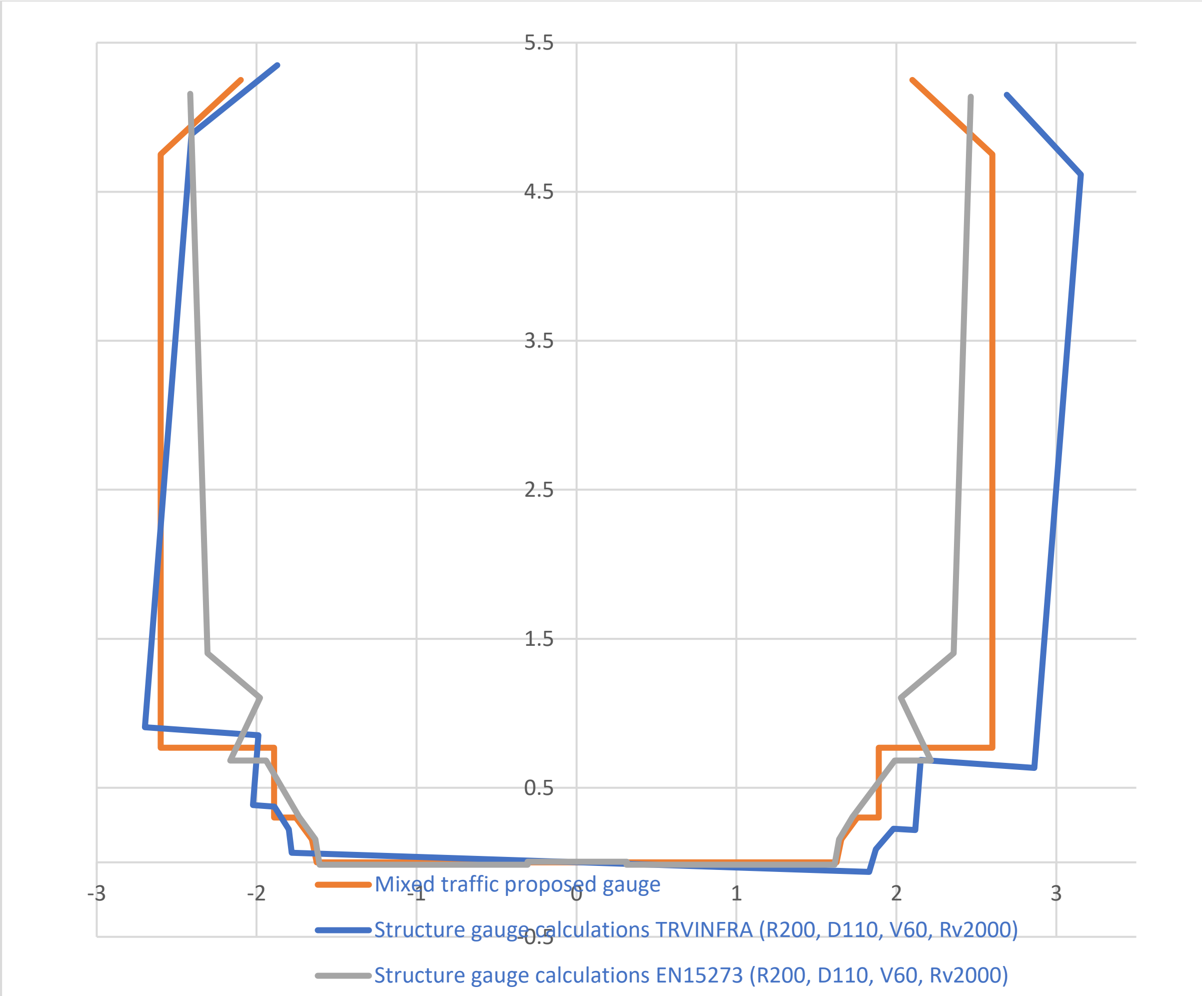


Table 54 Structure gauge calculations TRVINFRA00398 (R200, D110, V60, Rv2000)

	h1	5.25	4.75	0.77	0.77	0.3	0.3	0.155	0
	b1	2.1	2.6	2.6	1.89	1.89	1.755	1.655	1.625
inner	h1+V	5.151	4.614	0.634	0.686	0.216	0.226	0.089	-0.064
	b1+H+U	2.690	3.153	2.861	2.151	2.117	1.982	1.871	1.830
outer	h1+V	5.349	4.886	0.906	0.854	0.384	0.374	0.221	0.064
	b1+H+U	1.870	2.407	2.699	1.989	2.023	1.888	1.799	1.780

98. According to the diagrams, the gauge calculated for GI3 kinematic and Sec dynamic method following EN15273 standard is covered by the proposal for update for open line in the biggest part of the gauge.

The lower part of the gauge is on TOR level according to

99. Figure 42.

100. The upper edge of the gauge and the inner and outer widening at 0.78m height of the Sec gauge are not covered by the proposal for Design Guideline update. Since the proposed gauge width and height is compatible with or wider and higher than the Minsta Sektion and the widenings' calculations are following the methodology from TRVINFRA00398, then the oversized structure gauge calculations on these areas according to EN15273 are ignored.

Figure 39 Comparison of Design guideline update proposal and dynamic Sec-kinematic GI3 for the worst R-D-V combination

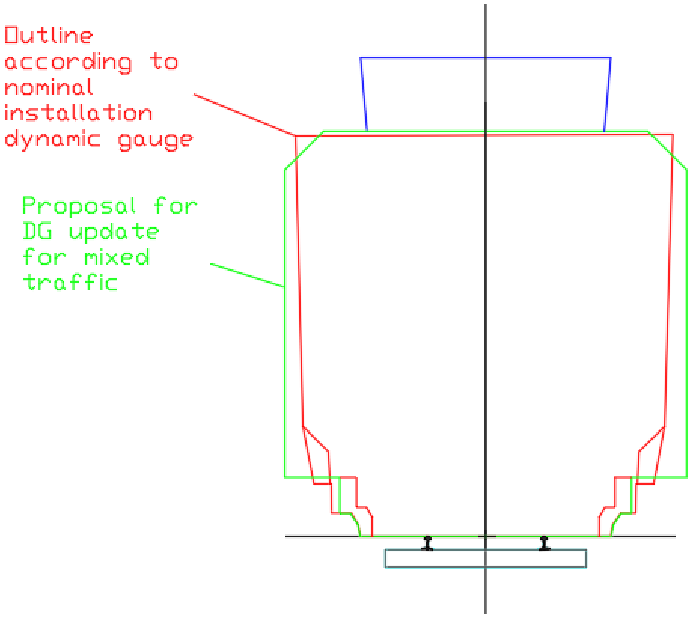
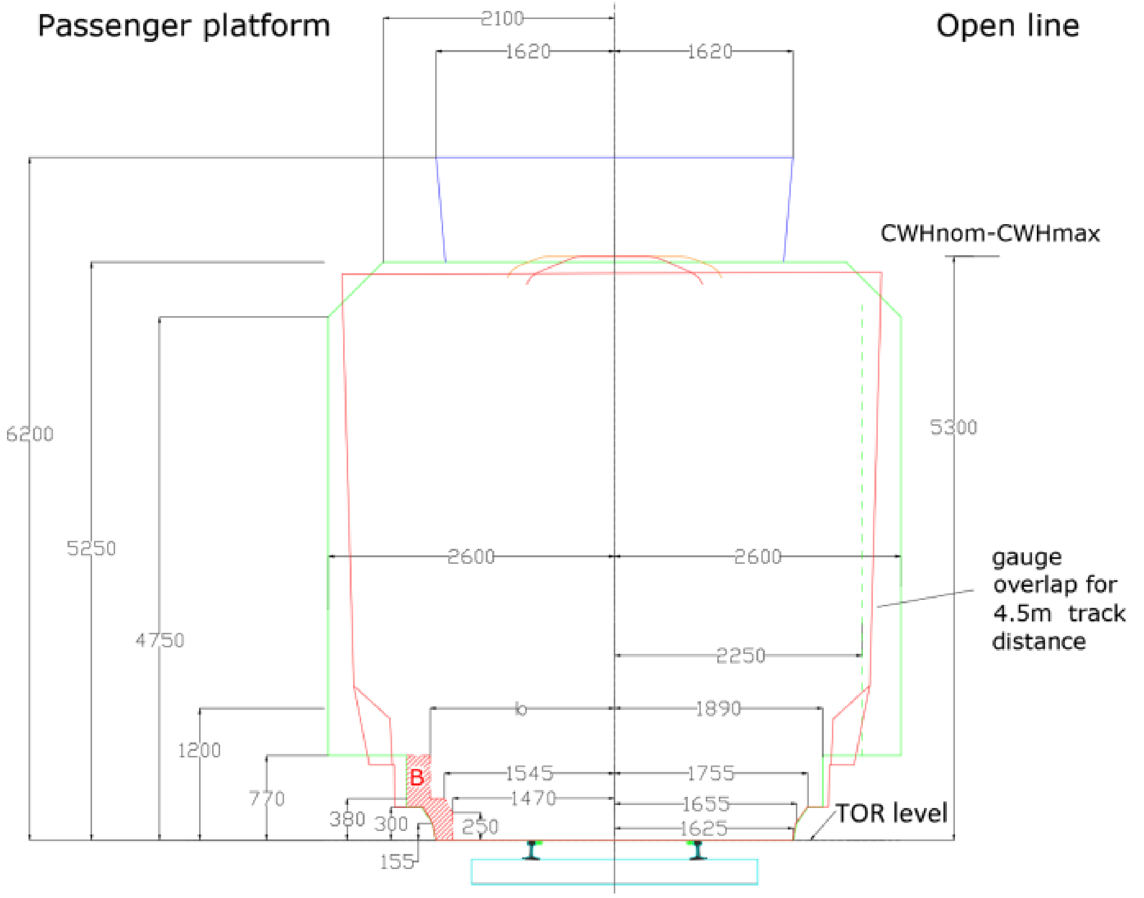


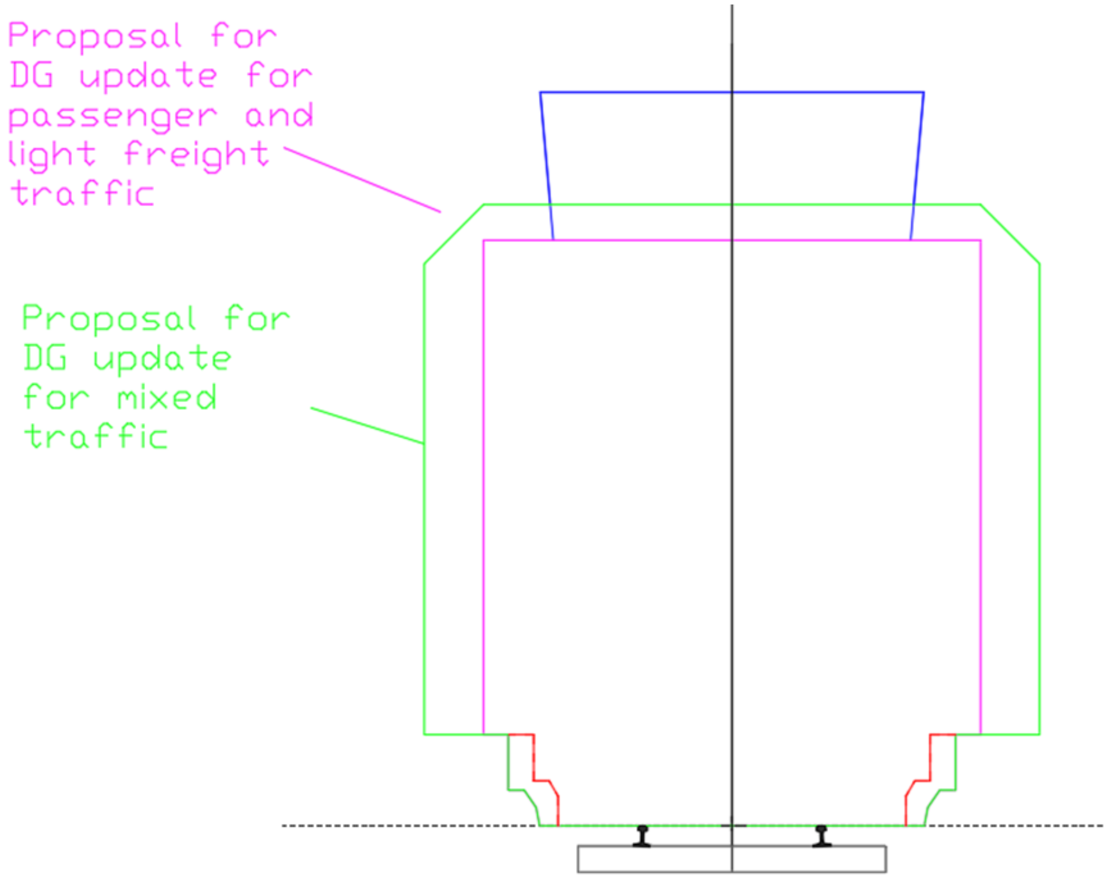
Figure 40: Proposal for RBDG-MAN-012 gauge update for mixed traffic



101.The proposed gauge for mixed traffic is compatible with the width from the Normal Sektion N (TRVINFRA-00398, K30153) that was applied so far in RBDG-MAN-012 4.2 and the middle part (at platform area 400-770mm) of the Minsta Section C (TRVINFRA-0398, K30186). The lower part is unified with that from the uniform gauge resulting from GI3 kinematic reference profile for the worst scenario.

102.The gauge width on the upper parts was extended to match 2.6m along the sides. The upper corners were not extended in order to avoid an increase in the height in comparison with the Normal Sektion N that was used in the design so far.

Figure 41: Comparison of proposed gauges for Mixed and Passenger only and light freight traffic

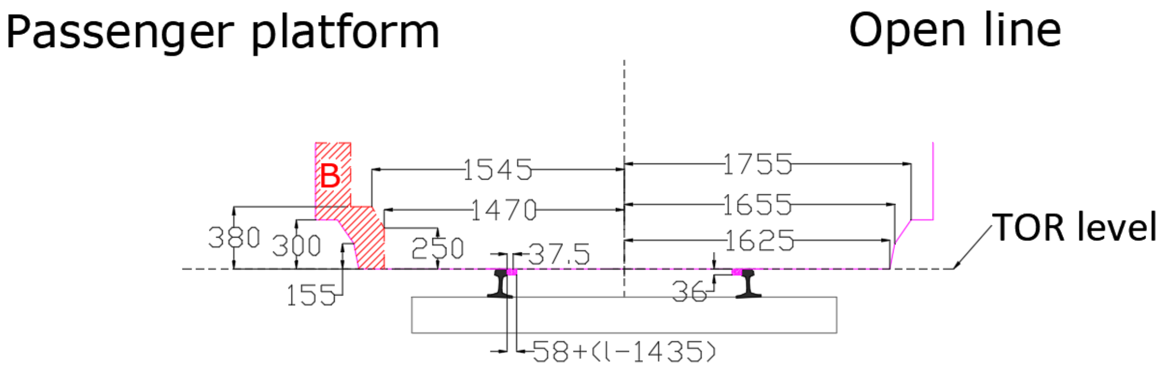


3. LOWER PARTS OF THE GAUGE

103. The lower part of the gauge is unified for both Mixed and Passenger and Light freight traffic sections, considering GI3 kinematic reference profile, without taking into account the free space up to 50mm above TOR as they are defined in the Swedish standard TRVINFRA00398. According to the calculations for the uniform gauge for Passenger and light freight traffic, the lower part is at TOR level for the worst case scenario tested for the network.

104. The resulting common gauge is proposed to be applied for lower parts, both for Mixed and Passenger only/Light freight Traffic sections.

Figure 42: Proposal for DG012 update for the lower part of the gauges



105.For specific locations on the network, the kinematic method according to EN15273-1, 2, 3 shall be applied for obtaining the exact dimensions for the respective horizontal and vertical geometry.