Railway Group Standard
GERT8073
Issue: 4.1 **Draft:** 1a
Date: December 2022

Application of Standard Vehicle Gauges

Synopsis

This document defines standard vehicle gauges and the associated application rules for rolling stock and for infrastructure.

Published by RSSB

Issue record

Issue	Date	Comments
One	01/04/2008	Original document. Replaces GE/GN8573 Guidance on Gauging, issue 1, Appendices 1, 2, 3, 4, 5, 6, 7, 8, 10, and 11.
Two	01/10/2009	Replaces issue one. Small scale change: The requirements in respect to the locomotive gauge in sections 2.13, 3.13 and Appendix L have been amended to correct technical errors and improve clarity.
Three	01/12/2015	Replaces issue two. Gauges for W11, UK1, C1, and Appendix A have been withdrawn. W10a, Passenger-Gauge 1 (20 m) (PG1), Passenger-Gauge 2 (23 m) (PG2) and Lower Sector Vehicle Gauge (LSVG) have been added. The methods of calculating dynamic movements of W6-W12 upper gauges and locomotive gauges have been revised to improve accuracy of clearances.
Four	05/12/2020	Replaces issue three. W9Plus has been withdrawn. New gauges W7a, W8a, W9a, PG3 and LG2 have been introduced. LSVG, PG1 and PG2 have been updated to reflect misunderstanding of the use of a 100mph vehicle as a limit of validity of the gauge. The method for calculating dynamic movements for W6a - W10a upper gauges has been further refined.Tripcock gauge has been modified.
4.1	03/12/2022 [proposed]	Replaces issue four. W6a, W7, W8, W9, W10 and W10a gauges have been updated to reinstate the issue three movement tables. W7a, W8a and W9a have been updated to clarify the interface between the upper and lower sector gauges. An error in the overthrow coefficients for LG2 has been corrected.

Revisions have been marked by a vertical black line in this issue.

Clauses and tables that are only renumbered have not been marked by a vertical black line in this issue.

References to Technical Specifications for Interoperability (TSIs) remain in this interim update of GERT8073. These will be updated to refer to National Technical Specification Notices (NTSNs) in the next full issue of GERT8073.

Superseded documents

The following Railway Group documents are superseded, either in whole or in part as indicated:

Superseded documents	Sections superseded	Date when sections are superseded
GERT8073 issue four Requirements for the Application of Standard Vehicle Gauges	All	03 December 2022 [proposed]

Supply

The authoritative version of this document is available at www.rssb.co.uk/standards-catalogue. Enquiries on this document can be submitted through the RSSB Customer Self-Service Portal https://customer-portal.rssb.co.uk/

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Part 1 Purpose and Introduction

1.1 Purpose

1.1.1 This document sets out requirements for standard vehicle gauges and the associated application rules for rolling stock and for infrastructure.

1.2 Introduction

1.2.1 Background

1.2.1.1 This is part of a suite of Railway Group Standards requirements, *1.2.4* and *1.2.5*, for maintaining adequate clearance between vehicles and adjacent structures and maintaining adequate passing clearance between vehicles and other vehicles operating on adjacent tracks.

1.2.1.2 The following standard vehicle gauges are defined in this document:

Vehicle Gauge	Typical Application
W6a Lower Gauge	Legacy lower sector gauge previously used for the design of freight wagons and On Track Machines (in their running mode).
Lower Sector Vehicle Gauge (LSVG)	Lower sector vehicle gauge for all vehicles
W6a Upper Gauge	Vehicle gauge for freight wagons and On Track Machines (in their running mode), W6a can also be a load gauge.
W7 Upper Gauge	Load gauges See J tables for wagon load combinations that comply with each of the gauges.
W7a Upper Gauge	
W8 Upper Gauge	
W8a Upper Gauge	
W9 Upper Gauge	
W9a Upper Gauge	
W10 Upper Gauge	
W10a Upper Gauge	

Vehicle Gauge	Typical Application
W12 Upper Gauge	Load gauge for containers - wagon specific
Passenger Gauge 1 (20 m) (PG1)	Vehicle gauge for 20 m passenger vehicles
Passenger Gauge 2 (23 m) (PG2)	Vehicle gauge for 23 m passenger vehicles
Passenger Gauge 3 (26 m) (PG3)	Vehicle gauge for 26 m passenger vehicles
Locomotive Gauge 1- LG1	Vehicle gauge for existing locomotives
Locomotive Gauge 2 - LG2	Vehicle gauge for new locomotives

Table 1: Standard Vehicle Gauges

1.2.1.3 The gauges defined in this document are not intended to be exhaustive. Not all gauges are compatible with all routes on the Great Britain (GB) network. As new gauges are developed, they should be proposed for inclusion within this document to ensure consistent application.

1.2.1.4 A number of the standard vehicle gauges defined in this document are long-established gauges and their associated rules have therefore been retained, but adapted to conform to the concepts set out in GIRT7073.

1.2.1.5 The gauges defined in this document do not include provision for pantographs. These requirements are set out in GMRT2173.

1.2.1.6 The gauges defined in this document are NOT compatible with the standard UIC / EN / TSI processes and are not to be considered as reference profiles within that methodology.

1.2.1.7 References to Technical Specifications for Interoperability (TSIs) are maintained in this document and these references will be updated to National Technical Specification Notices (NTSNs) in a future revision of GERT8073.

1.2.2 Principles

1.2.2.1 The requirements of this document are based on the following principles.

1.2.2.2 This document sets out requirements that meet the characteristics of National Technical Rules (NTRs) and are applicable to the Great Britain (GB) mainline railway system. Compliance with NTRs is required under the Railways (Interoperability) Regulations 2011 (as amended).

1.2.2.3 The NTRs in this document are used for the purpose of supporting GB or UK specific cases in Technical Specifications for Interoperability (TSIs).

1.2.3 Structure of this document

1.2.3.1 Where relevant, the national technical rules relating to relevant NTSN parameters have been identified together with the relevant clause from the NTSN.

1.2.3.2 This document sets out a series of requirements that are sequentially numbered. This document also sets out the rationale for the requirement, explaining why the requirement is needed and its purpose and, where relevant, guidance to support the requirement. The rationale and the guidance are prefixed by the letter 'G'.

1.2.3.3 Some subjects do not have specific requirements but the subject is addressed through guidance only and, where this is the case, it is distinguished under a heading of 'Guidance' and is prefixed by the letter 'G'.

1.2.4 Related requirements in other documents

1.2.4.1 The following Railway Group Standards contain requirements that are related to the scope of this document:

a) GIRT7073 Requirements for the Position of Infrastructure and for Defining and Maintaining Clearances – this document sets out requirements for positioning infrastructure and maintaining the position of track relative to infrastructure to achieve gauge compatibility with rolling stock.
b) GMRT2173 Size of Vehicles and Position of Equipment – this document sets out the methods of determining, and the requirements for maintaining, the swept envelope for rail vehicles. It sets out the format of the prescribed parameters for defining the size of railway vehicles.
c) GLRT1210 AC Energy Subsystem and Interfaces to Rolling Stock Subsystem – this document sets out the requirements for the AC energy system and the interface to rolling stock operating over the AC electrified railway.
d) GLRT1212 DC Conductor Rail Energy Subsystem and Interfaces to Rolling Stock Subsystem – this document sets out the requirements for the DC energy system and the interfaces to rolling stock operating over the DC electrified railway.

1.2.5 Supporting documents

1.2.5.1 The following Rail Industry Standards are harmonised with requirements in this Railway Group Standard:

a) RIS-2773-RST Format for Vehicle Gauging Data -This document provides a standard format for defining the data used for calculation of vehicle swept envelopes for the purposes of compatibility assessment when undertaking absolute or comparative gauging. It can also be used for the purposes of assessment against standard dynamic vehicle gauges.
b) RIS-8270-RST Route Level Assessment of Technical Compatibility between Vehicles and Infrastructure – this document sets out requirements and responsibilities for the assessment of compatibility of rolling stock and infrastructure.
c) RIS-8273-RST Assessment of Compatibility of Rolling Stock and Infrastructure - Gauging and Stepping Distances.

1.3 Approval and authorisation of this document

1.3.1 The content of this document was approved by Rolling Stock Standards Committee on 14 January 2022.

1.3.2 This document was authorised by RSSB on 28 October 2022 [proposed].

Part 2 Guidance on the application of Standard Vehicle Gauges

2.1 Introduction to gauges

Guidance

G 2.1.1 Gauging frequently refers to gauges, a term whose original definition related to an envelope in which a vehicle is to remain (vehicle gauge), or within which a structure is not to intrude (structure gauge), separated by a clearance.

G 2.1.2 RIS-8273-RST sets out the processes for the assessment of gauge compatibility, one of which is using standard vehicle gauges. Standard vehicle gauges, and their rules for application, are set out in this standard.

G 2.1.3 Gauges simplify the process of gauging. If all vehicles were built within a gauge, and structures constructed to be clear of that gauge in all circumstances, then the gauging process would simply involve ensuring track and structures retained their clearance to a gauge, and vehicles were maintained within the gauge over their service life.

G 2.1.4 The evolution of railways has meant that gauges that were originally fit for purpose no longer satisfy current business capacity needs. This has meant that progressively larger gauges have been developed.

G 2.1.5 In order to simplify the calculation process, some existing vehicles possess only basic swept envelope information that represents generalised input conditions. Such vehicles may have restricted gauge clearance due to the cautious approach that is adopted when considering them in gauging analysis. Advances in computer speed now allow rapid calculation of gauge clearances, which gives a more accurate assessment of the clearances that may exist for the individual input conditions to the vehicle at every location along a route and over the actual shape of the vehicle profile. It is therefore beneficial to enhance the swept envelope information for a vehicle to provide the detailed data required to permit more detailed modelling.

G 2.1.6 Modern advances in computer technology also enable vehicle swept envelopes to be calculated with greater confidence, so that they reflect the vehicle behaviours more accurately thus enabling clearances to be analysed more precisely. These advances enable better use to be made of the available capability of the infrastructure.

G 2.1.7 Standard Vehicle Gauges still have an important role in the design and maintenance of vehicles and infrastructure, permitting more advanced techniques to be used by exception.

G 2.1.8 An agreed method of specifying vehicle gauges is required to provide clarity to both infrastructure managers and railway undertakings for the construction and operation of new vehicles.

G 2.1.9 Gauges enable the Infrastructure Manager to define the space available for gauge-clearing a route and maintaining the route to that gauge.

2.2 Guidance on the types of vehicle gauges

Guidance

G 2.2.1 The gauges specified in this document consist of a profile, which is adjusted in accordance with the movements induced by cant, curve radius and / or speed.

G 2.2.2 For clarity, only principal dimensions and nominal numbered points are shown on the associated gauge diagrams.

G 2.2.3 Co-ordinates relate to the plane of the rails and to a datum on the track centreline.

G 2.2.4 There are three approaches to how these movements are expressed:

a) A profile valid for any cant, irrespective of speed - type D1 (W6a lower gauge).
b) A profile adjusted in accordance with the movements provided in the applicable Standard Vehicle Gauge Data workbook - type D2. The applicable workbook is identified with each of the gauges.
c) A profile within which a vehicle or vehicle and load must fit statically and when adjusted for overthrow and dynamic movements - type D3. Dynamic movements are provided in the applicable Standard Vehicle Gauge Data workbook.

Gauges	**Type**
W6a lower gauge	D1
Lower Sector Vehicle Gauge (LSVG)	D2
All Freight Upper gauges	D3
All Passenger Gauges	D2
Locomotive Gauge 1 (LG1)	D3
Locomotive Gauge 2 (LG2)	D2

Table 2: Types of Standard Vehicle Gauges

G 2.2.5 Standard Vehicle Gauge Data (SVGD) is defined for the application of dynamic movements in Excel™ workbooks. The SVGD workbooks (8073SVGD_______) are available through the GERT8073 Standards Catalogue entry or by searching on the RSSB website (www.rssb.co.uk).

Part 3 Requirements for the application of Standard Vehicle Gauges

3.1 Requirements for the application of Standard Vehicle Gauges to vehicles

3.1.1 Requirements for vehicle gauge declaration

3.1.1.1 For W6a Lower gauge (type D1 gauge), the vehicle shall be contained within the dynamic gauge line on relevant track geometry, considering all tolerances and suspension movements.

3.1.1.2 For type D2 gauge, the vehicle body, adjusted for dynamic movements and overthrow, shall remain within the dynamic gauge profile under all conditions. Dynamic movements shall include lateral, vertical and roll movements, applying the mean plus 2.12 standard deviations.

3.1.1.3 For type D3 gauge, the static profile of the vehicle or load, plus the fastening tolerances, shall fit within the base profile with no movements or overthrow applied.

3.1.1.4 For type D3, The vehicle or load profile, adjusted for dynamic movements, shall fit within the dynamic gauge profile. Dynamic movements shall be calculated by applying the mean plus 2.12 standard deviations.

3.1.1.5 For type D3 gauge, overthrows shall not be greater than the overthrows allowed for in the gauge, or width / height reduction shall be applied.

3.1.1.6 Where wheel / rail flange clearance limits are exceeded, the gauge line shall be reduced to account for the effects.

Rationale

G 3.1.1.7 Specific cases 7.3.2.2. of the LOC & PAS TSI, 7.7.17.1. of the INF TSI and 7.3.2.1a of the WAG TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 3.1.1.8 The rules defined in this document form part of a suite of gauging requirements that manage the risk of collision of vehicles with infrastructure and vehicles with other vehicles.

Guidance

G 3.1.1.9 This section defines general requirements for the application of the standard vehicle gauges to vehicles; specific application rules for each gauge are set out in parts 4, 5, 6 and 7 of this standard.

G 3.1.1.10 For each D2 type gauge, the dynamic gauge profile is calculated using the dynamic movements in the applicable Standard Vehicle Gauge Data (SVGD) and the application rules defined under each gauge (see parts 4, 5, 6 and 7). The SVGD workbook applicable to each gauge is set out in Table *3* for quick reference.

Workbook	**Applicable gauges**
8073SVGD - LSVG	LSVG

Workbook	**Applicable gauges**
8073SVGD - W6a	W6a
8073SVGD - W7	W7
8073SVGD - W7a	W7a
8073SVGD - W8	W8
8073SVGD - W8a	W8a
8073SVGD - W9	W9
8073SVGD - W9a	W9a
8073SVGD - W10	W10
8073SVGD - W10a	W10a
8073SVGD - W12	W12
8073SVGD - PG1	PG1
8073SVGD - PG2	PG2
8073SVGD - PG3	PG3
8073SVGD - LG1	LG1
8073SVGD - LG2	LG2

Table 3: Standard Vehicle Gauge Data workbooks

G 3.1.1.11 The requirements for deriving the swept envelope of the vehicle are set out in GMRT2173.

G 3.1.1.12 A vehicle can be shown to comply with the gauge if the vehicle profile is inside the base profile, and overthrow on curved track and vehicle movements do not exceed the benchmark suspension movements in the relevant SVGD workbook.

G 3.1.1.13 Where the vehicle dimensions, (bogie centres, axle spacing or length), exceed those allowed for by the gauge, width / height reductions can be applied to the vehicle in order to meet the requirements of the gauge.

G 3.1.1.14 For a D3 type gauge, it is possible to fit within the dynamic gauge profile by using a benchmark or established suspension, or by demonstrating that dynamic movements are no greater than the benchmark movements. Where movements are larger than the benchmark movements, width / height reduction can be applied to fit within the gauge.

G 3.1.1.15 The SVGD workbooks (8073SVGD______) are available through the GERT8073 Standards Catalogue entry or by searching on the RSSB website (www.rssb.co.uk).

G 3.1.1.16 Where de-mountable loads are used, the fixity of such loads is considered relative to the allowances provided for in the gauge (if any).

G 3.1.1.17 Limits on wheel flange wear and nominal wheel / rail clearance are delivered by compliance with the requirements for wheelsets set out in GMRT2466.

3.2 Requirements for the application of Standard Vehicle Gauges to Infrastructure

3.2.1 Gauge declaration for Infrastructure

3.2.1.1 For a route or section of a route to be declared as cleared for a standard vehicle gauge, as set out in table *1*, it shall be assessed using the application rules defined alongside each gauge.

3.2.1.2 For dynamic (type D1 gauge) gauges, the 'gauge line incorporating dynamic movements' shall be used.

3.2.1.3 For dynamic (type D2 gauge) gauges, movements shall be applied to the gauge using the applicable Standard Vehicle Gauge Data, considering local conditions of curvature, cant and speed (see table *3*). Dynamic movements shall include lateral, vertical and roll movements, applying the mean plus 2.12 standard deviations.

3.2.1.4 Where wheel / flange clearance limits are specified, the dynamic gauge profile shall be enlarged laterally to accommodate these.

3.2.1.5 Where the gauge is subject to overthrow, the dynamic gauge profile shall be enlarged laterally and vertically in accordance with the rules defined in the application of the gauge to rolling stock and infrastructure.

3.2.1.6 Where specified, tolerances and allowances shall be added to the dynamic gauge profile.

3.2.1.7 Required infrastructure clearances, defined in GIRT7073, shall be provided between the dynamic swept envelope and the infrastructure.

Rationale

G 3.2.1.8 Specific cases 7.3.2.2 of the LOC & PAS TSI, 7.7.17.1 of the INF TSI and 7.3.2.1a of the WAG TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 3.2.1.9 The rules defined in this document form part of a suite of gauging requirements that manage the risk of collision of vehicles with infrastructure and vehicles with other vehicles.

Guidance

G 3.2.1.10 This section defines general requirements for the application of the standard vehicle gauges to infrastructure; specific application rules for each gauge are set out in parts 4, 5, 6 and 7 of this standard.

G 3.2.1.11 For all gauges it is necessary to generate the dynamic swept envelope at the specific infrastructure location.

G 3.2.1.12 Route clearance assessments consider outside/inside of curves and upper and lower sector worst cases. This would generally be undertaken using computer simulation.

G 3.2.1.13 On transition curves, consideration is given to the conditions leading to maximum dynamic movement, and applied appropriately.

G 3.2.1.14 For each gauge, formulae are provided to calculate overthrow on curves, which use the following nomenclature:

- T_i is the overthrow towards the inside of the curve in mm.
- T_o is the overthrow towards the outside of the curve in mm.
- R is the curve radius in m.

3.2.2 Requirements for clearances

3.2.2.1 Clearances shall be calculated relative to the dynamic swept envelope, including appropriate dynamic movements, overthrows and applicable allowances as set out in GMRT2173.

3.2.2.2 Where dynamic movements are not calculated with reference to the characteristics of a standard suspension, clearances shall be adjusted to include the effects of 12.5 mm wheel / rail clearance.

Rationale

G 3.2.2.3 Specific cases 7.3.2.2. of the LOC and PAS TSI and 7.7.17.1. of the INF TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 3.2.2.4 The rules defined in this document form part of a suite of gauging requirements that manage the risk of collision of vehicles with infrastructure and vehicles with other vehicles.

Guidance

G 3.2.2.5 Clearances required are set out in GIRT7073.

G 3.2.2.6 It is important to consider all possible additional movements due to tolerances and wear.

Part 4 Gauges applicable to the lower sector

4.1 W6a lower gauge

4.1.1 Definition of W6a lower gauge

4.1.1.1 The W6a lower gauge, defined by the co-ordinates in table *4*, shall be used in accordance with the application rules set out in *4.1.2* and *4.1.3*.

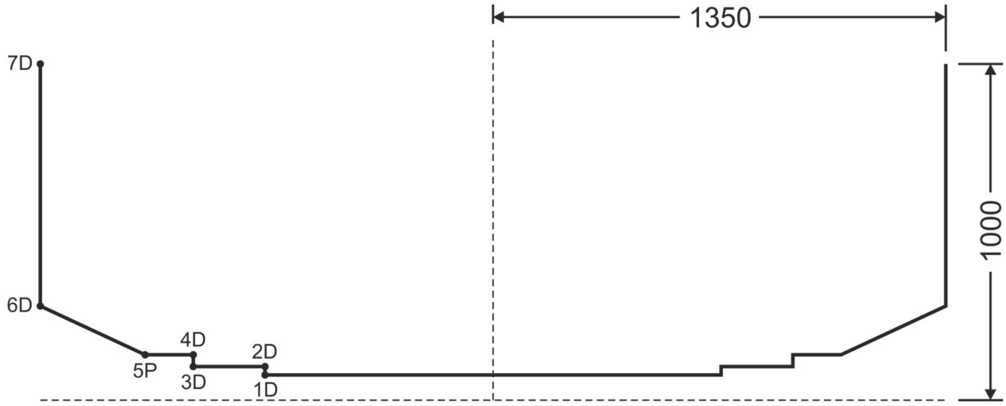


Figure 1: W6a Lower Gauge diagram

Point	X (mm)	Y (mm)
1D	680	75
2D	680	100
3D	894	100
4D	894	135
5P	1037.5	135
6D	1350	280
7D	1350	1000

Table 4: W6a Lower Gauge co-ordinates, incorporating dynamic movements

Rationale

G 4.1.1.2 Specific cases 7.3.2.2. of the LOC & PAS TSI, 7.7.17.1. of the INF TSI and 7.3.2.1a of the WAG TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 4.1.1.3 These requirements ensure that the largest possible swept envelope for the vehicle is accommodated within the gauge, and therefore compatible with infrastructure that has been declared compliant to the gauge.

Guidance

G 4.1.1.4 W6a Lower Gauge represents the lower part of the W6a 'standard' freight vehicle gauge, which is compatible with a significant proportion of the GB railway network in the lower sector. W6a freight lower gauge was originally published in document PO/CL527 (BR DM&EE Department, 20 September 1990).

G 4.1.1.5 The gauge line is a dynamic gauge line (type D1 gauge), see section *2.2*, which defines the extreme envelope that may be occupied on straight and level track for all relevant speeds, with fully displaced and worn suspension. Rules take into account some additional movement due to defined overthrow.

G 4.1.1.6 GERT8073 issue two provided co-ordinates 5D and 5P, where 5P was an option that provided for a 'bigger' vehicle envelope, but could only be utilised for OTMs. With the widespread network compatibility for W6a utilising the 5P co-ordinate, the 5D co-ordinate was removed in GERT8073 issue three to enable all freight vehicles to use the 5P co-ordinate.

G 4.1.1.7 GMRT2173 sets out requirements and limitations for the continued use of W6a beyond December 2021. The requirements in GMRT2173 were established in order to encourage the general migration to using Lower Sector Vehicle Gauge (LSVG).

G 4.1.1.8 For W6a, the location of the wheels is not shown. Requirements for wheelset back-to-back and wheel rim width dimensions are set out in GMRT2466 and are compatible with the Lower Sector Infrastructure Gauge (See GIRT7073). Other items which, are in close proximity to the wheels (e.g. life guards or sander nozzles) also use this space.

4.1.2 Application of W6a lower gauge to rolling stock

4.1.2.1 Any part of the vehicle that falls below 1000 mm above rail level (ARL) dynamically, including suspension failure conditions, shall be contained within the area bounded by the co-ordinates incorporating dynamic movements, including:

a) Full lateral suspension travel and wear limits.
b) Full downward vertical suspension movements to bumpstop condition and wear.
c) Lateral curve overthrows.
d) Vertical curve overthrows in planes at 75 mm, 100 mm and 135 mm above rail level (ARL) (points 1 D to 5 P) when on a vertical curve of 500 m radius.
e) Radial wheel wear.

4.1.2.2 Any part of the vehicle that falls below 1000 mm above rail level (ARL), statically or dynamically, shall be contained within the gauge.

4.1.2.3 The gauge shall be adjusted for lateral overthrow on curves below 360m radius, points 6D and 7D shall be increased laterally to provide a maximum semi width as follows:

a) < 360 m radius, 0 mm (maximum semi-width of 1350 mm).
b) 200 m radius, 60 mm (maximum semi-width of 1410 mm).
c) 160 m radius, 100 mm (maximum semi-width of 1450 mm).

4.1.2.4 The following shall not be included:

a) Vehicle roll movements.

b) Axle guard / horn guide deflections.
c) Wheel flange wear and wheel / rail clearance.

Rationale

G 4.1.2.5 Specific cases 7.3.2.2 of the LOC & PAS TSI, 7.7.17.1 of the INF TSI and 7.3.2.1a of the WAG TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 4.1.2.6 These requirements ensure that the largest possible swept envelope for the vehicle is accommodated within the gauge and therefore compatible with infrastructure that has been declared compliant to the gauge.

Guidance

G 4.1.2.7 The maximum semi-width of the vehicle is calculated from the static vehicle profile, plus lateral suspension travel and lateral suspension interface wear.

G 4.1.2.8 For W6a lower gauge only, overthrows are calculated using the following formulae:

$T_i = \frac{(AN_i - N_i^2)}{2R}$, $T_o = \frac{(AN_o + N_o^2)}{2R}$ where;

- T_i is inner throw in metres.
- T_o is end throw in metres.
- A is bogie centres in metres.
- N_i/N_o is the distance in metres from the nearest axle or bogie centre.
- R is curve radius in metres.

4.1.3 Application of W6a lower gauge to infrastructure

4.1.3.1 The W6a lower gauge shall not be adjusted for horizontal curve overthrow on curves of greater than or equal to 360 m radius.

4.1.3.2 The W6a lower gauge shall be enlarged for horizontal curve overthrow on curves of less than 360 m radius and greater than or equal to 200 m radius using the following formulae: $T_i = \left(\frac{27000}{R}\right) - 75$, $T_o = \left(\frac{27000}{R}\right) - 75$

4.1.3.3 The W6a lower gauge shall be enlarged for horizontal curve overthrow on curves of less than 200 m radius and greater than or equal to 160 m radius using the following formulae: $T_i = \left(\frac{32000}{R}\right) - 100$, $T_o = \left(\frac{32000}{R}\right) - 100$

4.1.3.4 The W6a lower gauge shall be enlarged for vertical curve overthrow on curves of less than 500 m radius using the following formulae: $T_i = \frac{21085}{R}$, $T_o = \frac{20480}{R}$

Rationale

G 4.1.3.5 Specific cases 7.3.2.2 of the LOC & PAS TSI, 7.7.17.1. of the INF TSI and 7.3.2.1a of the WAG TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 4.1.3.6 These requirements ensure that the largest possible swept envelope is considered in the assessment of gauge compatibility with the infrastructure.

Guidance

G 4.1.3.7 The formulae generate lateral throws at different curve radii from 360 m down to 160 m. The throws are added to the base profile to generate the maximum width of the gauge.

G 4.1.3.8 The gauge is also enlarged for vertical curves with radius of less than 500 m.

4.2 Lower Sector Vehicle Gauge

4.2.1 Definition of Lower Sector Vehicle Gauge

4.2.1.1 Lower Sector Vehicle Gauge (LSVG), defined by the co-ordinates in table *5*, shall be used in accordance with the application rules set out in *4.2.2* and *4.2.3*.

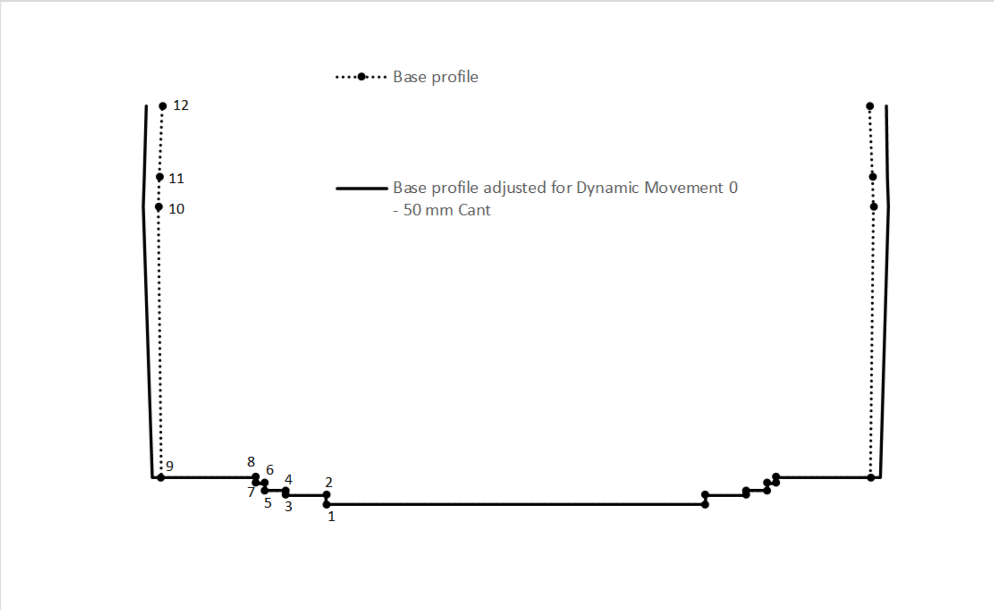


Figure 2: LSVG base profile diagram

Point	X(mm)	Y (mm)
1	679.5	75
2	679.5	101.5
3	825.5	101.5
4	825.5	114
5	900.5	114
6	900.5	135
7	932.5	135
8	932.5	152
7a	998	135
8a	1050	152
9	1272.2	150.5
10	1282.3	915.1
11	1277.8	1000
12	1267.1	1199.7

Table 5: LSVG co-ordinates, the co-ordinates represent the base profile

Note: Co-ordinates 7a and 8a to be used in place of 7 and 8 except for lines with 3rd and 4th rail DC conductor rails.

Rationale

G 4.2.1.2 Specific cases 7.3.2.2 of the LOC & PAS TSI, 7.7.17.1 of the INF TSI and 7.3.2.1a of the WAG TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 4.2.1.3 These requirements ensure that the largest possible swept envelope for the vehicle is accommodated within the gauge and is therefore compatible with infrastructure that has been declared compliant to the gauge.

G 4.2.1.4 LSVG was derived to provide normal clearances with the standard lower sector infrastructure gauge (LSIG). The objective of developing LSVG was to reduce costs associated with gauging analysis for vehicle introduction and cascade, at the same time as providing a good trade-off between maximising the size of the vehicle and recognising the constraints due to the existing infrastructure.

Guidance

G 4.2.1.5 LSVG is a lower sector vehicle gauge for rolling stock and it is compatible with lower sector infrastructure gauge (see GIRT7073).

G 4.2.1.6 The gauge diagram shows the base profile with the dotted line: this is the profile to which the dynamic movements are applied. For illustrative purposes, the solid line shows the gauge line adjusted with movements applied for 0 mm to 50 mm cant.

G 4.2.1.7 There is no requirement to build to the base profile. Dynamic movements are applied in all cases, therefore the build profile will be larger than the base profile. Dynamic movements are applied in accordance with workbook 8073SVGD - LSVG. See Appendix *B*.

G 4.2.1.8 LSVG was developed in the RSSB research project *T977 (2012)*, using the dynamic characteristics typical of a 160 km/h (100 mph) vehicle with soft suspension characteristics. This was revisited in 2016 (*Passenger Gauge 1, Passenger Gauge 2 and Lower Sector Vehicle Gauge Revision)* to provide movements for the gauge up to 200 km/h (125 mph). LSVG has been established based upon a notional 20 m long bodyshell, 14.173 m bogie centres and 2.6 m axle spacing on a minimum curve radius of 160 m.

G 4.2.1.9 The line between 152 mm ARL and 915 mm ARL was derived based on the number of platforms that exist with a riser wall directly below (flush faced) the platform edge corner (i.e. no recess is provided), and which are located on curved and canted track. With the requirement to maintain platform stepping distances, the bottom corner of the vehicle gauge is moved closer to the platform riser wall, which can compromise the clearance. To manage this effect, the line is sloped inwards a calculated amount to reflect 110 mm of cant on a track adjacent to a platform with a flush faced riser wall.

G 4.2.1.10 For LSVG, the location of the wheels is not shown. Requirements for wheelset back-to-back and wheel rim width dimensions are set out in GMRT2466, and are compatible with the lower sector infrastructure gauge. Other items which are in close proximity to the wheels (e.g. life guards or sander nozzles) also use this space.

4.2.2 Application of LSVG to rolling stock

4.2.2.1 The vehicle, including dynamic movements, overthrows and tolerances, shall remain within the LSVG dynamic gauge profile (including all LSVG dynamic allowances, allowed overthrows and tolerances as set out in Standard Vehicle Gauge Data workbook 8073SVGD – LSVG) for all the full range of operating conditions, speeds, cant deficiencies and curvatures (vertical and lateral) that the vehicle will see in service.

4.2.2.2 The gauge co-ordinates shall be adjusted for horizontal curve overthrow as follows:

a) R ≥ 360 m radius - 0 mm.

b) R < 360 m radius - Points 9 to 12 shall be adjusted for horizontal curve overthrow using the following formulae: $T_i = \left(\frac{26000}{R}\right) - 72$, $T_o = \left(\frac{26000}{R}\right) - 72$

4.2.2.3 Where the applicable upper gauge overlaps the lower gauge, the upper gauge shall become the applicable gauge line. Where no upper sector gauge is specified and absolute gauging is used, compliance with LSVG is required up to the interface with the vehicle swept envelope, and this point shall be defined.

Rationale

G 4.2.2.4 Specific cases 7.3.2.2 of the LOC & PAS TSI, 7.7.17.1 of the INF TSI and 7.3.2.1a of the WAG TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 4.2.2.5 These requirements ensure that the largest possible swept envelope for the vehicle is accommodated within the gauge and is therefore compatible with infrastructure that has been declared compliant to the gauge.

Guidance

G 4.2.2.6 For further guidance on the application of dynamic movements see Appendix *B*

G 4.2.2.7 In applying dynamic movements to LSVG, only Points 9 to 12 of the base profile are adjusted.

4.2.3 Application of LSVG to infrastructure

4.2.3.1 The gauge co-ordinates shall be adjusted for horizontal curve overthrow as follows:

a) R ≥ 360 m radius - 0 mm.

b) R < 360 m radius - Points 9 to 12 shall be adjusted for horizontal curve overthrow using the following formulae: $T_i = \left(\frac{26000}{R}\right) - 72$, $T_o = \left(\frac{26000}{R}\right) - 72$

4.2.3.2 The LSVG base profile shall be further enlarged for dynamic movements relating to cant and wheelset movements depending on curve radius, in accordance with the values given in Standard Vehicle Gauging Data workbook 8073SVGD - LSVG.

Rationale

G 4.2.3.3 Specific cases 7.3.2.2 of the LOC & PAS TSI, 7.7.17.1 of the INF TSI and 7.3.2.1a of the WAG TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 4.2.3.4 These requirements ensure that the largest possible swept envelope is considered in the assessment of gauge compatibility with the infrastructure.

Guidance

G 4.2.3.5 For further guidance relating to overthrow on curves see Appendix *A*.

G 4.2.3.6 Although LSVG is applicable on curves down to 160m, overthrow values are included in the LSVG SVGD workbook to allow special assessment of infrastructure on curves below this. Note that LSVG compliant vehicles with long bogie centres may have smaller clearances than LSVG on curves below 160m due to increased curve overthrow.

G 4.2.3.7 For further guidance on the application of dynamic movements see Appendix *B*

4.3 Supplementary lower sector vehicle gauges

4.3.1 Swept envelope for shoegear

4.3.1.1 Shoegear and associated equipment shall remain within the swept envelope set out in Figure *3*, when subject to the following two sets of conditions:

a) Case A: Displacements towards the outside of a curve:

   i) The curve overthrows resulting from a 160 m radius simple curve.
   ii) The displacements when operating at the speed which produces maximum design cant deficiency with an installed track cant of 150 mm.

b) Case B: Displacements towards the inside of a curve:

   i) The curve overthrows resulting from a 160 m radius simple curve.
   ii) The displacements when operating at a speed of 3 mph (5 km/h) with an installed track cant of 150 mm.

Note: Conditions i) and ii) in each of the two cases are independent conditions and are not intended to be co-incident. Requirements for track geometry design, including the combination of curvature and cant are set out in GCRT5021.

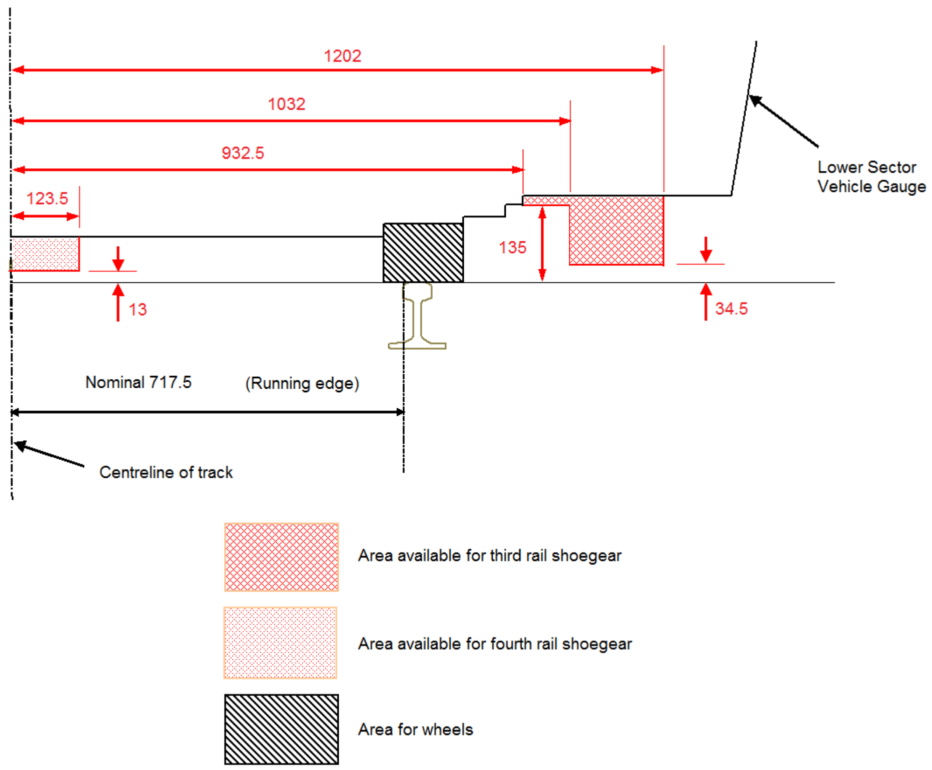


Figure 3: Swept envelope for shoegear

Rationale

G 4.3.1.2 There is a need for some equipment to exist in the space between Lower Sector Vehicle Gauge (LSVG) and Lower Sector Infrastructure Gauge (LSIG) in order to fulfil their functions. It is important that the positions of these equipment are controlled for technical compatibility with the infrastructure.

Guidance

G 4.3.1.3 As part of RSSB Research project *T977 (2012)* to develop the LSVG, the area available for shoegear was also assessed and revised (see Figure 4). There were two changes made to the space available for shoegear:

a) Above the 3rd rail location - The lowest point above rail level (ARL) was lowered from 50 mm to 34.5 mm, to align with an existing derogation (10-218-DGN) to enable good current collection forces.
b) Adjacent to the 3rd rail location - The lowest point ARL was lifted from 105 mm to 135 mm ARL. The reason for increasing the height was due to a tolerance review that concluded that the installation height of the 3rd rail guard board could reach 108 mm. This meant that theoretically existing vehicles compliant to the 105 mm height could have a 3 mm foul condition with the guard boards, (and possibly more if the 3rd rail mounting is not on the same sleeper as the running rail). For this reason, a 25 mm 'Normal' clearance value (for the lower sector) was added to the 108 mm height giving a new shoegear area height of 133 mm. This was then

increased by 2 mm to fall in line with one of the step change heights at 135 mm on the LSVG (and W6a lower sector gauge).

G 4.3.1.4 The 3 mm theoretical foul to the old height of 105 mm is not considered to be a safety concern, as these dimensions have been used for many years and no complaints have been raised regarding correctly maintained shoegear contacting correctly maintained guard boarding.

G 4.3.1.5 For the foul to occur, both the rolling stock and the infrastructure parameters would have to be at the extreme of their movements, (such as: vehicle loading, wheel wear, dynamic movements, curve overthrow, rail wear, guard board size and installation tolerances etc.), so the probability of contact occurring is extremely low.

G 4.3.1.6 Additional control measures may need to be identified as part of the route compatibility assessment (RIS-8270-RST). Additional controls may include physical modification to the infrastructure, vehicle and/or implementation of operational controls.

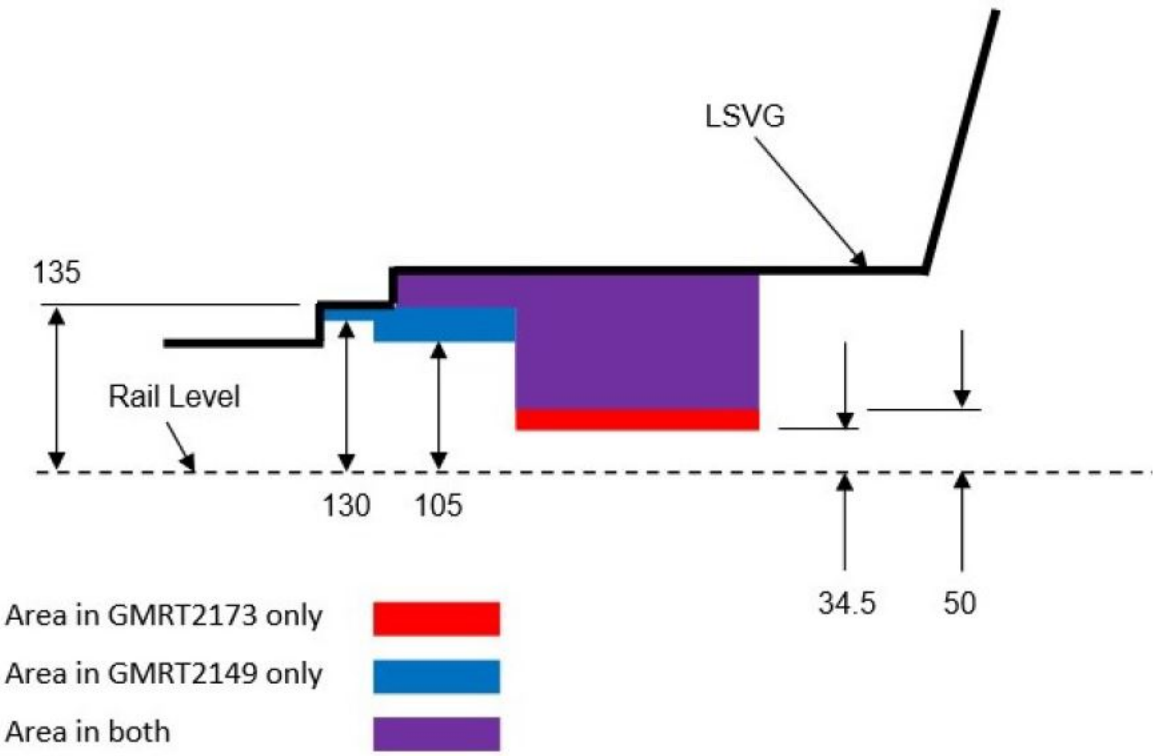


Figure 4: Changes in the area reserved for shoegear between GMRT2149 and GMRT2173

4.3.2 Location of tripcocks

4.3.2.1 Tripcocks, provided to initiate an emergency brake application in the event of the train passing a signal at danger, shall remain within the zone designated by the points 1 to 7 shown in Figure 5 under all conditions.

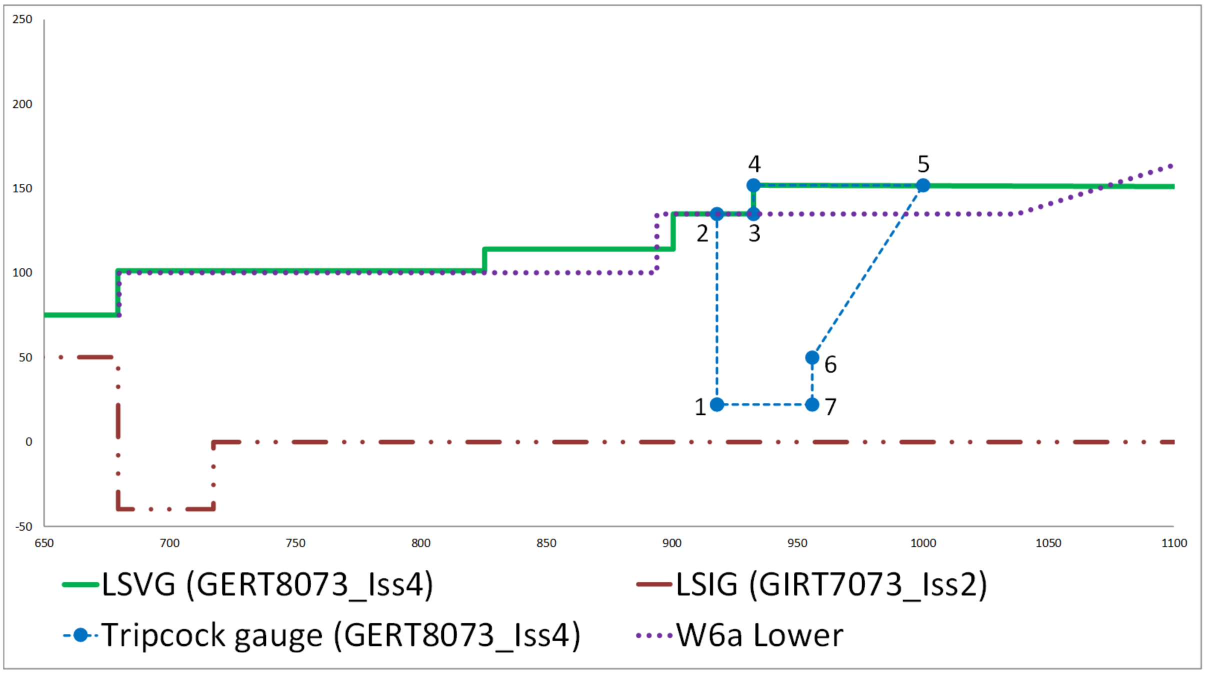


Figure 5: Area reserved for tripcocks

Point	X (mm)	Y (mm)
1	918	22
2	918	135
3	932.5	135
4	932.5	152
5	1000	152
6	956	50
7	956	22

Table 6: Co-ordinates for the area reserved for tripcocks

Rationale

G 4.3.2.2 There is a need for some equipment to exist in the space between Lower Sector Vehicle Gauge (LSVG) and Lower Sector Infrastructure Gauge (LSIG) in order to fulfil its function. It is important that the position of this equipment is controlled for technical compatibility with the infrastructure.

G 4.3.2.3 Tripcocks are necessary to operate safely on systems with trainstops, where together they mitigate risks associated with signals passed at danger. The position of the tripcock is controlled to ensure that it correctly interfaces with the trainstop when in operation, and remains compatible with other features of the infrastructure.

Guidance

G 4.3.2.4 It is important to consider lateral curve overthrow, vertical static wheel wear and vertical displacements due to axlebox pitch movements (when significant).

G 4.3.2.5 The gauge line for the location of tripcocks has been modified to eliminate the potential conflict between tripcocks, conductor rail guard boards and automatic power control (APC) magnets (see Figure 6).

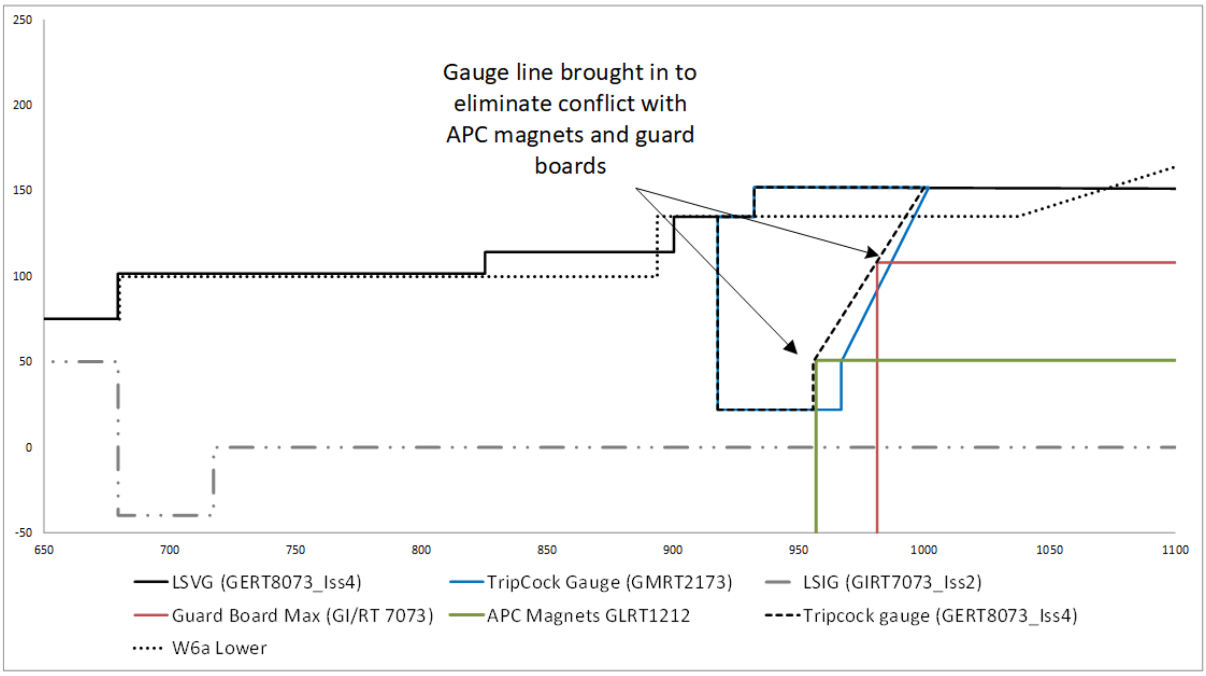


Figure 6: Modification to the area reserved for tripcocks

G 4.3.2.6 On vehicles where tripcocks are fitted it is important to consider the potential conflict with some other parts of the infrastructure. Conductor rail side entry ramps at the limits of their allowable position can conflict with the allowable position of the tripcock (see Figure 7).

G 4.3.2.7 Whilst conductor rail side entry ramps are not permitted where tripcocks are operational (see GLRT1212), a conflict may arise where vehicles with tripcocks fitted traverse across different infrastructure systems, e.g. On Track Machines working across both Network Rail and TfL infrastructure.

G 4.3.2.8 Additional control measures may need to be identified as part of the route compatibility assessment (RIS-8270-RST). Additional controls may include physical modification to the infrastructure, vehicle and/or implementation of operational controls for tripcock deployment.

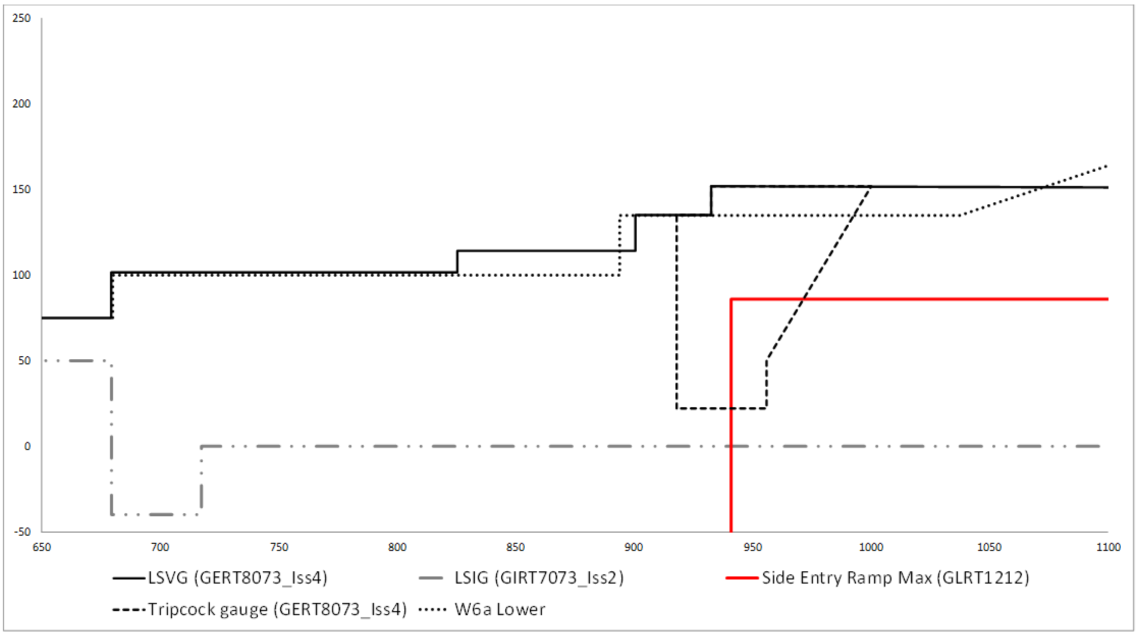


Figure 7: Tripcock relative to permitted location of conductor rail side entry ramp

4.3.3 Equipment permitted in the area for wheels

4.3.3.1 Equipment designed to be located close to the rail in order to fulfil its function shall remain within the area for wheels as shown in figure *3*.

Rationale

G 4.3.3.2 There is a need for some equipment to exist in the space between Lower Sector Vehicle Gauge (LSVG) and Lower Sector Infrastructure Gauge (LSIG) in order to fulfil its function. It is important that the position of this equipment is controlled for technical compatibility with the infrastructure.

Guidance

G 4.3.3.3 Most gauging requirements relate to the provision of adequate structure and passing clearances. Clearly, the interaction of wheels and running rails is based on managed contact and is outside the scope of this document. However, some systems utilise equipment which is shared between rolling stock and infrastructure, and rely on the equipment remaining in close proximity or being in contact in order for it to function correctly.

G 4.3.3.4 Types of equipment that need to occupy this space include: lifeguards, sanding equipment and magnetic track brakes.

G 4.3.3.5 Requirements for wheelset back-to-back and wheel rim width dimensions are set out in GMRT2466, and are compatible with the lower sector infrastructure gauge.

G 4.3.3.6 The area for wheels was derived from GMRT2466 requirements for wheelsets. This area is available for wheels and other items in close proximity to the wheels.

Part 5 Freight gauges applicable to the upper sector

5.1 General guidance on the application of freight upper gauges

Guidance

G 5.1.1 The freight upper gauges are dynamic gauges. They consist of a base profile and a set of rules defining allowable overthrow and dynamic movements.

G 5.1.2 For the freight gauges, vehicle / load compliance is achieved by separately demonstrating all of the following:

a) The static profile of the the load, plus the fastening tolerances, fitting within the base profile.
b) The vehicle or load fitting within the dynamic gauge profile, with dynamic movements applied.
c) The overthrows are no greater than the overthrows allowed for in the gauge, or width / height reductions are applied.

G 5.1.3 All freight gauges relate to a standard vehicle configuration. Where bogie centres, vehicle lengths, axle spacings or dynamic movements vary beyond those specified for the gauge, width reduction is applied to ensure that the dynamic gauge profile does not exceed that of the standard configuration. Freight containers are of standard sizes and, although they have different widths, the containers themselves cannot be width reduced.

G 5.1.4 Where the configuration of a vehicle differs considerably from the standard configuration, such as having articulation, it is important to consider changes of curvature that may occur within the length of the vehicle, e.g. at switches and crossings and on transition curves.

G 5.1.5 Each gauge set out in this section of the document defines which standard vehicle gauging data to apply for dynamic movements.

G 5.1.6 Research project *T1109 (2017)* developed a new set of benchmark movement characteristics for freight bogies and described a method for determining whether new bogies were compatible with these benchmarks, these fourth generation benchmarks are used in the the new gauges W7a, W8a and W9a. (see Appendix *C* for further guidance).

G 5.1.7 The new benchmark movement characteristics were determined for a range of traditional and low track force freight bogies using multi-body simulations, which were used to define a series of benchmark characteristics. These movement characteristics are set out in the Standard Vehicle Gauging Data workbooks for W7a, W8a and W9a.

G 5.1.8 The freight bogie types, used to develop the benchmark movement characteristics, are set out in research project T1109 (2017) and have demonstrated that they are compatible with the benchmark movement characteristics for W7a, W8a and W9a.

G 5.1.9 W12 gauge is a wagon specific gauge; the gauge is adjusted for dynamic movements in accordance with Standard Vehicle Gauge Data workbook 8073SVGD - W12, applying the worksheets specific to the wagon suspension type.

G 5.1.10 Wagon–load combinations deemed compliant with each gauge are published alongside this standard. The current definitive register of wagon–load combinations are set out in the J tables. The J tables can also be found by searching on the RSSB website (www.rssb.co.uk).

5.2 Requirements for tolerances associated with the fastening fixity for demountable loads

5.2.1 Where demountable loads are carried (e.g. ISO containers), the tolerances for fastening fixity shall be used in accordance with Table *7*.

Fastening Type	**Tolerances**
Twistlock fastenings	± 6 mm
Holland autolock fastenings	± 6 mm
UIC spigots	± 12.5 mm

Table 7: Fastening type tolerances

5.2.2 When new fastenings are introduced, their fixity tolerance shall be determined and used.

5.2.3 For each of the freight gauges set out in this section of the standard, the fastenings for demountable loads that have been used to define the gauge are stated. Where a different fastening system is used, the width of container allowed to be carried by the wagon shall be reduced by the difference in the tolerance between the fastening used and that already accommodated by the gauge.

Rationale

G 5.2.4 Specific cases 7.3.2.2 of the LOC & PAS TSI, 7.7.17.1 of the INF TSI and 7.3.2.1a of the WAG TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 5.2.5 Different fastening types for demountable loads allow for a different amount of free movement, which can impact on the size of the gauge. These requirements ensure that the largest possible swept envelope for the vehicle is accommodated within the gauge and is therefore compatible with infrastructure that has been declared compliant to the gauge.

Guidance

G 5.2.6 Further information on the mechanical requirements of fastenings for demountable loads can be found in *GMGN2688 Guidance on Designing Rail Freight Wagons for use on the GB Mainline Railway*.

5.3 W6a upper gauge

5.3.1 Definition of W6a upper gauge

5.3.1.1 The W6a upper gauge base profile, defined by the co-ordinates in table 8, shall be used in accordance with the application rules set out in 5.3.2 and 5.3.3. W6a upper gauge is based upon wagons with bogie centres or axle spacing of 12.8 m and a bogie wheelbase of up to 2.2 m.

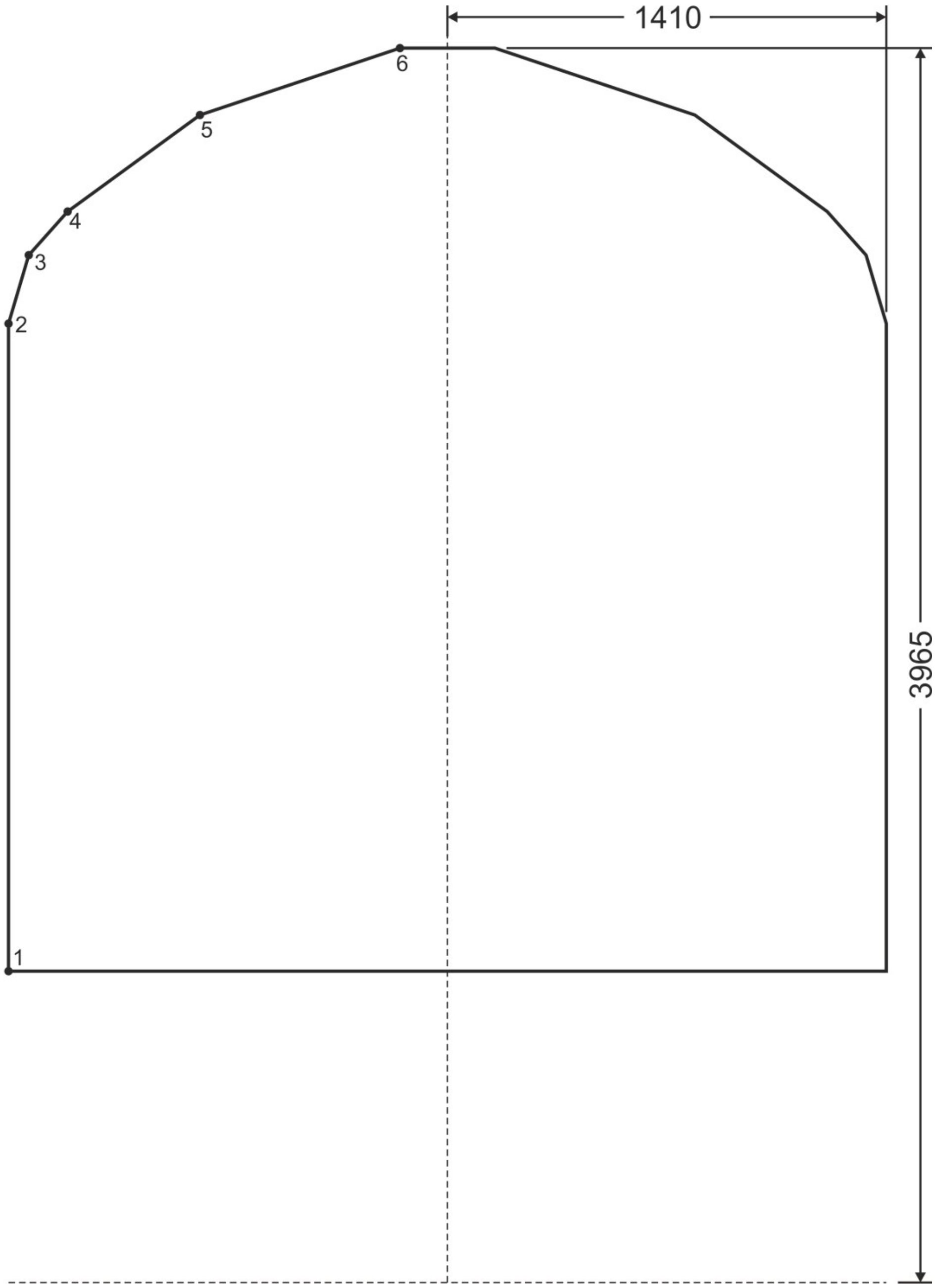


Figure 8: W6a upper gauge diagram

Point	X (mm)	Y (mm)
1	1410	1000
2	1410	3080
3	1345	3300
4	1220	3440
5	795	3750
6	152.5	3965

Table 8: W6a upper gauge co-ordinates

Rationale

G 5.3.1.2 Specific cases 7.3.2.2 of the LOC & PAS TSI, 7.7.17.1 of the INF TSI and 7.3.2.1a of the WAG TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 5.3.1.3 These requirements ensure that the largest possible swept envelope for the vehicle is accommodated within the gauge and is therefore compatible with infrastructure that has been declared compliant to the gauge.

Guidance

G 5.3.1.4 W6a Upper Gauge represents the ‘standard’ freight vehicle gauge to which most of the GB railway network, with specific exceptions, complies. W6a upper gauge was originally published in document PO/CL527 (1990).

G 5.3.1.5 W6a Upper Gauge assumes the use of Twistlock fastenings for the carriage of demountable loads.

5.3.2 Application of W6a upper gauge to rolling stock

5.3.2.1 W6a upper gauge shall enclose all parts of the vehicle protruding above a lower gauge and shall include the tolerances defined for this gauge.

5.3.2.2 Suspension movements shall not exceed those of the benchmark characteristics given in Standard Vehicle Gauge Data workbook *8073SVGD_W6a.*

5.3.2.3 Any part of the vehicle dropping below 1000 mm above rail level (ARL) under any conditions, shall comply with the requirements of the applicable lower gauge.

5.3.2.4 Where the distance between bogie centres or axle spacing exceeds 12.8 m, width reductions shall be applied to the gauge. Using a detailed methodology (e.g. as set out in Appendix *A*), the gauge width is reduced by the difference between the actual maximum horizontal overthrow of the vehicle and that given by the following reference values:

- Curve radius = 200 m
- Bogie centres or axle spacing = 12.8 m
- Overthrow at curve radius = 0.1055 m

5.3.2.5 Maximum overthrows to the outside of a curve (defined relative to the centre of radius of the curve) shall not exceed those of an 18.3 m load carried centrally on non-bogied wagons with 12.8 m axle spacing.

Rationale

G 5.3.2.6 Specific cases 7.3.2.2 of the LOC & PAS TSI, 7.7.17.1 of the INF TSI and 7.3.2.1a of the WAG TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 5.3.2.7 These requirements ensure that the largest possible swept envelope for the vehicle is accommodated within the gauge and is therefore compatible with infrastructure that has been declared compliant to the gauge.

G 5.3.2.8 The reference overthrow at a curve radius is calculated using the method in Appendix *A*.

Guidance

G 5.3.2.9 Maximum end overthrow is determined by the longest load on the shortest bogie centres (or axle spacing). Bogie overthrow increases centre overthrow, but reduces end overthrow.

5.3.3 Application of W6a upper gauge to infrastructure

5.3.3.1 The gauge co-ordinates shall be adjusted for horizontal curve overthrow using the following formulae: $T_i = \frac{21091}{R}$, $T_o = \frac{20478}{R}$

5.3.3.2 The W6a upper loading gauge shall be further adjusted for dynamic movements relating to cant and wheelset movements in accordance with the values of the benchmark characteristics given in Standard Vehicle Gauge Data workbook *8073SVGD - W6a, W7, W8, W9, W10 and W10a Gauges 4.1*

Rationale

G 5.3.3.3 Specific cases 7.3.2.2 of the LOC & PAS TSI, 7.7.17.1 of the INF TSI and 7.3.2.1a of the WAG TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 5.3.3.4 These requirements ensure that the largest possible swept envelope is considered in the assessment of gauge compatibility with the infrastructure.

Guidance

G 5.3.3.5 It is not necessary to consider additional wheel / rail clearance unless rail sidewear is present.

5.4 W7 upper gauge

5.4.1 Definition of W7 upper gauge

5.4.1.1 The W7 upper gauge base profile, defined by the co-ordinates in Table *9*, shall be used in accordance with the application rules set out in *5.4.2* and *5.4.3*. W7 defines the maximum size of a load that may be carried on wagons with a maximum bogie spacing (or axle spacing) of 12.8 m and a bogie wheelbase of up to 2.2 m (without width reduction).

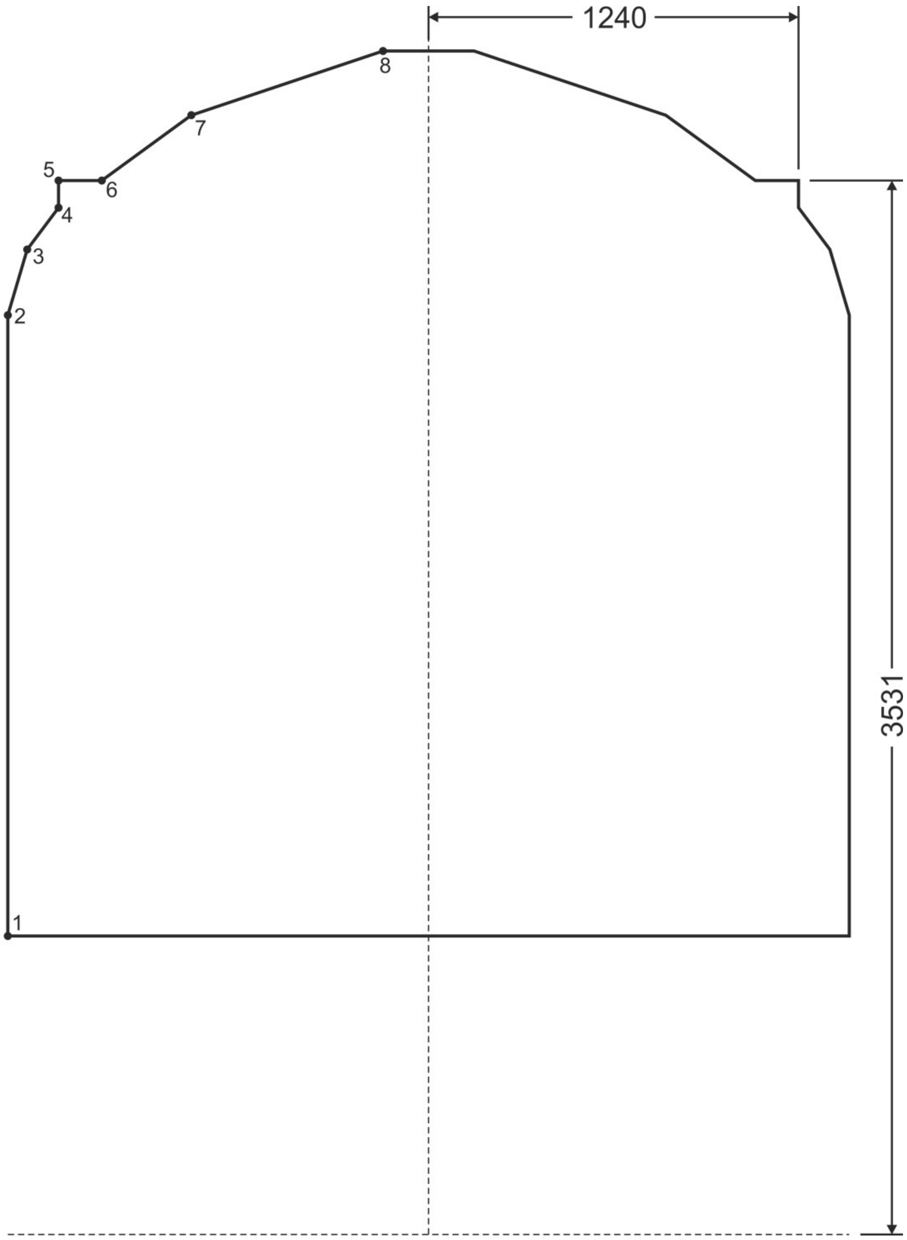


Figure 9: W7 upper gauge diagram

Note: Points 1-4 and 6-8 are on the W6a Upper Gauge line

Point	X (mm)	Y (mm)
1	1410	1000
2	1410	3080
3	1345	3300
4	1240	3418
5	1240	3531
6	1095	3531
7	795	3750
8	152.5	3965

Table 9: W7 upper gauge co-ordinates

Rationale

G 5.4.1.2 Specific cases 7.3.2.2 of the LOC & PAS TSI, 7.7.17.1 of the INF TSI and 7.3.2.1a of the WAG TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 5.4.1.3 These requirements ensure that the largest possible swept envelope for the vehicle is accommodated within the gauge and is therefore compatible with infrastructure that has been declared compliant to the gauge.

Guidance

G 5.4.1.4 W7 upper gauge is a load gauge commonly used for ISO 8’ 0” (2438 mm) high containers carried on lower gauge compliant wagons.

G 5.4.1.5 W7 base coordinates have been created to include the tolerances for Twistlock fastenings for the carriage of demountable loads

5.4.2 Application of W7 upper gauge to rolling stock

5.4.2.1 W7 upper gauge shall enclose all parts of the vehicle protruding above a lower gauge and shall include the tolerances defined for this gauge.

5.4.2.2 Suspension movements shall not exceed those of the benchmark characteristics given in Standard Vehicle Gauge Data workbook *8073SVGD - W7*.

5.4.2.3 Any part of the vehicle dropping below 1000 mm above rail level (ARL) under any conditions, shall comply with the requirements of the applicable lower gauge.

5.4.2.4 Where the distance between bogie centres or axle spacing exceeds 12.8 m, width reductions shall be applied to the gauge. Using a detailed methodology (e.g. as set out in Appendix *A*), the gauge width is reduced by the difference between the actual maximum horizontal overthrow of the vehicle and that given by the following reference values:

- Curve radius = 200 m
- Bogie centres or axle spacing = 12.8 m
- Overthrow at curve radius = 0.1055 m

5.4.2.5 Maximum overthrows to the outside of a curve (defined relative to the centre of radius of the curve) shall not exceed those of an 18.3 m load carried centrally on non-bogied wagons with 12.8 m axle spacing.

Rationale

G 5.4.2.6 Specific cases 7.3.2.2 of the LOC & PAS TSI, 7.7.17.1 of the INF TSI and 7.3.2.1a of the WAG TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 5.4.2.7 These requirements ensure that the largest possible swept envelope for the vehicle is accommodated within the gauge and is therefore compatible with infrastructure that has been declared compliant to the gauge.

G 5.4.2.8 The reference overthrow at a curve radius is calculated using the method in Appendix *A*.

Guidance

G 5.4.2.9 Maximum end overthrow is determined by the longest load on the shortest bogie centres (or axle spacing) and container overhang beyond bogie (or axle) centre. Bogie overthrow increases centre overthrow, but reduces end overthrow.

G 5.4.2.10 Gauge width reductions reduce the width of a demountable load that the wagon can carry within the gauge.

5.4.3 Application of W7 upper gauge to infrastructure

5.4.3.1 Routes carrying W7 loads shall also be cleared for W6a upper gauge.

5.4.3.2 The gauge co-ordinates shall be adjusted for horizontal curve overthrow using the following formulae:

$$T_i = \frac{21091}{R}, T_o = \frac{20478}{R}$$

5.4.3.3 The W7 Upper Gauge shall be further adjusted for dynamic movements relating to cant and wheelset movements depending on curve radius, in accordance with the benchmark characteristics given in Standard Vehicle Gauge Data workbook *8073SVGD - W6a, W7, W8, W9, W10 and W10a Gauges 4.1.*

Rationale

G 5.4.3.4 Specific cases 7.3.2.2 of the LOC & PAS TSI, 7.7.17.1 of the INF TSI and 7.3.2.1a of the WAG TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 5.4.3.5 These requirements ensure that the largest possible swept envelope is considered in the assessment of gauge compatibility with the infrastructure.

Guidance

G 5.4.3.6 It is not necessary to consider additional wheel / rail clearance unless rail sidewear is present.

5.5 W7a upper gauge

5.5.1 Definition of W7a upper gauge

5.5.1.1 The W7a upper gauge base profile, defined by the co-ordinates in table *10*, shall be used in accordance with the application rules set out in *5.5.2* and *5.5.3*. W7a upper gauge is a gauge for demountable loads carried on W6a compliant wagons. It defines the maximum size of a load that may be carried on wagons with a maximum bogie spacing (or axle spacing) of 14.2 m and a bogie wheelbase of up to 2.2 m without width or height reduction.

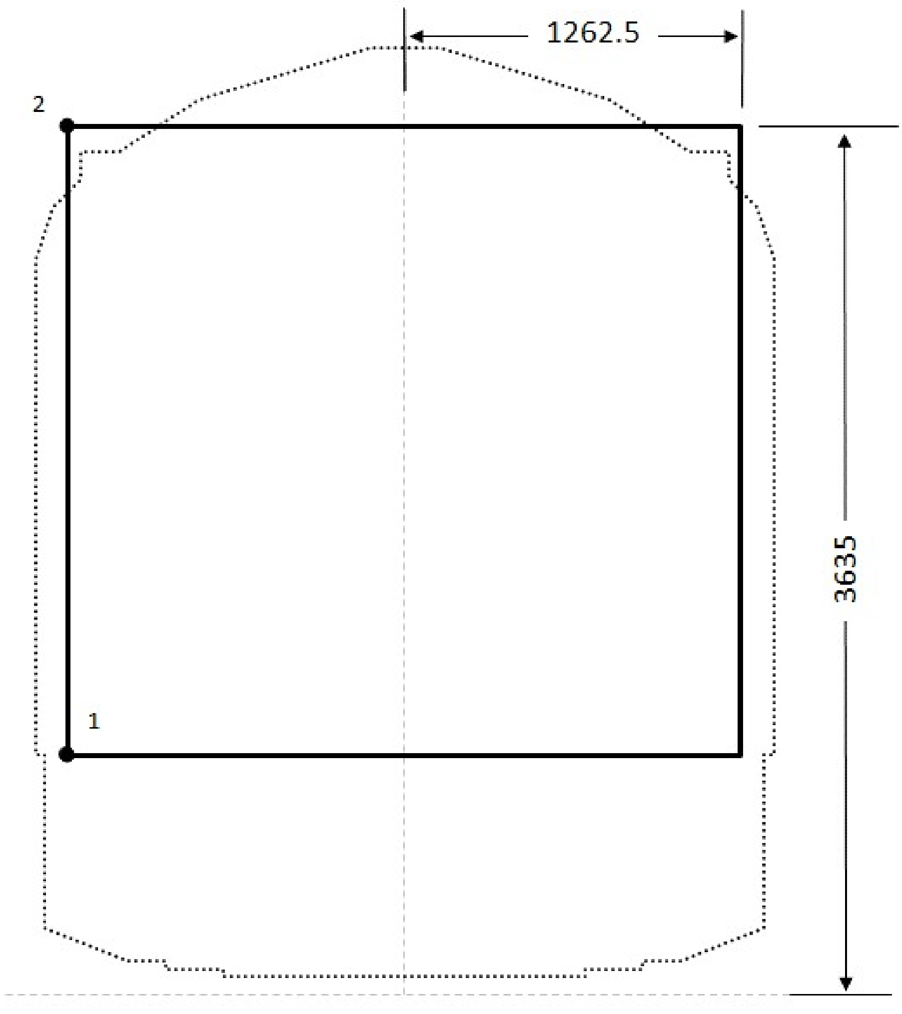


Figure 10: W7a upper gauge diagram

Note: W7 Upper Sector gauge with width reductions for 14.2m bogie centres and W6a Lower Sector are also shown by the dotted line, for reference only.

Point	X (mm)	Y (mm)
1	1262.5	1000
2	1262.5	3635

Table 10: W7a upper gauge co-ordinates

Rationale

G 5.5.1.2 Specific cases 7.3.2.2 of the LOC & PAS TSI, 7.7.17.1 of the INF TSI and 7.3.2.1a of the WAG TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 5.5.1.3 These requirements ensure that the largest possible swept envelope for the vehicle is accommodated within the gauge and is therefore compatible with infrastructure that has been declared compliant to the gauge.

G 5.5.1.4 W7a Upper Gauge was developed as part of RSSB research project *T1132 (2019)*.

Guidance

G 5.5.1.5 A semi-width of 1262.5 mm represents a 2500 mm wide demountable load on UIC Spigot fastenings, having a fixity tolerance of ±12.5 mm.

5.5.2 Application of W7a upper gauge to rolling stock

5.5.2.1 W7a upper gauge shall enclose all parts of the vehicle protruding beyond a lower gauge, including allowances and tolerances of the vehicle and the fixity of the container fastening system used, but excluding allowances for wheel flange wear and wheel / rail clearance.

5.5.2.2 Suspension movements shall not exceed those of the benchmark characteristics given in Standard Vehicle Gauge Data workbook *8073SVGD - W7a.*

5.5.2.3 Any part of the vehicle dropping below 1000 mm above rail level (ARL) under any conditions, shall comply with the requirements of the applicable lower gauge.

5.5.2.4 Where the distance between bogie centres or axle spacing exceeds 14.2 m, width reductions shall be applied to the gauge. Using a detailed methodology (e.g. as set out in Appendix A), the gauge width shall be reduced by the difference between the actual maximum horizontal overthrow of the vehicle and that given by the following reference values:

- Curve radius = 200 m
- Bogie centres or axle spacing = 14.2 m
- Overthrow at curve radius = 0.1291 m

5.5.2.5 Where the distance between bogie centres or axle spacing exceeds 14.2 m, height reductions shall be applied to the gauge. Using a detailed methodology (e.g. as set out in Appendix A), the gauge height shall be reduced by the difference between the actual maximum vertical overthrow of the vehicle and that given by the following reference values:

- Curve radius = 500 m
- Bogie centres or axle spacing = 14.2 m
- Overthrow at curve radius = 0.0516 m

5.5.2.6 Maximum overthrows to the outside of a curve (defined relative to the centre of radius of the curve) shall not exceed those of an 18.3 m load carried centrally on non-bogied wagons with 14.2 m axle spacing.

Rationale

G 5.5.2.7 Specific cases 7.3.2.2 of the LOC & PAS TSI, 7.7.17.1 of the INF TSI and 7.3.2.1a of the WAG TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 5.5.2.8 These requirements ensure that the largest possible swept envelope for the vehicle is accommodated within the gauge and is therefore compatible with infrastructure that has been declared compliant to the gauge.

G 5.5.2.9 Overthrow at reference curve radius has been calculated using the method in Appendix *A*.

Guidance

G 5.5.2.10 Maximum end overthrow is determined by the longest load on the shortest bogie centres (or axle spacing) and container overhang beyond bogie (or axle) centre. Bogie overthrow increases centre overthrow, but reduces end overthrow.

G 5.5.2.11 Demountable loads (e.g. containers) cannot be width- or height- reduced. Any width or height reduction simply reduces the width and height of a demountable load that the wagon is allowed to carry within the Gauge.

5.5.3 Application of W7a upper gauge to infrastructure

5.5.3.1 Routes carrying W7a loads shall also be cleared for W6a upper gauge.

5.5.3.2 The gauge co-ordinates shall be adjusted for horizontal and vertical curve overthrow using the following formulae: $T_i = \frac{25818}{R}$, $T_o = \frac{15785}{R}$

5.5.3.3 The W7a Upper Gauge shall be further adjusted for dynamic movements relating to cant and wheelset movements depending on curve radius, in accordance with the benchmark characteristics given in Standard Vehicle Gauge Data workbook *8073SVGD - W7a, W8a and W9a Gauges 4.1*.

Rationale

G 5.5.3.4 Specific cases 7.3.2.2 of the LOC & PAS TSI, 7.7.17.1 of the INF TSI and 7.3.2.1a of the WAG TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 5.5.3.5 These requirements ensure that the largest possible swept envelope is considered in the assessment of gauge compatibility with the infrastructure.

Guidance

G 5.5.3.6 It is not necessary to consider additional wheel / rail clearance unless rail side wear is present.

5.6 W8 upper gauge

5.6.1 Definition of W8 upper gauge

5.6.1.1 The W8 upper gauge base profile, defined by the co-ordinates in table *11*, shall be used in accordance with the application rules set out in *5.6.2* and *5.6.3*. W8 upper gauge is a load gauge carried on lower gauge compliant wagons. It defines the maximum size of a load that may be carried on wagons with a maximum bogie spacing (or axle spacing) of 12.8 m and a bogie wheelbase of up to 2.2 m (without width reduction).

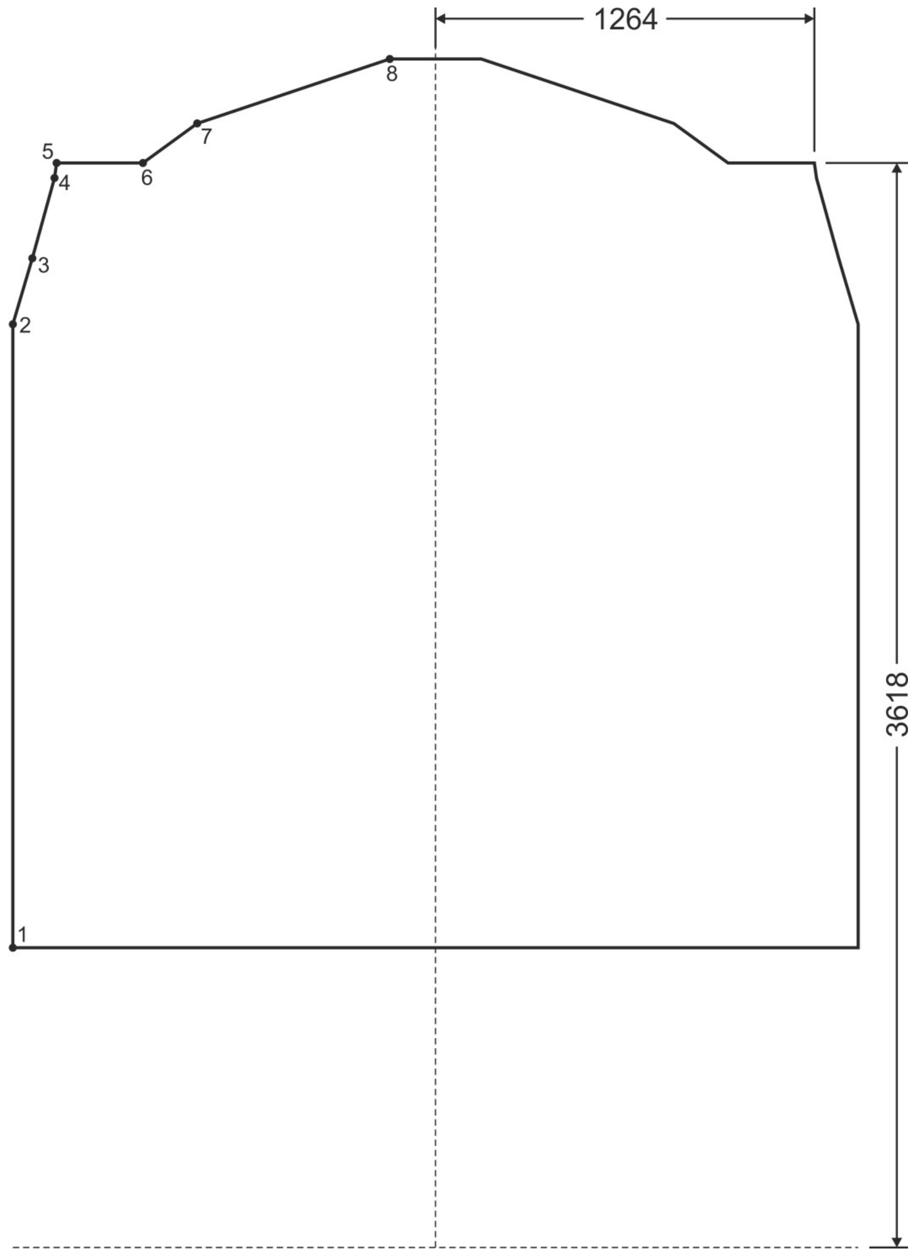


Figure 11: W8 upper gauge diagram

Note: Points 1-3 and 6-8 are on the W6a Upper Gauge line

Point	X (mm)	Y (mm)
1	1410	1000
2	1410	3080
3	1345	3300
4	1271	3568
5	1264	3618
6	976	3618
7	795	3750
8	152.5	3965

Table 11: W8 upper gauge co-ordinates

Rationale

G 5.6.1.2 Specific cases 7.3.2.2 of the LOC & PAS TSI, 7.7.17.1 of the INF TSI and 7.3.2.1a of the WAG TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 5.6.1.3 These requirements ensure that the largest possible swept envelope for the vehicle is accommodated within the gauge and is therefore compatible with infrastructure that has been declared compliant to the gauge.

Guidance

G 5.6.1.4 W8 Upper Gauge is a load gauge commonly used for ISO 8' 6" (2590 mm) high containers on lower gauge compliant wagons.

G 5.6.1.5 W8 gauge assumes the use of BR twistlock fastenings for the carriage of demountable loads.

5.6.2 Application of W8 upper gauge to rolling stock

5.6.2.1 W8 upper gauge shall enclose all parts of the vehicle protruding beyond a lower gauge, including allowances and tolerances of the vehicle and the fixity of the container fastening system used, but excluding allowances for wheel flange wear and wheel / rail clearance.

5.6.2.2 Suspension movements shall not exceed those of the benchmark characteristics given in Standard Vehicle Gauge Data workbook *8073SVGD - W8*.

5.6.2.3 Any part of the vehicle dropping below 1000 mm above rail level (ARL) under any conditions, shall comply with the requirements of the applicable lower gauge.

5.6.2.4 Where the distance between bogie centres or axle spacing exceeds 12.8 m, width reductions shall be applied to the gauge. Using a detailed methodology (e.g. as set out in Appendix *A*), the gauge width shall be reduced by the difference between the actual maximum horizontal overthrow of the vehicle and that given by the following reference values:

- Curve radius = 200 m
- Bogie centres or axle spacing = 12.8 m
- Overthrow at curve radius = 0.1055 m

5.6.2.5 Maximum overthrows to the outside of a curve (defined relative to the centre of radius of the curve) shall not exceed those of an 18.3 m load carried centrally on non-bogied wagons with 12.8 m axle spacing.

Rationale

G 5.6.2.6 Specific cases 7.3.2.2 of the LOC & PAS TSI, 7.7.17.1 of the INF TSI and 7.3.2.1a of the WAG TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 5.6.2.7 These requirements ensure that the largest possible swept envelope for the vehicle is accommodated within the gauge and is therefore compatible with infrastructure that has been declared compliant to the gauge.

G 5.6.2.8 Overthrow at reference curve radius has been calculated using the method in Appendix *A*.

Guidance

G 5.6.2.9 Maximum end overthrow is determined by the longest load on the shortest bogie centres (or axle spacing) and container overhang beyond bogie (or axle) centre. Bogie overthrow increases centre overthrow, but reduces end overthrow.

G 5.6.2.10 Demountable loads (e.g. containers) cannot be width- or height- reduced. Any width or height reduction simply reduces the width and height of a demountable load that the wagon is allowed to carry within the Gauge.

5.6.3 Application of W8 upper gauge to infrastructure

5.6.3.1 Routes carrying W8 loads shall also be cleared for W6a upper gauge.

5.6.3.2 The gauge co-ordinates shall be adjusted for horizontal curve overthrow using the following formulae:

$$T_i = \frac{21091}{R},\ T_o = \frac{20478}{R}$$

5.6.3.3 The W8 Upper Gauge shall be further adjusted for dynamic movements relating to cant and wheelset movements depending on curve radius, in accordance with the benchmark characteristics given in Standard Vehicle Gauge Data workbook *8073SVGD - W6a, W7, W8, W9, W10 and W10a Gauges 4.1*.

Rationale

G 5.6.3.4 Specific cases 7.3.2.2 of the LOC & PAS TSI, 7.7.17.1 of the INF TSI and 7.3.2.1a of the WAG TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 5.6.3.5 These requirements ensure that the largest swept possible envelope is considered in the assessment of gauge compatibility with the infrastructure.

Guidance

G 5.6.3.6 It is not necessary to consider additional wheel / rail clearance unless rail sidewear is present.

5.7 W8a upper gauge

5.7.1 Definition of W8a upper gauge

5.7.1.1 The W8a upper gauge base profile, defined by the co-ordinates in table *12*, shall be used in accordance with the application rules set out in *5.7.2* and *5.7.3*. W8a upper gauge is a load gauge carried on W6a compliant wagons. It defines the maximum size of a load that may be carried on wagons with a maximum bogie spacing (or axle spacing) of 14.2 m and a bogie wheelbase of up to 2.2 m without width or height reduction.

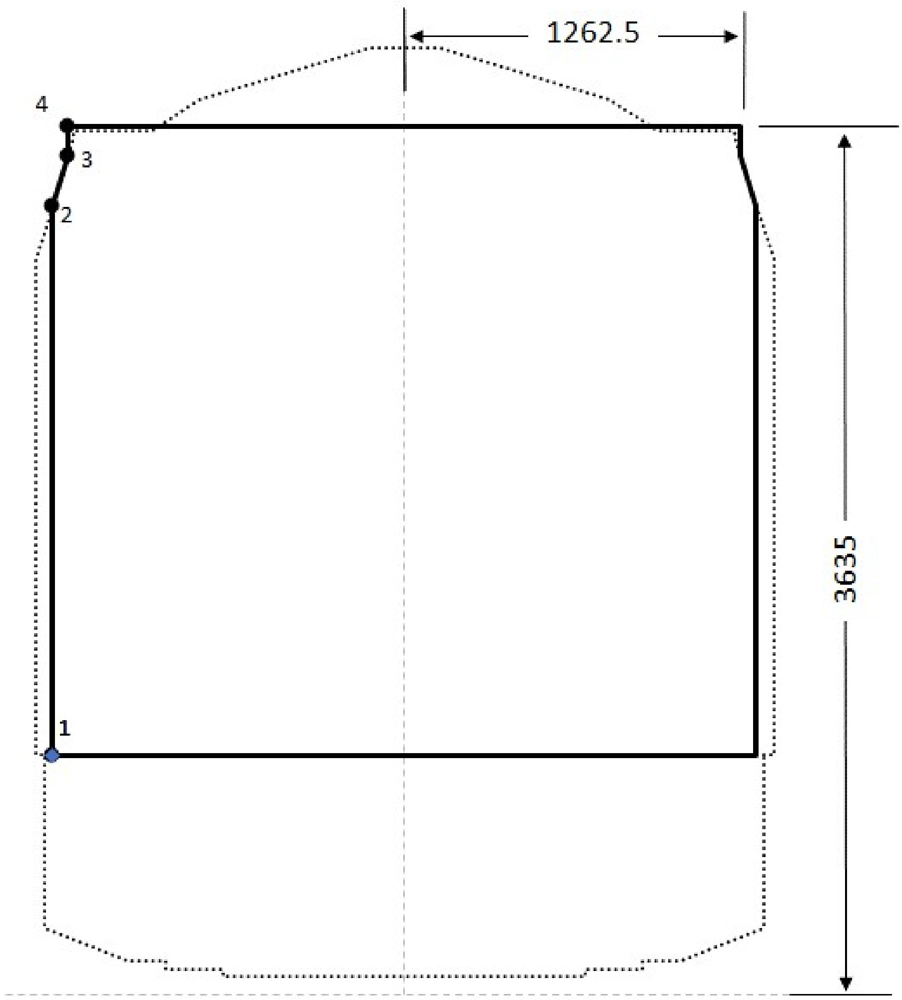


Figure 12: W8a upper gauge diagram

Note: W8 Upper Sector gauge with width reductions for 14.2m bogie centres and W6a Lower Sector are also shown by the dotted line.

Point	X (mm)	Y (mm)
1	1321.5	1000
2	1321.5	3300
3	1262.5	3512
4	1262.5	3635

Table 12: W8a upper gauge co-ordinates

Rationale

G 5.7.1.2 Specific cases 7.3.2.2 of the LOC & PAS TSI, 7.7.17.1 of the INF TSI and 7.3.2.1a of the WAG TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 5.7.1.3 These requirements ensure that the largest possible swept envelope for the vehicle is accommodated within the gauge and is therefore compatible with infrastructure that has been declared compliant to the gauge.

G 5.7.1.4 W8a upper gauge was developed as part of RSSB research project *T1132 (2019)*.

Guidance

G 5.7.1.5 A semi-width of 1262.5 mm represents a 2500 mm wide demountable load on UIC spigot fastenings, having a fixity tolerance of ±12.5 mm.

5.7.2 Application of W8a upper gauge to rolling stock

5.7.2.1 W8a upper gauge shall enclose all parts of the vehicle protruding beyond a lower gauge, including allowances and tolerances of the vehicle and the fixity of the container fastening system used, but excluding allowances for wheel flange wear and wheel / rail clearance.

5.7.2.2 Suspension movements shall not exceed those of the benchmark characteristics given in Standard Vehicle Gauge Data workbook *8073SVGD - W8a.*

5.7.2.3 Any part of the vehicle dropping below 1000 mm above rail level (ARL) under any conditions, shall comply with the requirements of the applicable lower gauge.

5.7.2.4 Where the distance between bogie centres or axle spacing exceeds 14.2 m, width reductions shall be applied to the gauge. Using a detailed methodology (e.g. as set out in Appendix *A*), the gauge width shall be reduced by the difference between the actual maximum horizontal overthrow of the vehicle and that given by the following reference values:

- Curve radius = 200 m
- Bogie centres or axle spacing = 14.2 m
- Overthrow at curve radius = 0.1291 m

5.7.2.5 Where the distance between bogie centres or axle spacing exceeds 14.2 m, height reductions shall be applied to the gauge. Using a detailed methodology (e.g. as set out in Appendix *A*), the gauge height shall be reduced by the difference between the actual maximum vertical overthrow of the vehicle and that given by the following reference values:

- Curve radius = 500 m
- Bogie centres or axle spacing = 14.2 m
- Overthrow at curve radius = 0.0516 m

5.7.2.6 Maximum overthrows to the outside of a curve (defined relative to the centre of radius of the curve) shall not exceed those of an 18.3 m load carried centrally on non-bogied wagons with 14.2 m axle spacing.

Rationale

G 5.7.2.7 Specific cases 7.3.2.2 of the LOC & PAS TSI, 7.7.17.1 of the INF TSI and 7.3.2.1a of the WAG TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 5.7.2.8 These requirements ensure that the largest possible swept envelope for the vehicle is accommodated within the gauge and is therefore compatible with infrastructure that has been declared compliant to the gauge.

G 5.7.2.9 Overthrow at reference curve radius has been calculated using the method in Appendix *A*.

Guidance

G 5.7.2.10 Maximum end overthrow is determined by the longest load on the shortest bogie centres (or axle spacing) and container overhang beyond bogie (or axle) centre. Bogie overthrow increases centre overthrow, but reduces end overthrow.

G 5.7.2.11 Demountable loads (e.g. containers) cannot be width- or height-reduced. Any width or height reduction simply reduces the width and height of a demountable load that the wagon is allowed to carry within the Gauge.

5.7.3 Application of W8a upper gauge to infrastructure

5.7.3.1 Routes carrying W8a loads shall also be cleared for W6a upper gauge.

5.7.3.2 The gauge co-ordinates shall be adjusted for horizontal and vertical curve overthrow using the following formulae:

$$T_i = \frac{25818}{R},\ T_o = \frac{15785}{R}$$

5.7.3.3 The W8a Upper Gauge shall be further adjusted for dynamic movements relating to cant and wheelset movements depending on curve radius, in accordance with the benchmark characteristics given in workbook *8073SVGD - W7a, W8a and W9a Gauges 4.1.*

Rationale

G 5.7.3.4 Specific cases 7.3.2.2 of the LOC & PAS TSI, 7.7.17.1 of the INF TSI and 7.3.2.1a of the WAG TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 5.7.3.5 These requirements ensure that the largest possible swept envelope is considered in the assessment of gauge compatibility with the infrastructure.

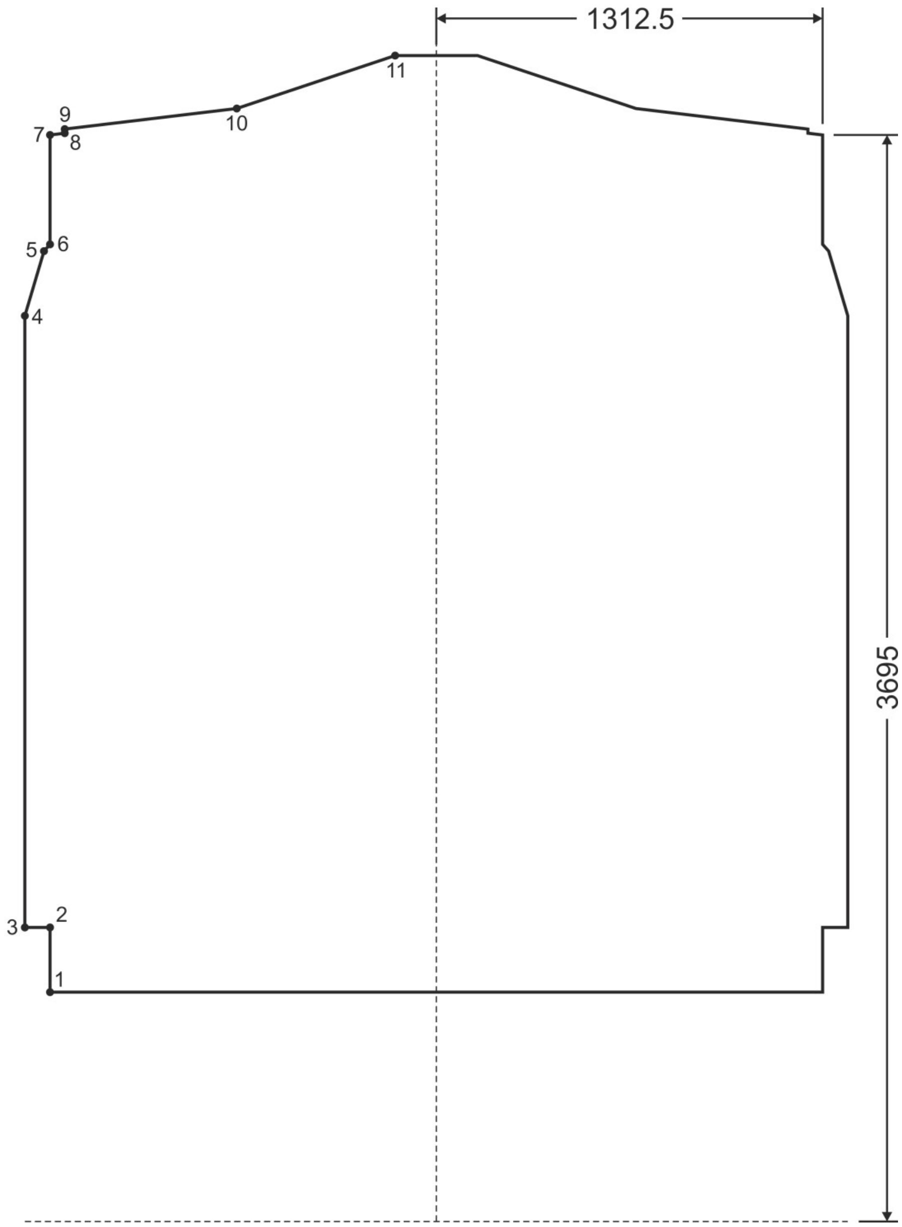
Guidance

G 5.7.3.6 It is not necessary to consider additional wheel / rail clearance unless rail sidewear is present.

5.8 W9 upper gauge

5.8.1 Definition of W9 upper gauge

5.8.1.1 The W9 upper gauge base profile, defined by the co-ordinates in table *13*, shall be used in accordance with the application rules set out in *5.8.2* and *5.8.3*. W9 upper gauge is a load gauge carried on W6a compliant wagons. It defines the maximum size of a load that may be carried on wagons with a maximum bogie spacing (or axle spacing) of 13.5 m and a bogie wheelbase between 1.8 m and 2.2 m without width reduction.



Note: Points 1 and 2 only apply to cross-sections between bogie centres.

Figure 13: W9 upper gauge diagram

Point	X (mm)	Y (mm)
1	1312.5	780
2	1312.5	1000
3	1398	1000
4	1398	3080
5	1333	3300
6	1312.5	3323
7	1312.5	3695
8	1262.5	3701
9	1262.5	3715
10	678	3785
11	140	3965

Table 13: W9 upper gauge co-ordinates

Rationale

G 5.8.1.2 Specific cases 7.3.2.2 of the LOC & PAS TSI, 7.7.17.1 of the INF TSI and 7.3.2.1a of the WAG TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 5.8.1.3 These requirements ensure that the largest possible swept envelope for the vehicle is accommodated within the gauge and is therefore compatible with infrastructure that has been declared compliant to the gauge.

Guidance

G 5.8.1.4 A semi-width of 1312.5 mm represents a 2600 mm wide demountable load on UIC spigot fastenings, having a fixity tolerance of ±12.5 mm.

5.8.2 Application of W9 upper gauge to rolling stock

5.8.2.1 W9 upper gauge shall enclose all parts of the vehicle protruding beyond a lower gauge, including allowances and tolerances of the vehicle and the fixity of the container fastening system used, but excluding allowances for wheel flange wear and wheel / rail clearance.

5.8.2.2 Suspension movements shall not exceed those of the benchmark characteristics given in document Standard Vehicle Gauge Data workbook *8073SVGD - W9*.

5.8.2.3 Any part of the vehicle dropping below 780 mm above rail level (ARL) under any conditions, shall comply with the requirements of the applicable lower gauge.

5.8.2.4 Where the distance between bogie centres or axle spacing exceeds 13.5 m, width reductions shall be applied to the gauge. Using a detailed methodology (e.g. as set out in Appendix *A*), the gauge width shall be reduced by the difference between the actual maximum horizontal overthrow of the vehicle and that given by the following reference values:

- Curve radius = 200 m
- Bogie centres or axle spacing = 13.5 m
- Overthrow at curve radius = 0.1170 m

5.8.2.5 Maximum overthrows to the outside of a curve (defined relative to the centre of radius of the curve) shall not exceed those of an 18.3 m load carried centrally on non-bogied wagons with 13.5 m axle spacing.

Rationale

G 5.8.2.6 Specific cases 7.3.2.2 of the LOC & PAS TSI, 7.7.17.1 of the INF TSI and 7.3.2.1a of the WAG TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 5.8.2.7 These requirements ensure that the largest possible swept envelope for the vehicle is accommodated within the gauge and is therefore compatible with infrastructure that has been declared compliant to the gauge.

G 5.8.2.8 Overthrow at reference curve radius has been calculated using the method in Appendix *A*.

Guidance

G 5.8.2.9 Maximum end overthrow is determined by the longest load on the shortest bogie centres (or axle spacing) and container overhang beyond bogie (or axle) centre. Bogie overthrow increases centre overthrow but reduces end overthrow

G 5.8.2.10 Demountable loads (e.g. containers) cannot be width- or height-reduced. Any width or height reduction simply reduces the width and height of a demountable load that the wagon is allowed to carry within the Gauge.

5.8.3 Application of W9 upper gauge to infrastructure

5.8.3.1 Routes carrying W9 loads shall also be cleared for W6a upper gauge.

5.8.3.2 The gauge co-ordinates shall be adjusted for horizontal curve overthrow using the following formulae:

$$T_i = \frac{23393}{R}, T_o = \frac{18180}{R}$$

5.8.3.3 The W9 Upper Gauge shall be further adjusted for dynamic movements relating to cant and wheelset movements depending on curve radius, in accordance with the benchmark characteristics given in Standard Vehicle Gauge Data workbook *8073SVGD - W6a, W7, W8, W9, W10 and W10a Gauges 4.1.*

Rationale

G 5.8.3.4 Specific cases 7.3.2.2 of the LOC & PAS TSI, 7.7.17.1 of the INF TSI and 7.3.2.1a of the WAG TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 5.8.3.5 These requirements ensure that the largest possible swept envelope is considered in the assessment of gauge compatibility with the infrastructure.

Guidance

G 5.8.3.6 It is not necessary to consider additional wheel / rail clearance unless rail sidewear is present.

5.9 W9a upper gauge

5.9.1 Definition of W9a upper gauge

5.9.1.1 The W9a upper gauge base profile, defined by the co-ordinates in table *14*, shall be used in accordance with the application rules set out in *5.9.2* and *5.9.3*. W9a upper gauge is a load gauge carried on W6a compliant wagons. It defines the maximum size of a load that may be carried on wagons with a maximum bogie spacing (or axle spacing) of 14.2 m and a bogie wheelbase of up to 2.2 m without width or height reduction.

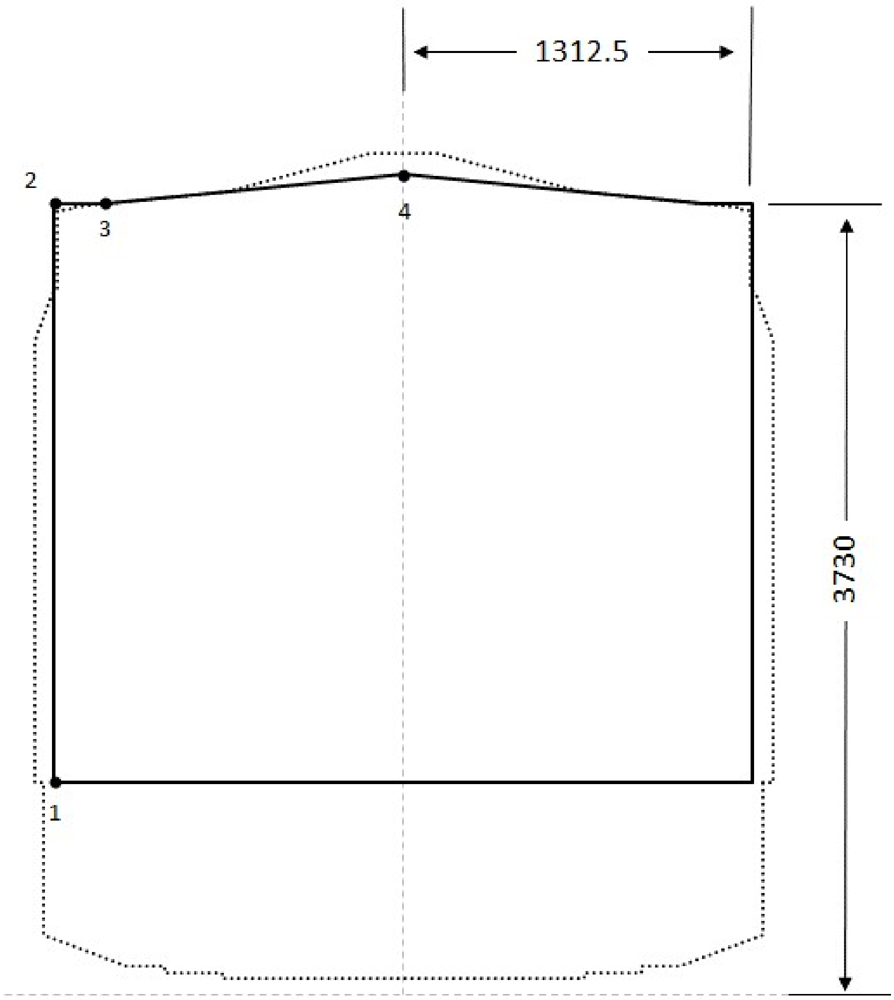


Figure 14: W9a upper gauge diagram

Note: W9 Upper Sector gauge with width reductions for 14.2 m bogie centres and W6a Lower Sector are also shown by the dotted line.

Point	X (mm)	Y (mm)
1	1312.5	1000
2	1312.5	3730
3	1125	3730
4	0	3866

Table 14: W9a upper gauge co-ordinates

Rationale

G 5.9.1.2 Specific cases 7.3.2.2 of the LOC & PAS TSI, 7.7.17.1 of the INF TSI and 7.3.2.1a of the WAG TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 5.9.1.3 These requirements ensure that the largest possible swept envelope for the vehicle is accommodated within the gauge and is therefore compatible with infrastructure that has been declared compliant to the gauge.

G 5.9.1.4 W9a Upper Gauge was developed as part of RSSB research project *T1132 (2019)*.

Guidance

G 5.9.1.5 A semi-width of 1312.5 mm represents a 2600 mm wide demountable load on UIC Spigot fastenings, having a fixity tolerance of ±12.5 mm.

5.9.2 Application of W9a upper gauge to rolling stock

5.9.2.1 W9a upper gauge shall enclose all parts of the vehicle protruding beyond a lower gauge, including allowances and tolerances of the vehicle and the fixity of the container fastening system used, but excluding allowances for wheel flange wear and wheel / rail clearance.

5.9.2.2 Suspension movements shall not exceed those of the benchmark characteristics given in Standard Vehicle Gauge Data workbook *8073SVGD - W9a.*

5.9.2.3 Any part of the vehicle dropping below 1000 mm above rail level (ARL) under any conditions, shall comply with the requirements of the applicable lower gauge.

5.9.2.4 Where the distance between bogie centres or axle spacing exceeds 14.2 m, width reductions shall be applied to the gauge. Using a detailed methodology (e.g. as set out in Appendix *A*), the gauge width shall be reduced by the difference between the actual maximum horizontal overthrow of the vehicle and that given by the following reference values:

- Curve radius = 200 m
- Bogie centres or axle spacing = 14.2 m
- Overthrow at curve radius = 0.1291 m

5.9.2.5 Where the distance between bogie centres or axle spacing exceeds 14.2 m, height reductions shall be applied to the gauge. Using a detailed methodology (e.g. as set out in Appendix *A*), the gauge height shall be reduced by the difference between the actual maximum vertical overthrow of the vehicle and that given by the following reference values:

- Curve radius = 500 m
- Bogie centres or axle spacing = 14.2 m
- Overthrow at curve radius = 0.0516 m

5.9.2.6 Maximum overthrows to the outside of a curve (defined relative to the centre of radius of the curve) shall not exceed those of an 18.3 m load carried centrally on non-bogied wagons with 14.2 m axle spacing.

Rationale

G 5.9.2.7 Specific cases 7.3.2.2 of the LOC & PAS TSI, 7.7.17.1 of the INF TSI and 7.3.2.1a of the WAG TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 5.9.2.8 These requirements ensure that the largest possible swept envelope for the vehicle is accommodated within the gauge and is therefore compatible with infrastructure that has been declared compliant to the gauge.

G 5.9.2.9 Overthrow at reference curve radius has been calculated using the method in Appendix *A*.

Guidance

G 5.9.2.10 Maximum end overthrow is determined by the longest load on the shortest bogie centres (or axle spacing) and container overhang beyond bogie (or axle) centre. Bogie overthrow increases centre overthrow, but reduces end overthrow.

G 5.9.2.11 Demountable loads (e.g. containers) cannot be width- or height-reduced. Any width or height reduction simply reduces the width and height of a demountable load that the wagon is allowed to carry within the gauge.

5.9.3 Application of W9a upper gauge to infrastructure

5.9.3.1 Routes carrying W9a loads shall also be cleared for W6a upper gauge.

5.9.3.2 The gauge co-ordinates shall be adjusted for horizontal and vertical curve overthrow using the following formulae:

$$T_i = \frac{25818}{R}, T_o = \frac{15775}{R}$$

5.9.3.3 The W9a Upper Gauge shall be further adjusted for dynamic movements relating to cant and wheelset movements depending on curve radius, in accordance with the benchmark characteristics given in Standard Vehicle Gauge Data workbook *8073SVGD - W7a, W8a and W9a Gauges 4.1.*

Rationale

G 5.9.3.4 Specific cases 7.3.2.2 of the LOC & PAS TSI, 7.7.17.1 of the INF TSI and 7.3.2.1a of the WAG TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 5.9.3.5 These requirements ensure that the largest possible swept envelope is considered in the assessment of gauge compatibility with the infrastructure.

Guidance

G 5.9.3.6 It is not necessary to consider additional wheel / rail clearance unless rail sidewear is present.

5.10 W10 upper gauge

5.10.1 Definition of W10 upper gauge

5.10.1.1 The W10 upper gauge base profile, defined by the co-ordinates in table *15*, shall be used in accordance with the application rules set out in *5.10.2* and *5.10.3*. W10 upper gauge is a load gauge carried on W6a compliant wagons. It defines the maximum size of a load that may be carried on wagons with a deck height of between 820 mm and 995 mm, with a maximum bogie spacing (or axle spacing) of up to 14.02 m and a bogie wheelbase between 1.8 m and 2.2 m without width reduction.

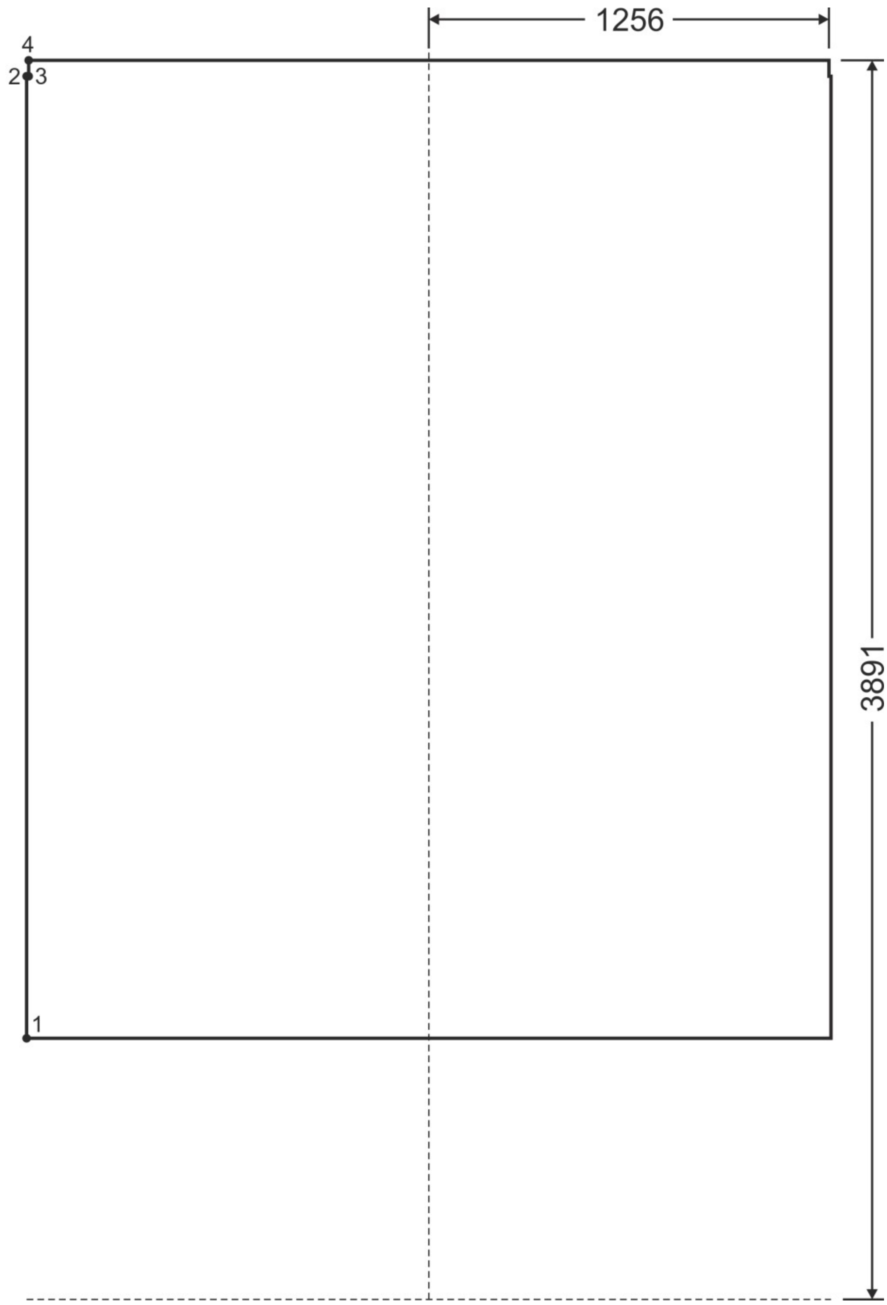


Figure 15: W10 upper gauge diagram

Point	X (mm)	Y (mm)
1	1262.5	820
2	1262.5	3841
3	1256	3841
4	1256	3891

Table 15: W10 upper gauge co-ordinates

Rationale

G 5.10.1.2 Specific cases 7.3.2.2 of the LOC & PAS TSI, 7.7.17.1 of the INF TSI and 7.3.2.1a of the WAG TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 5.10.1.3 These requirements ensure that the largest possible swept envelope for the vehicle is accommodated within the gauge and is therefore compatible with infrastructure that has been declared compliant to the gauge.

Guidance

G 5.10.1.4 A semi-width of 1256 mm represents a 2500 mm wide demountable load on BR twistlock fastenings, having a fixity tolerance of ±6 mm.

5.10.2 Application of W10 upper gauge to rolling stock

5.10.2.1 W10 upper gauge shall enclose all parts of the vehicle protruding beyond a lower gauge, including allowances and tolerances of the vehicle and the fixity of the container fastening system used, but excluding allowances for wheel flange wear and wheel / rail clearance.

5.10.2.2 Suspension movements shall not exceed those of the benchmark characteristics given in Standard Vehicle Gauge Data workbook *8073SVGD - W10.*

5.10.2.3 Where the distance between bogie centres or axle spacing exceeds 14.02 m, width reductions shall be applied to the gauge. Using a detailed methodology (e.g. as set out in Appendix *A*), the gauge width shall be reduced by the difference between the actual maximum horizontal overthrow of the vehicle and that given by the following reference values:

- Curve radius = 200 m
- Bogie centres or axle spacing = 14.02 m
- Overthrow at curve radius = 0.1259 m

5.10.2.4 Maximum overthrows to the outside of a curve (defined relative to the centre of radius of the curve) shall not exceed those of an 18.3 m load carried centrally on non-bogied wagons with 14.02 m axle spacing.

Rationale

G 5.10.2.5 Specific cases 7.3.2.2 of the LOC & PAS TSI, 7.7.17.1 of the INF TSI and 7.3.2.1a of the WAG TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 5.10.2.6 These requirements ensure that the largest possible swept envelope for the vehicle is accommodated within the gauge and therefore compatible with infrastructure that has been declared compliant to the gauge.

G 5.10.2.7 Overthrow at reference curve radius has been calculated using the method in Appendix *A*.

Guidance

G 5.10.2.8 Maximum end overthrow is determined by the longest load on the shortest bogie centres (or axle spacing) and container overhang beyond bogie (or axle) centre. Bogie overthrow increases centre overthrow, but reduces end overthrow

G 5.10.2.9 Demountable loads (e.g. containers) cannot be width- or height-reduced. Any width or height reduction simply reduces the width and height of a demountable load that the wagon is allowed to carry within the gauge.

5.10.3 Application of W10 upper gauge to infrastructure

5.10.3.1 Routes carrying W10 loads shall also be cleared for W6a upper gauge.

5.10.3.2 The gauge co-ordinates shall be adjusted for horizontal curve overthrow using the following formulae:

$$T_i = \frac{25183}{R},\ T_o = \frac{16422}{R}$$

5.10.3.3 The W10 upper gauge shall be further adjusted for dynamic movements relating to cant and wheelset movements depending on curve radius, in accordance with the benchmark characteristics given in Standard Vehicle Gauge Data workbook *8073SVGD - W6a, W7, W8, W9, W10 and W10a Gauges 4.1.*

Rationale

G 5.10.3.4 Specific cases 7.3.2.2 of the LOC & PAS TSI, 7.7.17.1 of the INF TSI and 7.3.2.1a of the WAG TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 5.10.3.5 These requirements ensure that the largest possible swept envelope is considered in the assessment of gauge compatibility with the infrastructure.

Guidance

G 5.10.3.6 It is not necessary to consider additional wheel / rail clearance unless rail sidewear is present.

5.11 W10a upper gauge

5.11.1 Definition of W10a upper gauge

5.11.1.1 The W10a upper gauge base profile, defined by the co-ordinates in table *16*, shall be used in accordance with the application rules set out in *5.11.2* and *5.11.3*. W10a upper gauge is a load gauge carried on W6a compliant wagons . It defines the maximum size of a load that may be carried on wagons with a deck height of between 820 mm and 995 mm, with a maximum bogie spacing (or axle spacing) of 14.02 m and a bogie wheelbase between 1.8 m and 2.2 m without width reduction.

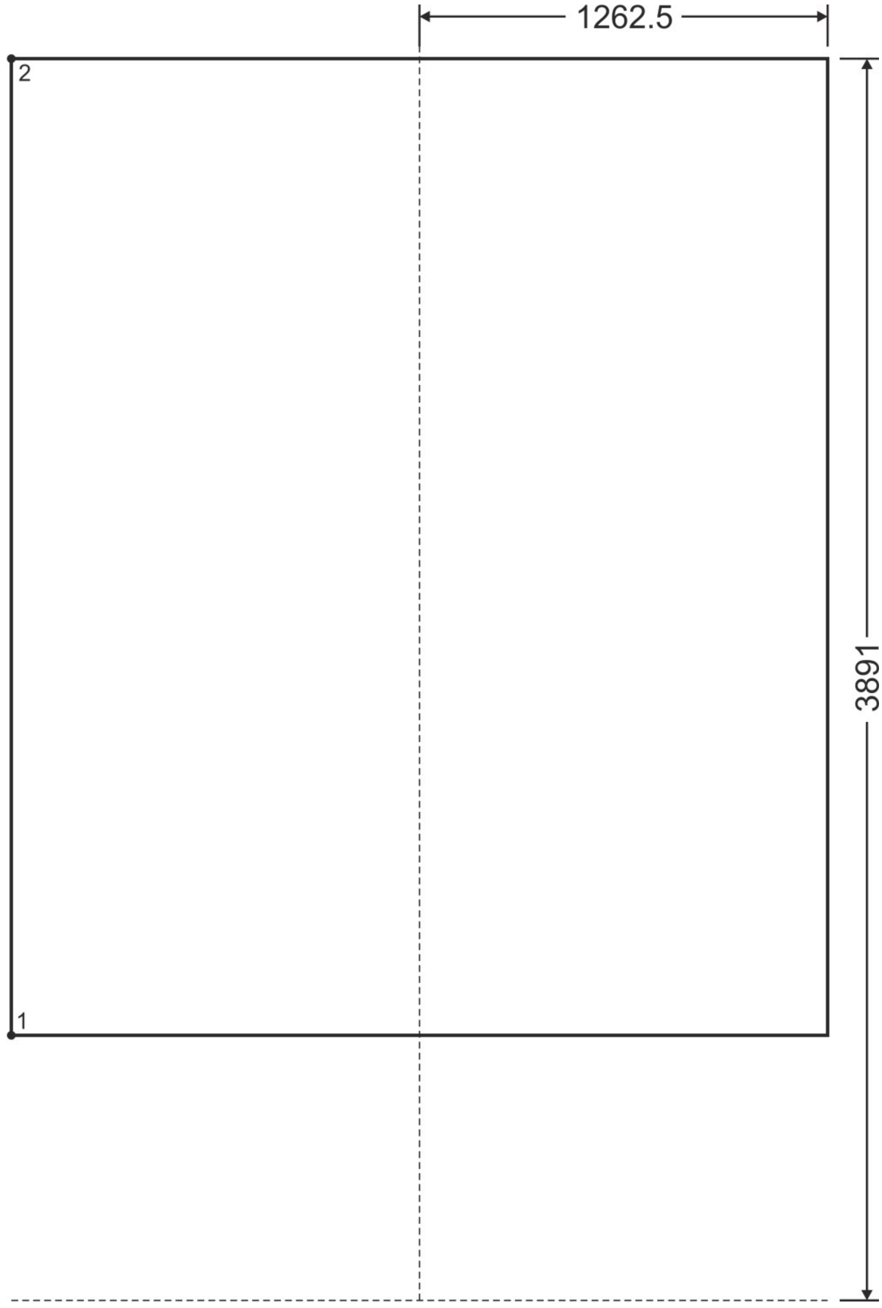


Figure 16: W10a upper gauge diagram

Point	X (mm)	Y (mm)
1	1262.5	820
2	1262.5	3891

Table 16: W10a upper gauge co-ordinates

Rationale

G 5.11.1.2 Specific cases 7.3.2.2 of the LOC & PAS TSI, 7.7.17.1 of the INF TSI and 7.3.2.1a of the WAG TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 5.11.1.3 These requirements ensure that the largest possible swept envelope for the vehicle is accommodated within the gauge and is therefore compatible with infrastructure that has been declared compliant to the gauge.

Guidance

G 5.11.1.4 A semi-width of 1262.5 mm represents a 2500 mm wide demountable load on UIC Spigot fastenings, having a fixity tolerance of ±12.5 mm.

5.11.2 Application of W10a upper gauge to rolling stock

5.11.2.1 W10a upper gauge shall enclose all parts of the vehicle protruding beyond a lower gauge, including allowances and tolerances of the vehicle and the fixity of the container fastening system used, but excluding allowances for wheel flange wear and wheel / rail clearance.

5.11.2.2 Suspension movements shall not exceed those of the benchmark characteristics given in standard vehicle gauge data workbook *8073SVGD - W10a.*

5.11.2.3 Where the distance between bogie centres or axle spacing exceeds 14.02 m, width reductions shall be applied to the gauge. Using a detailed methodology (e.g. as set out in Appendix *A*), the gauge width shall be reduced by the difference between the actual maximum horizontal overthrow of the vehicle and that given by the following reference values:

- Curve radius = 200 m
- Bogie centres or axle spacing = 14.02 m
- Overthrow at curve radius = 0.1259 m

5.11.2.4 Maximum overthrows to the outside of a curve (defined relative to the centre of radius of the curve) shall not exceed those of an 18.3 m load carried centrally on non-bogied wagons with 14.02 m axle spacing.

Rationale

G 5.11.2.5 Specific cases 7.3.2.2 of the LOC & PAS TSI, 7.7.17.1 of the INF TSI and 7.3.2.1a of the WAG TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 5.11.2.6 These requirements ensure that the largest possible swept envelope for the vehicle is accommodated within the gauge and is therefore compatible with infrastructure that has been declared compliant to the gauge.

G 5.11.2.7 Overthrow at reference curve radius has been calculated using the method in Appendix *A*.

Guidance

G 5.11.2.8 Maximum end overthrow is determined by the longest load on the shortest bogie centres (or axle spacing) and container overhang beyond bogie (or axle) centre. Bogie overthrow increases centre overthrow, but reduces end overthrow

G 5.11.2.9 Demountable loads (e.g. containers) cannot be width- or height-reduced. Any width or height reduction simply reduces the width and height of a demountable load that the wagon is allowed to carry within the gauge.

5.11.3 Application of W10a upper gauge to infrastructure

5.11.3.1 Routes carrying W10a loads shall also be cleared for W6a upper gauge.

5.11.3.2 The gauge co-ordinates shall be adjusted for horizontal overthrow using the following formulae:

$$T_i = \frac{25183}{R}, \; T_o = \frac{16420}{R}$$

5.11.3.3 The W10a upper gauge shall be further adjusted for dynamic movements relating to cant and wheelset movements depending on curve radius, in accordance with the benchmark characteristics given in Standard Vehicle Gauge Data workbook *8073SVGD - W6a, W7, W8, W9, W10 and W10a Gauges 4.1.*

Rationale

G 5.11.3.4 Specific cases 7.3.2.2 of the LOC & PAS TSI, 7.7.17.1 of the INF TSI and 7.3.2.1a of the WAG TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 5.11.3.5 These requirements ensure that the largest possible swept envelope is considered in the assessment of gauge compatibility with the infrastructure.

Guidance

G 5.11.3.6 It is not necessary to consider additional wheel / rail clearance unless rail sidewear is present.

5.12 W12 upper gauge

5.12.1 Definition of W12 upper gauge

5.12.1.1 The W12 upper gauge base profile, defined by the co-ordinates in table *17*, shall be used in accordance with the application rules set out in *5.12.2* and *5.12.3*. W12 is a wagon specific gauge, the wagons that define the gauge are set out in Table *18*.

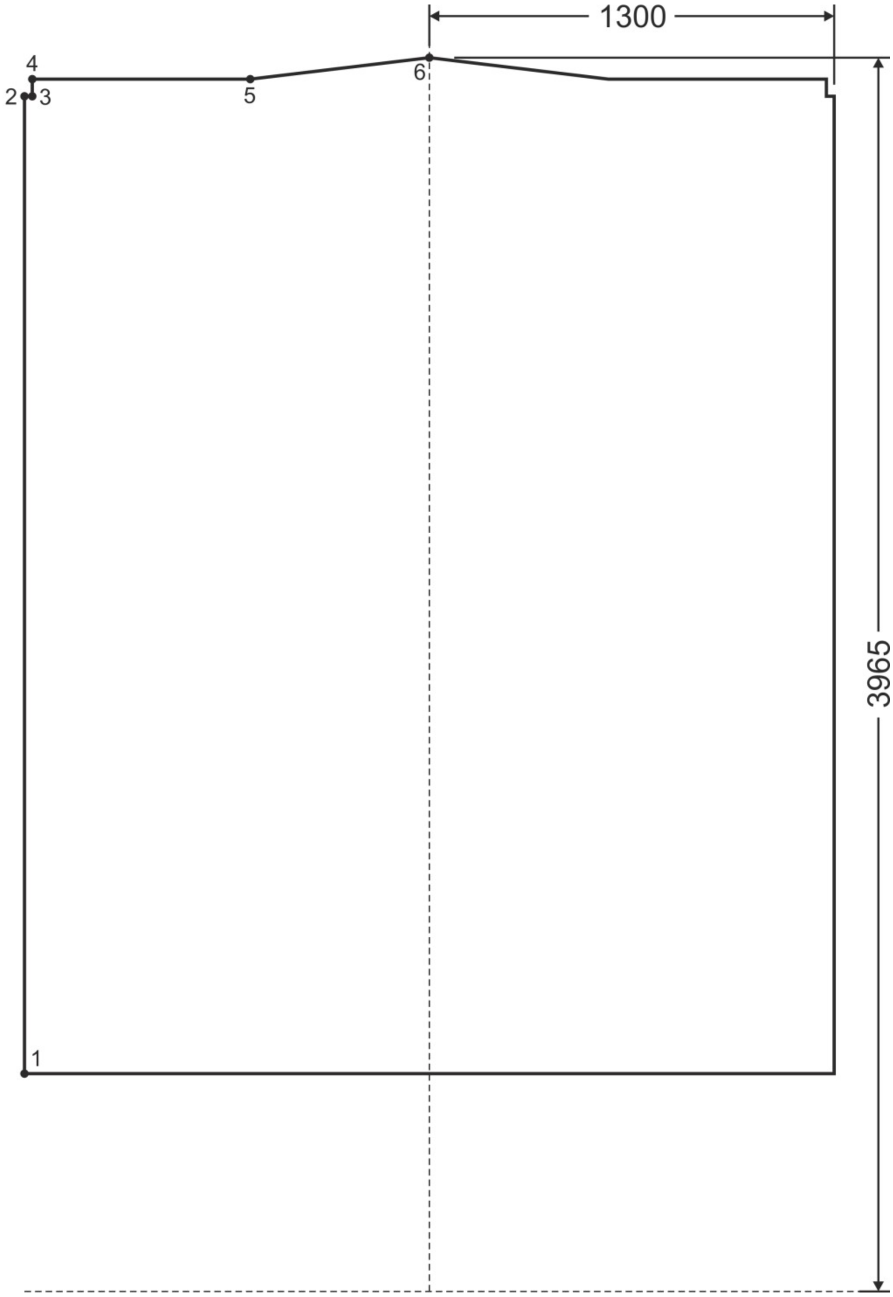


Figure 17: W12 upper gauge diagram

Point	X (mm)	Y (mm)
1	1300	700
2	1300	3841
3	1275	3841
4	1275	3896
5	575	3896
6	0	3965

Table 17: W12 upper Gauge co-ordinates

Wagon code	Bogie Type	Bogie wheel base (mm)	Bogie Centres (mm)	Load length (no. of 20" boxes)	Load length (mm)	Speed (km/h)	Fastening
FCA	Swing motion	1829	13540	3	18288	120	Holland Autolock
KAA	Y33c	2000	11500	2	12192	145	UIC Spigot
FIA	Y33a	2000	13080	2	18592	120	UIC Spigot
IFA	Y33	2000	13080	2	18592	120	UIC Spigot
IKA	Y33a	2000	13080	2	12192	120	UIC Spigot
FKA	Y33	2000	12910	2	12192	120	UIC Spigot
FAA	Y33	1800	15388	2	12192	120	Holland Autolock
FFA	3-piece	2000	14020	3	18288	120	Twistlock
FGA	3-piece	2000	14020	3	18592	120	Twistlock

Wagon code	Bogie Type	Bogie wheel base (mm)	Bogie Centres (mm)	Load length (no. of 20" boxes)	Load length (mm)	Speed (km/h)	Fastening
FSA	Y25	1800	14100	3	18592	120	Twistlock
FTA	Y25	1800	14100	3	18592	120	Twistlock
KFA	Y25	1800	14000	3	18288	120	Twistlock
IJA	Y25	1800	14240	3	18288	120	UIC Spigot
KHA	Y25	1800	14000	3	18288	120	UIC Spigot
FLA	LTF13	1800	9600	2	12192	120	UIC Spigot

Table 18: Wagon, bogie and load combinations covered by the gauge

Rationale

G 5.12.1.2 Specific cases 7.3.2.2 of the LOC & PAS TSI, 7.7.17.1 of the INF TSI and 7.3.2.1a of the WAG TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 5.12.1.3 These requirements ensure that the largest possible swept envelope for the vehicle is accommodated within the gauge and is therefore compatible with infrastructure that has been declared compliant to the gauge.

G 5.12.1.4 W12 gauge was developed to accommodate 9' 6" x 2600 mm container traffic.

Guidance

G 5.12.1.5 W12 includes the following capability:

a) ISO 9' 6" (2896 mm) x 2600 mm container on 700 mm – 945 mm deck height wagons.
b) ISO 9' 6" (2896 mm) x 2550 mm container on 700 mm – 1000 mm deck height wagons.
c) S Coded 2551 mm – 2600 mm swap bodies of up to 3810 mm corner height (S365 on 1000 mm deck, S371 on 945 mm deck).
d) S Coded 2500 mm – 2550 mm swap bodies of up to 3815 mm corner height (S36 on 1000 mm deck, S41 on 945 mm deck).

G 5.12.1.6 Kinematic envelopes are set out in the Standard Vehicle Gauge Data workbook 8073SVGD - W12.

5.12.2 Application of W12 upper gauge to rolling stock

5.12.2.1 The W12 gauge line shall be adjusted for dynamic movements relating to cant and speed and wheelset movements in accordance with curve radius, in accordance with the values for the applicable bogie type indicated in Standard Vehicle Gauge Data workbook *8073SVGD - W12*.

5.12.2.2 W12 upper gauge shall enclose all parts of the vehicle protruding beyond a lower gauge, including allowances and tolerances of the vehicle and the fixity of the container fastening system used, but excluding allowances for wheel flange wear and wheel / rail clearance.

Rationale

G 5.12.2.3 Specific cases 7.3.2.2 of the LOC & PAS TSI, 7.7.17.1 of the INF TSI and 7.3.2.1a of the WAG TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 5.12.2.4 These requirements ensure that the largest possible swept envelope for the vehicle is accommodated within the gauge and is therefore compatible with infrastructure that has been declared compliant to the gauge.

G 5.12.2.5 A review of W12 gauge was undertaken in 2013 and developed the third generation of W12. The review identified the ruling gauges from the wagon/suspension combinations covered by the gauge. The review also made a refinement of the dynamic movements applied to the gauge.

Guidance

G 5.12.2.6 The method for calculating overthrow is found in Appendix *A*

G 5.12.2.7 Fastening tolerances for the specific wagon are to be applied individually. The base profile does not include the fastening tolerances.

5.12.3 Application of W12 upper gauge to infrastructure

5.12.3.1 For declaration to W12 gauge, the infrastructure shall be assessed for all of the wagon / bogie combinations.

5.12.3.2 W12 gauge shall be adjusted for horizontal curve overthrow for each of the wagon/ bogie combinations using the following formulae:

$$T_i = \frac{K_i}{R},\ T_o = \frac{K_o}{R}$$

where K_i and K_o are the overthrow coefficients, for centre throw and endthrow respectively. K_i and K_o are specified in Table *19* for each of the wagons.

Wagon	Fastening	K_i	K_o
FCA	Holland Autolock	23341	18198
KAA	UIC Spigot	17035	1429
FIA	UIC Spigot	21892	21037
IFA	UIC Spigot	23288	19643
IKA	UIC Spigot	21892	N/A
FKA	UIC Spigot	21339	N/A
FAA	Holland Autolock	30110	N/A
FFA	Twistlock	25078	16463
FGA	Twistlock	25078	17855
FSA	Twistlock	25264	17669
FTA	Twistlock	23976	18955
KFA	Twistlock	24913	16628
IJA	UIC Spigot	25760	15781
KHA	UIC Spigot	24913	16628
FLA	UIC Spigot	11927	6536

Table 19: Overthrow coefficients for wagons included in W12

Note: N/A in the table appears in cases where the calculated throw is negative - see guidance below

5.12.3.3 The W12 gauge line shall be further adjusted for dynamic movements relating to cant and speed and wheelset movements, in accordance with the values for the applicable suspension type in Standard Vehicle Gauge Data workbook *8073SVGD - W12.*

Rationale

G 5.12.3.4 Specific cases 7.3.2.2 of the LOC & PAS TSI, 7.7.17.1 of the INF TSI and 7.3.2.1a of the WAG TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 5.12.3.5 These requirements ensure that the largest possible swept envelope is considered in the assessment of gauge compatibility with the infrastructure.

Guidance

G 5.12.3.6 It is not necessary to consider additional wheel / rail clearance unless rail sidewear is present.

G 5.12.3.7 Not all wagon load combinations throw to the outside of the curve, owing to the maximum load length and the bogie centre dimensions, hence some of the coefficients for overthrow in Table *19* are N/A.

G 5.12.3.8 K_i and K_o are derived from the values for wagon configuration in Table *18* and the method for calculation overthrows as set out in Appendix *A*.

Part 6 Passenger stock gauges applicable to the upper sector

6.1 Passenger Gauge 1 (20 m) - PG1

6.1.1 Definition of PG1

6.1.1.1 PG1, defined by the co-ordinates in table *20*, shall be used in accordance with the application rules set out in *6.1.2* and *6.1.3*.

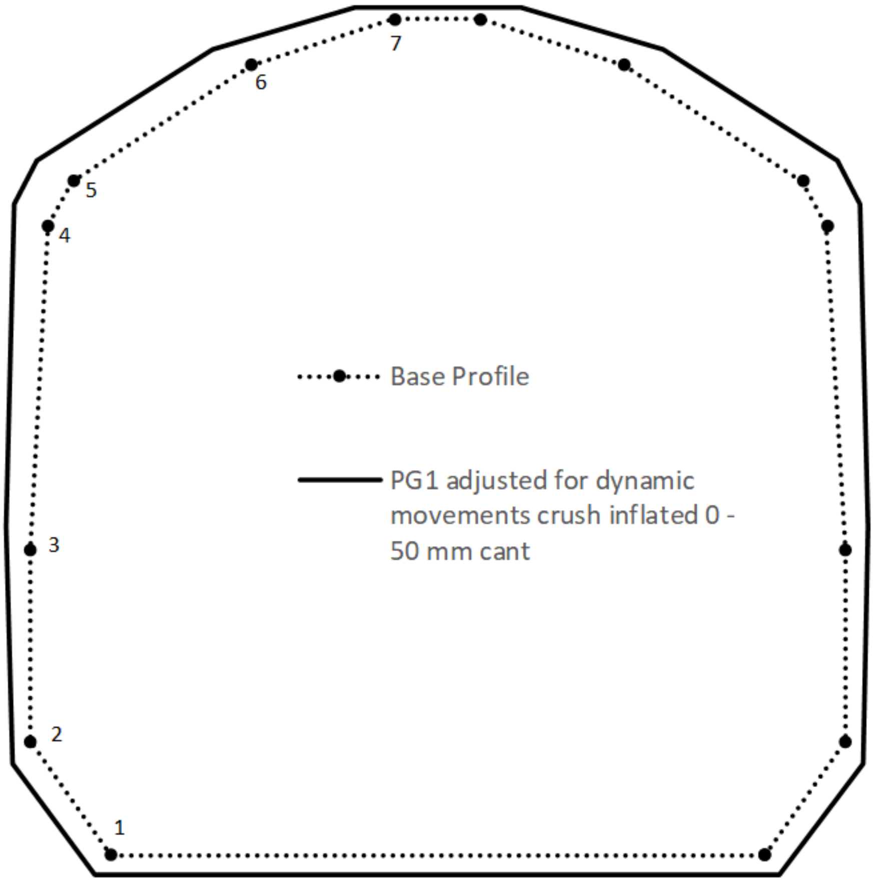


Figure 18: PG1 diagram

Point	X (mm)	Y (mm)
1	1132.1	950
2	1410	1359.7
3	1410	2054
4	1347.3	3222.8
5	1263.1	3381.9
6	645.1	3800.2
7	149.5	3966

Table 20: PG1 base profile co-ordinates

Rationale

G 6.1.1.2 Specific cases 7.3.2.2 of the LOC & PAS TSI and 7.7.17.1 of the INF TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 6.1.1.3 These requirements ensure that the largest possible swept envelope for the vehicle is accommodated within the gauge and is therefore compatible with infrastructure that has been declared compliant to the gauge.

G 6.1.1.4 The objective of developing PG1 was to reduce costs associated with gauging analysis for vehicle introduction and cascade, at the same time providing a good trade-off between maximising the size of the vehicle and recognising the constraints due to the existing infrastructure.

Guidance

G 6.1.1.5 The gauge diagram shows the base profile with the dotted line; this is the profile to which the dynamic movements are applied. For illustrative purposes, the solid line shows the gauge line adjusted with movements applied for 0 mm to 50 mm cant in the crush-inflated condition.

G 6.1.1.6 There is no requirement to build to the base profile. Dynamic movements are applied in all cases, therefore the build profile can be larger than the base profile. Dynamic movements are applied in accordance with workbook 8073SVGD - PG1. See Appendix *B*.

G 6.1.1.7 Passenger Gauge 1 (20 m) PG1 was developed from RSSB research project *T978 (2013)* and revisited in 2016 (*Passenger Gauge 1, Passenger Gauge 2 and Lower Sector Vehicle Gauge Revision)*. The standard vehicle gauge developed in this project was initially derived from existing infrastructure on 'suburban' routes, and then was subsequently analysed on the whole GB railway network.

G 6.1.1.8 PG1 was established based upon a notional 20.38 m long bodyshell, 14.173 m bogie centres and 2.6 m axle spacing on a minimum curve radius of 120 m. The gauge is applicable up to 125 mph. The gauge uses dynamic characteristics typical of a 100 mph vehicle with soft suspension characteristics and research shows these can be applied up to 125 mph without affecting the gauge definition.

G 6.1.1.9 The developed standard vehicle gauges from *T978 (2013)* are not limited to a particular type of route, and have been renamed for publication as PG1 . PG1 was derived to provide positive clearances relative to existing infrastructure and passing clearances in the upper sector. The gauge does not fit everywhere, and there are a number of known Exception Structures associated with the PG1. Some of these Exception Structures are critical and will dictate the design of vehicles on the routes on which they are located. The list of exception structures is available from the infrastructure manager. A comparative analysis was carried out on a number of classes of multiple units to confirm that the derived gauges were useable and in line with previous vehicle designs.

G 6.1.1.10 The derivation of some of the key co-ordinates of the gauge are set out below:

a) 3966 mm roof height is defined by the maximum dynamic W6a gauge, adjusted for vertical throw on a 500 m vertical curve.
b) Gauge shape above platform / solebar level is defined by existing rolling stock or existing infrastructure.
c) 2820 mm maximum width is defined as slightly wider than existing 20 m passenger rolling stock (typically 2810 mm), although it is noted that bodyside door indicator lights of Class 319 exceed these values.
d) Gauge shape at platform / solebar level is defined by the limiting space envelope of platforms on the suburban routes.
e) 950 mm lower boundary of the gauge is set at a nominal height to allow for interaction with the LSVG.

G 6.1.1.11 The gauge enlarges on vertical and horizontal curves by an amount equivalent to the throw of vehicles with 14.173 m bogie centres, a bogie wheelbase of 2.6 m and a body length of 20.38 m.

6.1.2 Application of PG1 to rolling stock

6.1.2.1 The vehicle, including dynamic movements and tolerances, shall remain within the PG1 dynamic gauge profile for all conditions, curvatures and cant deficiencies as sets out in Standard Vehicle Gauge Data workbook 8073SVGD – PG1 on horizontal curves down to 120m radius and vertical curves down to 500 m radius.

Rationale

G 6.1.2.2 Specific cases 7.3.2.2 of the LOC & PAS TSI and 7.7.17.1 of the INF TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 6.1.2.3 These requirements ensure that the largest possible swept envelope for the vehicle is accommodated within the gauge and is therefore compatible with infrastructure that has been declared compliant to the gauge.

Guidance

G 6.1.2.4 The application of PG1 is different from that of the W gauges (see 8073SVGD – PG1).

G 6.1.2.5 The intended application of PG1 is to use the base profile with the PG1 dynamic movements in a relevant gauging software package. The co-ordinates change in accordance with the cant deficiency / excess and vehicle condition (tare-inflated, crush-inflated, crush-deflated) and curve overthrow. Dynamic movements and reference overthrow values are defined within Standard Vehicle Gauge Data workbook 8073SVGD – PG1.

G 6.1.2.6 For further guidance on the application of dynamic movements see Appendix *B*.

G 6.1.2.7 PG1 extends below 1100 mm to permit for an overlap with the LSVG.

G 6.1.2.8 The following points are to be noted in conjunction with PG1:

a) PG1 does not adjust for speed.
b) The dynamic movements associated with 50 mm cant are assumed to remain constant for cant inputs between 0 mm and 50 mm to accommodate new vehicles with softer suspensions.
c) The vehicle profile and all body side and roof projections, including body side door indicator lights, Global System for Mobile Communications (GSM) antennae and Closed Circuit Television (CCTV) cameras are contained within PG1, for all suspension conditions and over the range of cant excess / deficiency cases.
d) At 150 mm cant deficiency / excess the dynamic gauge line is at maximum movements.
e) PG1 does not include provision for deployed pantographs. Stowed pantographs are included within the PG1 dynamic profiles.
f) PG1 does not include provision for rolling stock with opening windows.
g) PG1 does not include provision for footsteps; footsteps need to be considered separately.

6.1.3 Application of PG1 to infrastructure

6.1.3.1 The PG1 co-ordinates shall be adjusted for horizontal and vertical curve overthrow using the following formulae: $T_i = \frac{25978}{R}$, $T_o = \frac{23446}{R}$

6.1.3.2 The PG1 co-ordinates shall be further adjusted for dynamic movements relating to cant excess and cant deficiency and wheelset movements in accordance with the values set out in Standard Vehicle Gauge Data workbook 8073SVGD – PG1.

Rationale

G 6.1.3.3 Specific cases 7.3.2.2. of the LOC & PAS TSI and 7.7.17.1. of the INF TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 6.1.3.4 These requirements ensure that the largest possible swept envelope is considered in the assessment of gauge compatibility with the infrastructure.

Guidance

G 6.1.3.5 It should be noted that PG1 includes an allowance for flange / rail clearance; therefore these values are not added during clearance analysis.

G 6.1.3.6 For further guidance relating to overthrow on curves see Appendix *A*

G 6.1.3.7 For further guidance on the application of dynamic movements see Appendix *B*

6.2 Passenger Gauge 2 (23 m) - PG2

6.2.1 Definition of PG2

6.2.1.1 PG2, defined by the co-ordinates in table *21* and *22* , shall be used in accordance with the application rules set out in *6.2.2* and *6.2.3*.

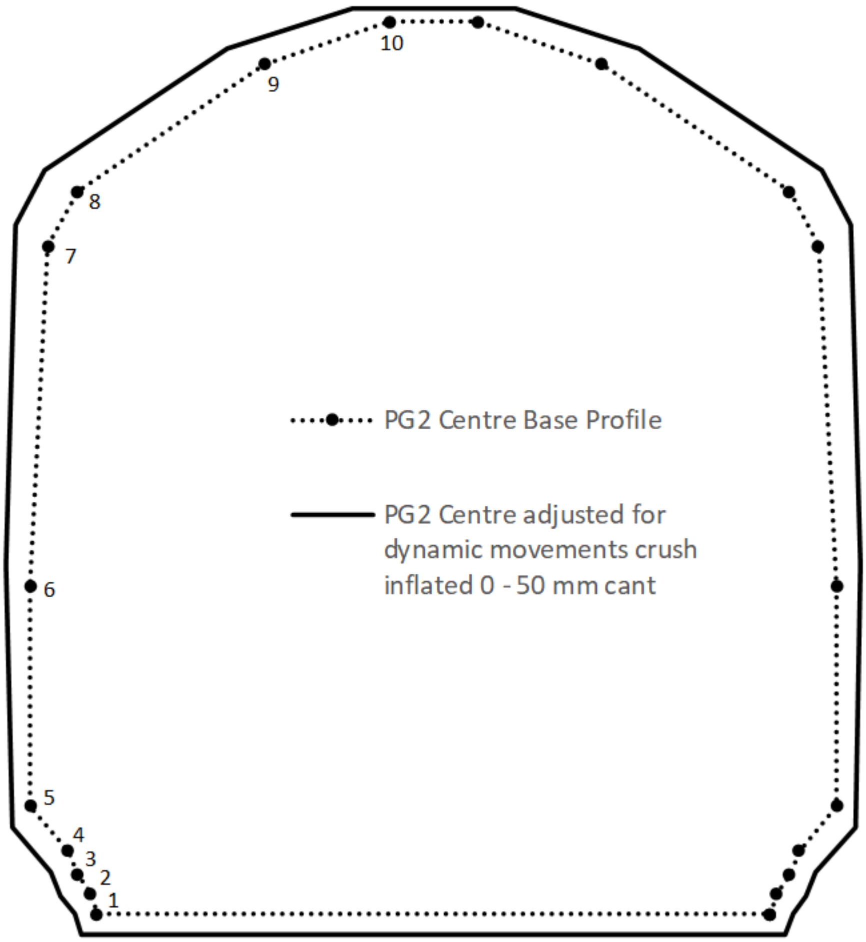


Figure 19: PG2 diagram - centre section

Point	X (mm)	Y (mm)
1	1143.4	950
2	1165.7	1018.4
3	1208.7	1080.4
4	1241.5	1161.5
5	1370	1314
6	1370	2053.9
7	1308.6	3197.2
8	1208.4	3380.4
9	573.5	3810.2
10	149.5	3952

Table 21: PG2 base profile co-ordinates centre section

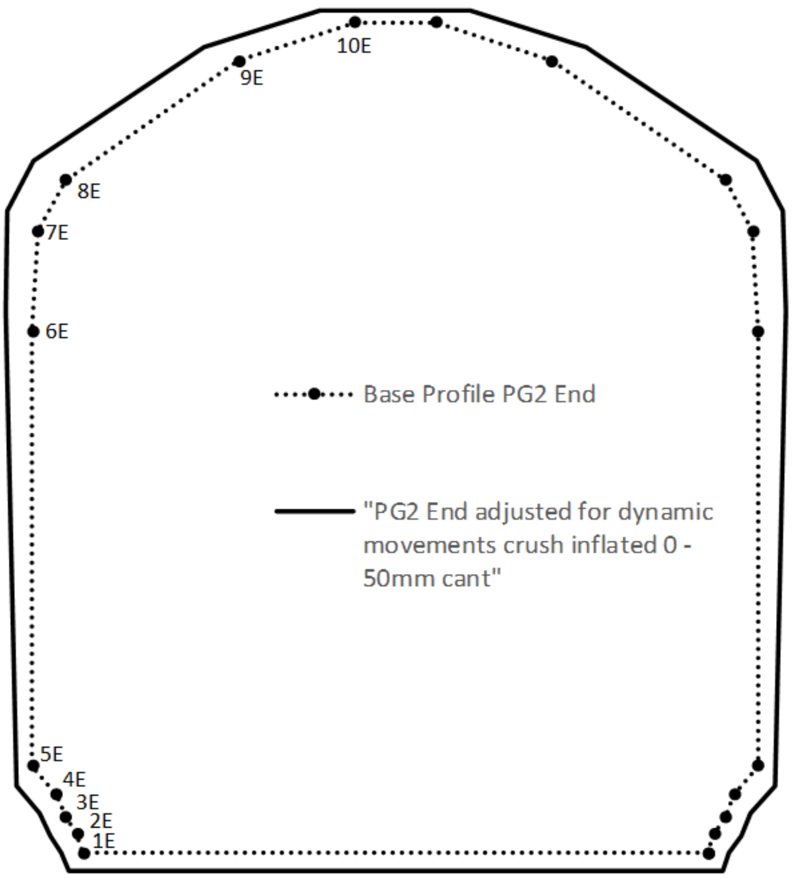


Figure 20: PG2 diagram - end section

Point	X (mm)	Y (mm)
1E	1143.4	950
2E	1165.7	1018.4
3E	1208.7	1080.4
4E	1241.5	1161.5
5E	1328	1264.2
6E	1328	2836.5
7E	1308.6	3197.2
8E	1208.4	3380.4
9E	573.5	3810.2
10E	149.5	3952

Table 22: PG2 base profile co-ordinates end section

Rationale

G 6.2.1.2 Specific cases 7.3.2.2 of the LOC & PAS TSI and 7.7.17.1 of the INF TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 6.2.1.3 These requirements ensure that the largest possible swept envelope for the vehicle is accommodated within the gauge and is therefore compatible with infrastructure that has been declared compliant to the gauge.

G 6.2.1.4 The objective of developing PG2 was to reduce costs associated with gauging analysis for vehicle introduction and cascade, at the same time providing a good trade-off between maximising the size of the vehicle and recognising the constraints due to the existing infrastructure.

Guidance

G 6.2.1.5 The gauge diagrams show the base profiles with the dotted lines; these are the profiles to which the dynamic movements are applied. For illustrative purposes, the solid line shows the gauge line adjusted with movements applied for 0 mm-50 mm cant in the crush-inflated condition.

G 6.2.1.6 There is no requirement to build to the base profile. Dynamic movements are applied in all cases, therefore the build profile can be larger than the base profile. Dynamic movements are applied in accordance with workbook 8073SVGD - PG2. See Appendix *B*.

G 6.2.1.7 Passenger Gauge 2 (23 m) PG2 was developed from RSSB research project *T978 (2013)* and revisited in 2016 (*Passenger Gauge 1, Passenger Gauge 2 and Lower Sector Vehicle Gauge Revision)*. The standard vehicle gauge developed in this project was initially derived from existing infrastructure on 'suburban' routes and then was subsequently analysed on the whole GB railway network.

G 6.2.1.8 PG2 was established based upon a notional 23.072 m long bodyshell, 16 m bogie centres and 2.6 m axle spacing on a minimum curve radius of 120 m. The gauge is applicable up to 125 mph. The gauge uses dynamic characteristics typical of a 100 mph vehicle with soft suspension characteristics and the research project shows these can be applied up to 125 mph without affecting the gauge definition.

G 6.2.1.9 The developed standard vehicle gauges from *T978 (2013)* are not limited to a particular type of route and have been renamed for publication as PG2 . PG2 was derived to provide positive clearances relative to existing infrastructure and passing clearances in the upper sector. The gauge does not fit everywhere and there are a number of known Exception Structures associated with the PG2. Some of these Exception Structures are critical and will dictate the design of vehicles on the routes on which they are located. A comparative analysis was carried out on a number of classes of electric multiple units to confirm that the derived gauges were useable and in line with previous vehicle designs.

G 6.2.1.10 PG2 includes a taper section (see Figure *21*) in order to benefit from the increased width, while providing passing clearances similar to those for the PG1. The start of the taper section is at 11.092 m (from the centreline) and the width of the end section reduces to 2656 mm based upon the endthrow of PG2 on a 120 m curve.

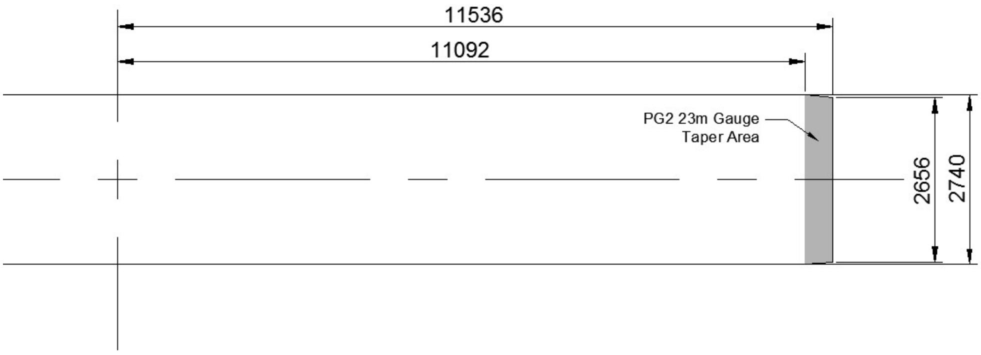


Figure 21: PG2 layout diagram

6.2.2 Application of PG2 to rolling stock

6.2.2.1 The vehicle, including dynamic movements and tolerances, shall remain within the PG2 dynamic gauge profile for all conditions, curvatures and cant deficiencies as sets out in Standard Vehicle Gauge Data workbook 8073SVGD – PG2.

Rationale

G 6.2.2.2 Specific cases 7.3.2.2 of the LOC & PAS TSI and 7.7.17.1 of the INF TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 6.2.2.3 These requirements ensure that the largest possible swept envelope for the vehicle is accommodated within the gauge and is therefore compatible with infrastructure that has been declared compliant to the gauge.

Guidance

G 6.2.2.4 The application of PG2 is different from that of the W gauges (see 8073SVGD – PG2).

G 6.2.2.5 The intended application of PG2 is to use the base profile with the PG2 dynamic movements in a relevant gauging software package. The co-ordinates change in accordance with the cant deficiency / excess and vehicle condition (tare-inflated, crush-inflated, crush-deflated) and curve overthrow. Dynamic movements and reference overthrow values are defined within Standard Vehicle Gauge Data workbook 8073SVGD – PG2.

G 6.2.2.6 PG2 extends below 1100 mm to permit for an overlap with the LSVG.

G 6.2.2.7 For further guidance on the application of dynamic movements see Appendix *B*

G 6.2.2.8 The following points are to be noted in conjunction with PG2:

a) PG2 does not adjust for speed.
b) The dynamic movements associated with 50 mm cant are assumed to remain constant for cant inputs between 0 mm and 50 mm to accommodate new vehicles with softer suspensions.
c) The vehicle profile and all body side and roof projections, including body side door indicator lights, Global System for Mobile Communications (GSM) antennae and Closed Circuit Television (CCTV) cameras are contained within PG2, for all suspension conditions and over the range of cant excess / deficiency cases.
d) At 150 mm cant deficiency / excess the dynamic gauge line is at maximum movements.
e) PG2 does not include provision for deployed pantographs. Stowed pantographs are included within the PG2 dynamic profiles.
f) PG2 does not include provision for rolling stock with opening windows.
g) PG2 does not include provision for footsteps; footsteps need to be considered separately.

6.2.3 Application of PG2 to infrastructure

6.2.3.1 PG2 shall be adjusted for horizontal and vertical curve overthrow using the following formulae: $T_i = \frac{32883}{R}$, $T_o = \frac{32906}{R}$

6.2.3.2 PG2 shall be further adjusted for dynamic movements relating to cant excess and cant deficiency and wheelset movements in accordance with the values set out in Standard Vehicle Gauge Data workbook 8073SVGD – PG2.

Rationale

G 6.2.3.3 Specific cases 7.3.2.2 of the LOC & PAS TSI and 7.7.17.1 of the INF TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 6.2.3.4 These requirements ensure that the largest possible swept envelope is considered in the assessment of gauge compatibility with the infrastructure.

Guidance

G 6.2.3.5 It should be noted that PG2 includes an allowance for flange / rail clearance; therefore these values are not added during clearance analysis.

G 6.2.3.6 For further guidance relating to overthrow on curves see Appendix *A*

G 6.2.3.7 For further guidance on the application of dynamic movements see Appendix *B*

6.3 Passenger Gauge 3 (26 m) - PG3

6.3.1 Definition of PG3

6.3.1.1 PG3, defined by the co-ordinates in table *23* and *24*, shall be used in accordance with the application rules set out in *6.3.2* and *6.3.3*.

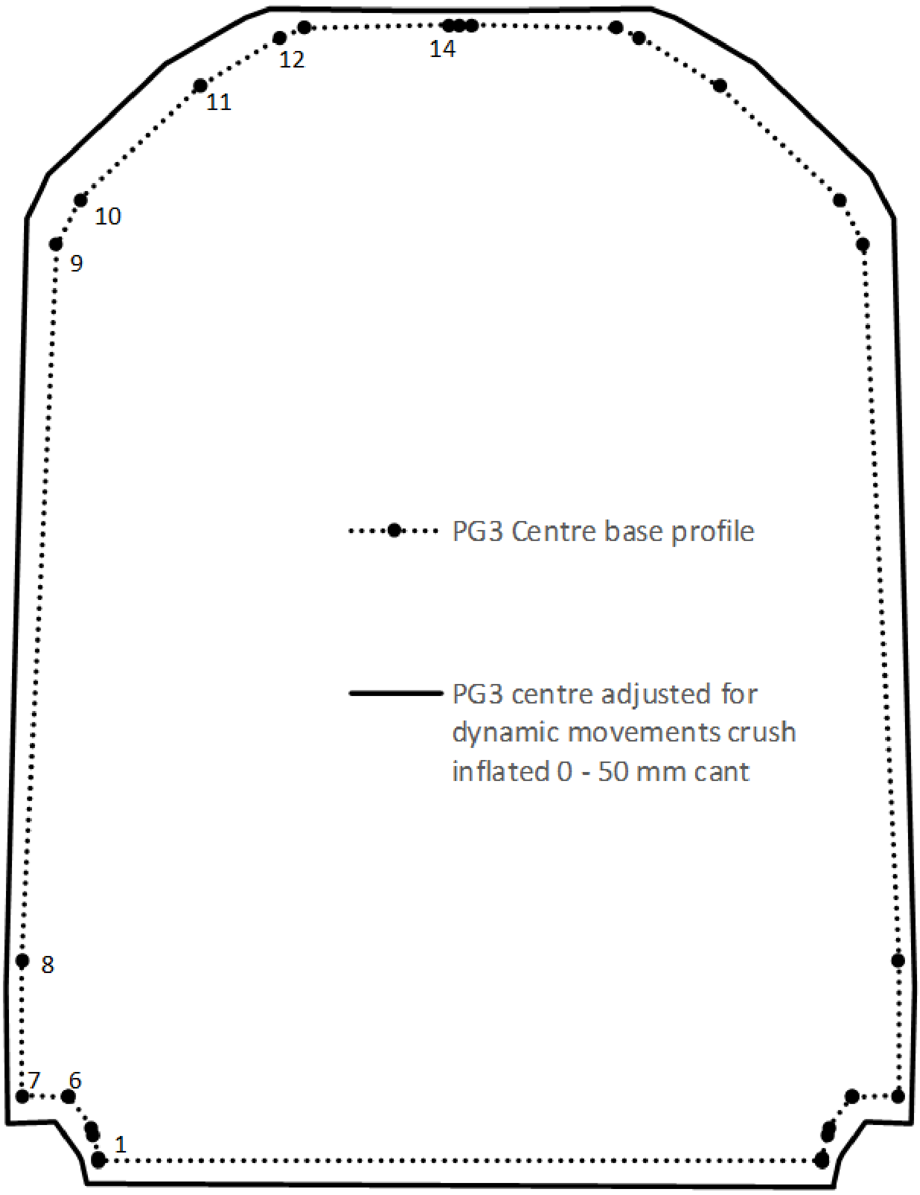


Figure 22: PG3 diagram - centre section

Point	X (mm)	Y (mm)
1	1148.4	950
2	1148.6	958.5
3	1164.3	1016.3
4	1171.5	1037.1
5	1243.6	1118
6	1244.1	1118.5
7	1392.2	1120.8
8	1392.2	1472.3
9	1281.1	3331.5
10	1206.9	3447.6
11	825.2	3743.7
12	570.9	3869.9
13	494	3896.1
14	35.4	3903
15	0	3903.2

Table 23: PG3 base profile co-ordinates - centre section

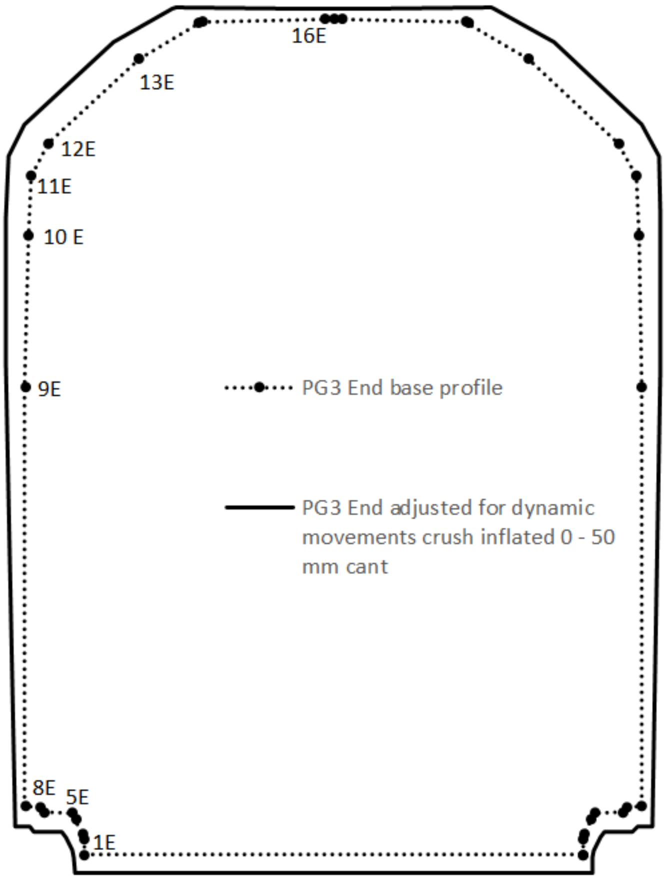


Figure 23: PG3 diagram - end section

Point	X (mm)	Y (mm)
1E	1057.2	950
2E	1057.2	1003.8
3E	1063.1	1025.6
4E	1091.4	1073.6
5E	1108.6	1096.2
6E	1227	1099.4
7E	1244.1	1118.5
8E	1305.9	1119.5
9E	1305.9	2592.2
10E	1293.6	3123.1
11E	1281.1	3331.5
12E	1206.9	3447.6
13E	825.2	3743.7
14E	570.9	3869.9
15E	557.9	3874.3
16E	35.2	3882.1
17E	0	3882.4

Table 24: PG3 co-ordinates - end section

Rationale

G 6.3.1.2 Specific cases 7.3.2.2 of the LOC & PAS TSI and 7.7.17.1 of the INF TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 6.3.1.3 These requirements ensure that the largest possible swept envelope for the vehicle is accommodated within the gauge and is therefore compatible with infrastructure that has been declared compliant to the gauge.

G 6.3.1.4 The objective of developing PG3 was to reduce costs associated with gauging analysis for vehicle introduction and cascade, at the same time providing a good trade-off between maximising the size of the vehicle and recognising the constraints of the existing infrastructure.

Guidance

G 6.3.1.5 The gauge diagram shows the base profile with the dotted line; this is the profile to which the dynamic movements are applied. For illustrative purposes, the solid line shows the gauge line adjusted with movements applied for 0 mm to 50 mm cant in the crush-inflated condition.

G 6.3.1.6 There is no requirement to build to the base profile. Dynamic movements are applied in all cases, therefore the build profile can be larger than the base profile. Dynamic movements are applied in accordance with workbook 8073SVGD - PG3. See Appendix *B*.

G 6.3.1.7 Passenger Gauge 3 (26 m) PG3 was developed from RSSB research project *T1092 (2018)*.

G 6.3.1.8 The developed standard vehicle gauge from *T1092 (2018)* is not limited to a particular type of route and has been named for publication as PG3. PG3 was derived to provide positive clearances relative to existing infrastructure and passing clearances in the upper sector. The gauge does not fit everywhere and there are a number of known Exception Structures associated with the PG3. Some of these Exception Structures are critical and will dictate the design of vehicles on the routes on which they are located.

G 6.3.1.9 PG3 includes a taper section (See Figure *24*) in order to benefit from the increased width while providing passing clearances similar to those for the PG1 and PG2. The start of the taper section is at 11.4 m (from the centreline) and the width of the end section reduces to 2612 mm based upon the endthrow of PG3 on a 120 m curve.

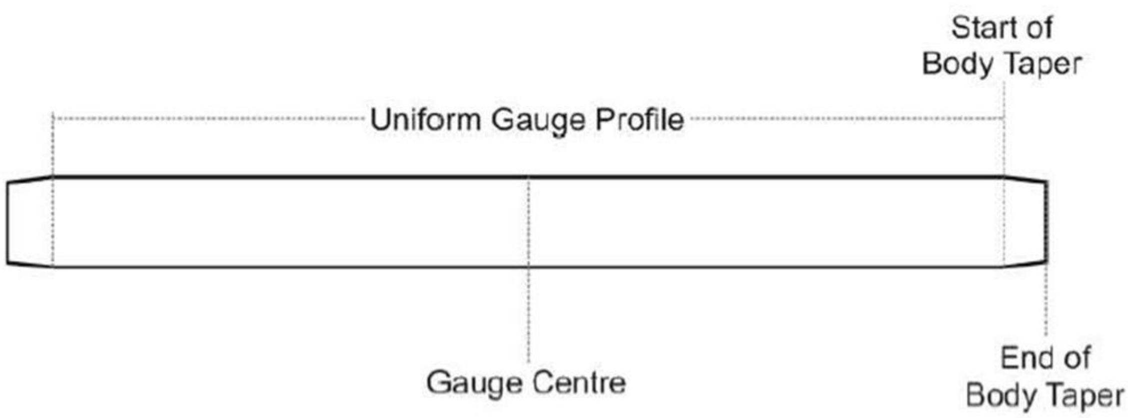


Figure 24: PG3 layout diagram

6.3.2 Application of PG3 to rolling stock

6.3.2.1 The vehicle, including dynamic movements and tolerances, shall remain within the PG3 dynamic gauge profile for all conditions, curvatures and cant deficiencies as set out in Standard Vehicle Gauge Data workbook 8073SVGD - PG3 on horizontal curves down to 120m radius and vertical curves down to 500 m radius.

Rationale

G 6.3.2.2 Specific cases 7.3.2.2 of the LOC & PAS TSI and 7.7.17.1 of the INF TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 6.3.2.3 These requirements ensure that the largest possible swept envelope for the vehicle is accommodated within the gauge and is therefore compatible with infrastructure that has been declared compliant to the gauge.

Guidance

G 6.3.2.4 The application of PG3 is different from that of the W gauges, see Standard Vehicle Gauge Data workbook 8073SVGD – PG3.

G 6.3.2.5 The intended application of PG3 is to use the base profile with the PG3 dynamic movements in a relevant gauging software package. The co-ordinates change in accordance with the cant deficiency / excess and vehicle condition (tare-inflated, crush-inflated, crush-deflated) and curve overthrow. Dynamic movements and reference overthrow values are defined within Standard Vehicle Gauge Data workbook 8073SVGD – PG3.

G 6.3.2.6 For further guidance on the application of dynamic movements see Appendix *B*.

G 6.3.2.7 PG3 extends below 1100 mm to permit for an overlap with LSVG.

G 6.3.2.8 The following points are to be noted in conjunction with PG3:

a) PG3 does not adjust for speed.
b) The dynamic movements associated with 50 mm cant are assumed to remain constant for cant inputs between 0 mm and 50 mm to accommodate new vehicles with softer suspensions.
c) The vehicle profile and all body side and roof projections, including body side door indicator lights, Global System for Mobile Communications (GSM) antennae and Closed Circuit Television (CCTV) cameras are contained within PG3, for all suspension conditions and over the range of cant excess / deficiency cases.
d) At 150 mm cant deficiency / excess the dynamic gauge line is at maximum movements.
e) PG3 does not include provision for deployed pantographs. Stowed pantographs are included within the PG3 dynamic profiles.
f) PG3 does not include provision for rolling stock with opening windows.
g) PG3 does not include provision for footsteps; footsteps need to be considered separately.

6.3.3 Application of PG3 to infrastructure

6.3.3.1 PG3 shall be adjusted for horizontal and vertical curve overthrow using the following formulae: $T_i = \frac{37084}{R}$, $T_o = \frac{46420}{R}$

6.3.3.2 PG3 shall be further adjusted for dynamic movements relating to cant and speed and wheelset movements in accordance with the values set out in Standard Vehicle Gauge Data workbook 8073SVGD – PG3.

Rationale

G 6.3.3.3 Specific cases 7.3.2.2 of the LOC & PAS TSI and 7.7.17.1 of the INF TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 6.3.3.4 These requirements ensure that the largest possible swept envelope is considered in the assessment of gauge compatibility with the infrastructure.

Guidance

G 6.3.3.5 It should be noted that PG3 includes an allowance for flange / rail clearance; therefore these values are not added during clearance analysis.

G 6.3.3.6 For further guidance relating to overthrow on curves see Appendix *A*.

G 6.3.3.7 For further guidance on the application of dynamic movements see Appendix *B*

Part 7 Gauges applicable to Locomotives

7.1 Locomotive Gauge 1 - LG1

7.1.1 Definition of LG1

7.1.1.1 LG1, defined by the co-ordinates in tables *25*, *26*, *27*, *28* and *29*, shall be used in accordance with the application rules set out in *7.1.2* and *7.1.3*.

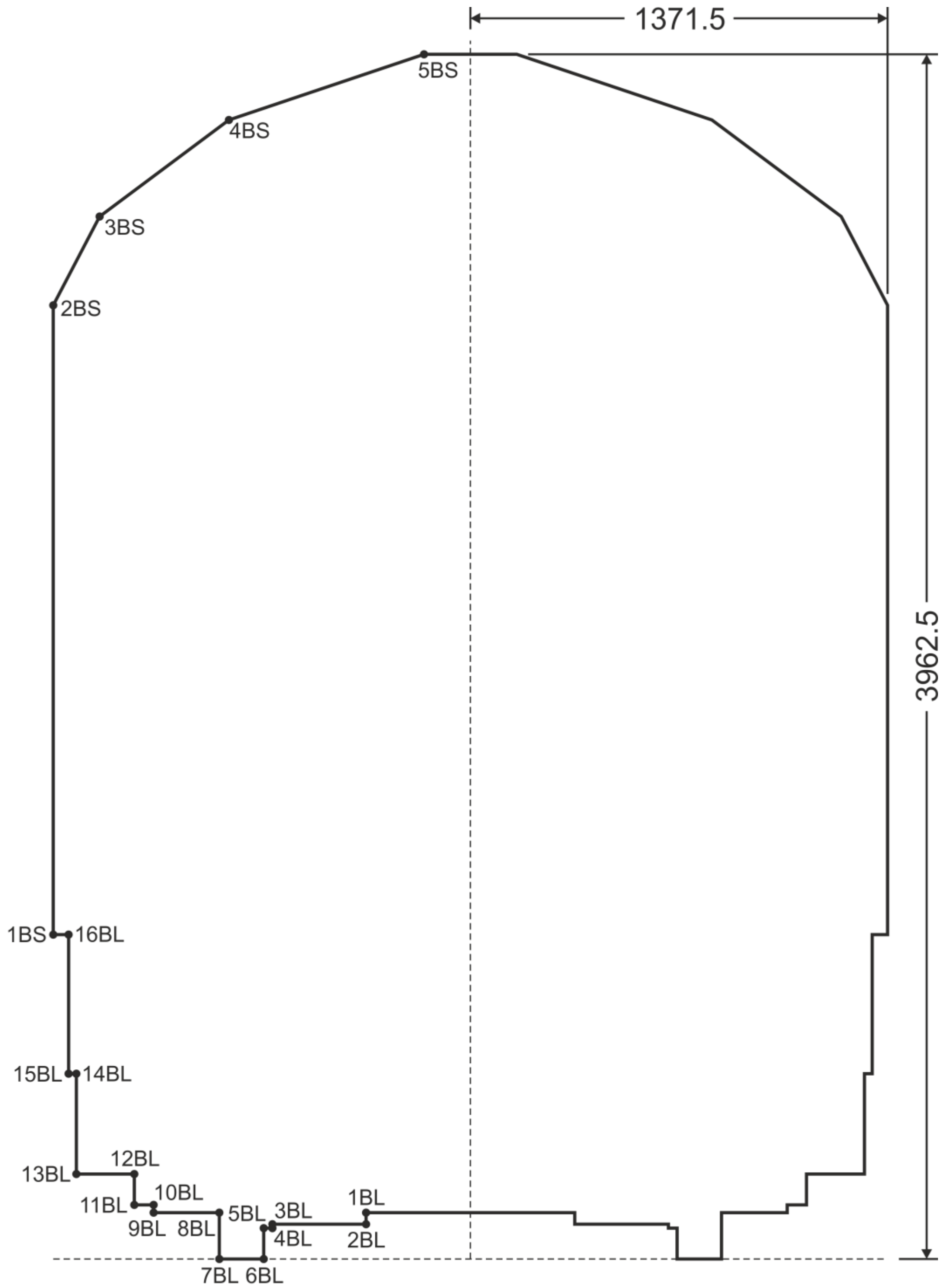


Figure 25: LG1 maximum build gauge diagram

Point	X (mm)	Y (mm)
1BS	1371.5	1067
2BS	1371.5	3137
3BS	1219	3429
4BS	794	3746.5
5BS	152.5	3962.5

Table 25: Maximum upper build gauge co-ordinates

Point	X (mm)	Y (mm)
1BL	343	152.5
2BL	343	114.5
3BL	651	114.5
4BL	651	101.5
5BL	679.5	101.5
6BL	679.5	0
7BL	825.5	0
8BL	825.5	152.5
9BL	1041.5	152.5
10BL	1041.5	178
11BL	1105	178
12BL	1105	279.5
13BL	1295.5	279.5
14BL	1295.5	609.5
15BL	1321	609.5
16BL	1321	1067

Table 26: Maximum lower build gauge co-ordinates, incorporating dynamic movements

Point	X (mm)	y (mm)
1TS	1345.5	1067
2TS	1345.5	1232
3TS	1371	1473
4TS	1371	2337
5TS	1345	3137
6TS	1193	3429
7TS	767.5	3746.5
8TS	126	3962.5

Table 27: Static co-ordinates of upper overthrow gauge

Note: There is no figure showing these co-ordinates

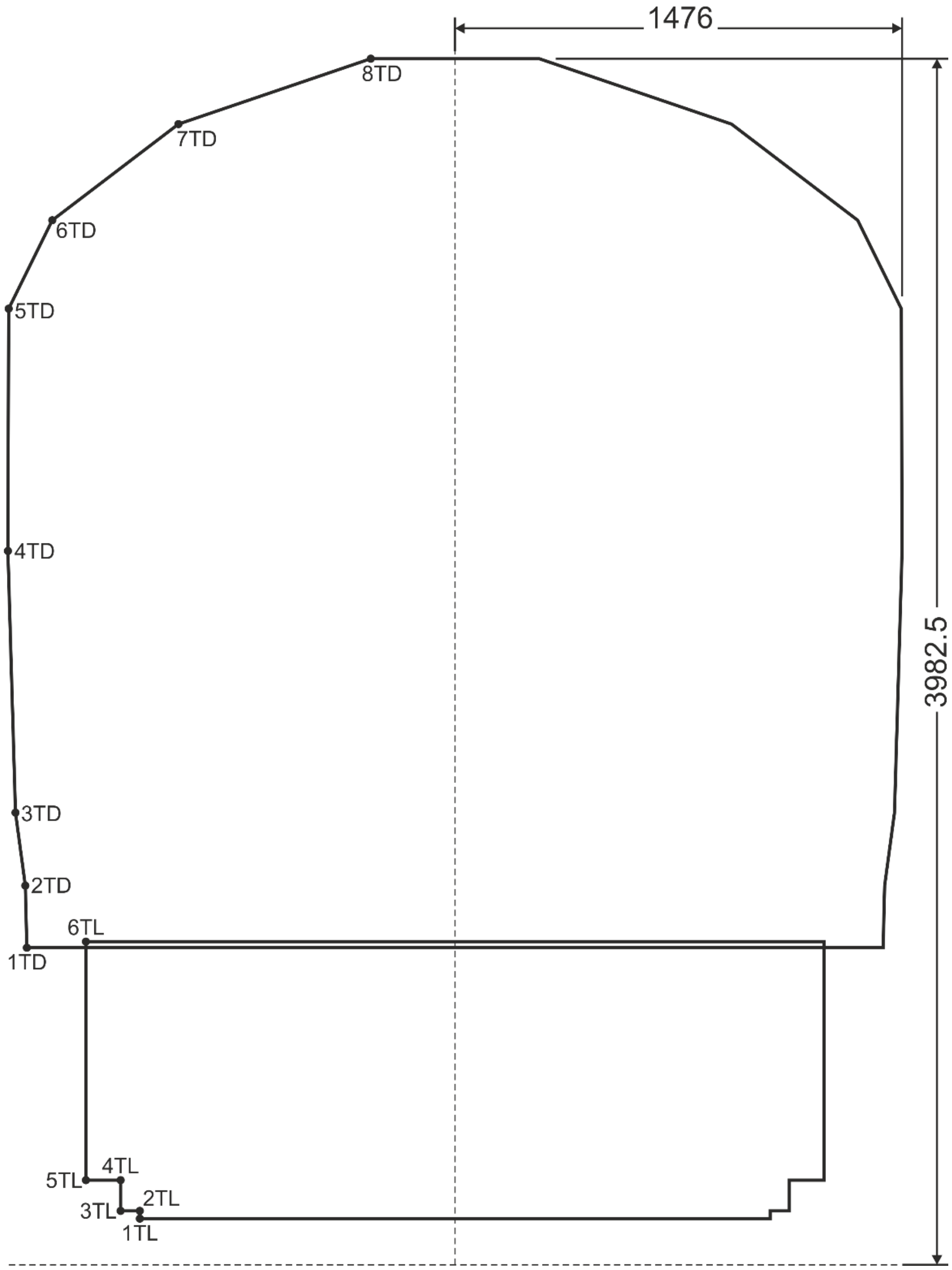


Figure 26: LG1 Overthrow gauge diagram, incorporating dynamic movements

Point	X (mm)	Y (mm)
1TD	1413.5	1047
2TD	1418.5	1252
3TD	1451	1493
4TD	1476	2357
5TD	1473.5	3157
6TD	1329.5	3449
7TD	913	3766.5
8TD	278	3982.5

Table 28: Co-ordinates of upper overthrow gauge, incorporating dynamic movements

Point	X (mm)	Y (mm)
1TL	1040.5	152.5
2TL	1040.5	178
3TL	1104	178
4TL	1104	279.5
5TL	1218.5	279.5
6TL	1218.5	1067

Table 29: Co-ordinates of lower overthrow gauge, incorporating dynamic movements.

Rationale

G 7.1.1.2 Specific cases 7.3.2.2 of the LOC & PAS TSI and 7.7.17.1 of the INF TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 7.1.1.3 These requirements ensure that the largest possible swept envelope for the vehicle is accommodated within the gauge and is therefore compatible with infrastructure that has been declared compliant to the gauge.

Guidance

G 7.1.1.4 LG1 was formerly called Locomotive Gauge; it has been renamed LG1 to be consistent with the naming convention used with the rest of the gauges and to differentiate it from the new locomotive gauge LG2. The definition of the gauge itself is unchanged.

G 7.1.1.5 LG1 is a vehicle gauge commonly used for locomotives.

G 7.1.1.6 Bogies consistent with the gauge and the vehicle gauging data for the established suspensions can be found in Standard Vehicle Gauging Data workbook 8073SVGD – LG1

G 7.1.1.7 Not all locomotives comply with LG1. It was originally defined on drawing L-A1-1806 (BR CM&EE Dept. 12 March 1970) updated to issue B (13 August 1970).

G 7.1.1.8 Overthrow gauge is derived from the broken line of L-A1-1806, representing the maximum overthrow contour on a 200 m curve. Accordingly, the semi-width has been reduced from L-A1-1806 by 102.5 mm. This is to allow standard overthrow formulae to be applied to curves of any radius when checking clearances.

G 7.1.1.9 The dimensions for LG1 were converted from the original drawing in imperial units to a resolution of 0.5 mm. Previous issues of the gauge have used approximations for some values.

G 7.1.1.10 The lower sector gauge has been extracted from the original gauge drawing, and defined as dynamic. This maintains a consistency between this gauge and other gauges.

7.1.2 Application of LG1 to rolling stock

7.1.2.1 No part of the locomotive shall exceed the maximum build gauge (see co-ordinates in tables *25* and *26*) when stationary on level track.

7.1.2.2 No part of the locomotive shall exceed the static upper overthrow gauge (see table *27*) adjusted for horizontal curve overthrow.

7.1.2.3 No part of the locomotive shall exceed the upper or lower overthrow gauges incorporating dynamic movements (see tables *28* and *29*) when adjusted for horizontal curve overthrow and when operating at up to its maximum speed and cant deficiency.

7.1.2.4 LG1 overthrow gauge shall be adjusted for horizontal and vertical overthrow using the following formulae:

$$T_i = \frac{20500}{R},\ T_o = \frac{20500}{R}$$

7.1.2.5 No part of the locomotive shall exceed the overthrow gauges, adjusted for vertical curve overthrow, on a vertical curve of 500 m radius.

Rationale

G 7.1.2.6 Specific cases 7.3.2.2 of the LOC & PAS TSI and 7.7.17.1 of the INF TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 7.1.2.7 These requirements ensure that the largest possible swept envelope for the vehicle is accommodated within the gauge and is therefore compatible with infrastructure that has been declared compliant to the gauge.

Guidance

G 7.1.2.8 The dynamic data can be found in Standard Vehicle Gauge Data workbook 8073SVGD – LG1, which was originally generated from the Class 58 locomotive.

7.1.3 Application of LG1 to infrastructure

7.1.3.1 LG1 overthrow gauge shall be adjusted for horizontal and vertical overthrow using the following formulae:

$$T_i = \frac{20500}{R}, T_o = \frac{20500}{R}$$

7.1.3.2 Clearances shall be taken to be the smaller of:

a) The clearance to the maximum build gauge incorporating dynamic movements.
b) The clearance to the overthrow gauge incorporating dynamic movements after adjustment for curve overthrow.

Rationale

G 7.1.3.3 Specific cases 7.3.2.2 of the LOC & PAS TSI and 7.7.17.1 of the INF TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 7.1.3.4 These requirements ensure that the largest possible swept envelope is considered in the assessment of gauge compatibility with the infrastructure.

G 7.1.3.5 It is necessary to provide clearances to both overthrow gauge, including dynamic movements, and to maximum build gauge, including dynamic movements. Due to different profiles defined by the original gauge lines with and without overthrow, individual points on each gauge become significant at different curve radii.

Guidance

G 7.1.3.6 The dynamic data can be found in Standard Vehicle Gauge Data workbook 8073SVGD – LG1, which was originally generated from the Class 58 locomotive.

G 7.1.3.7 Wheel / rail clearance and wheel flange wear values can also be found in Standard Vehicle Gauge Data workbook 8073SVGD – LG1. Rail wear, when present, should also be considered.

7.2 Locomotive Gauge 2 - LG2

7.2.1 Definition of LG2

7.2.1.1 LG2, defined by the co-ordinates in table 30, shall be used in accordance with the application rules set out in 7.2.2 and 7.2.3. LG2 has been established based upon a notional 19.672 m long bodyshell, up to 13.26 m bogie centres and up to 4.2 m bogie wheelbase.

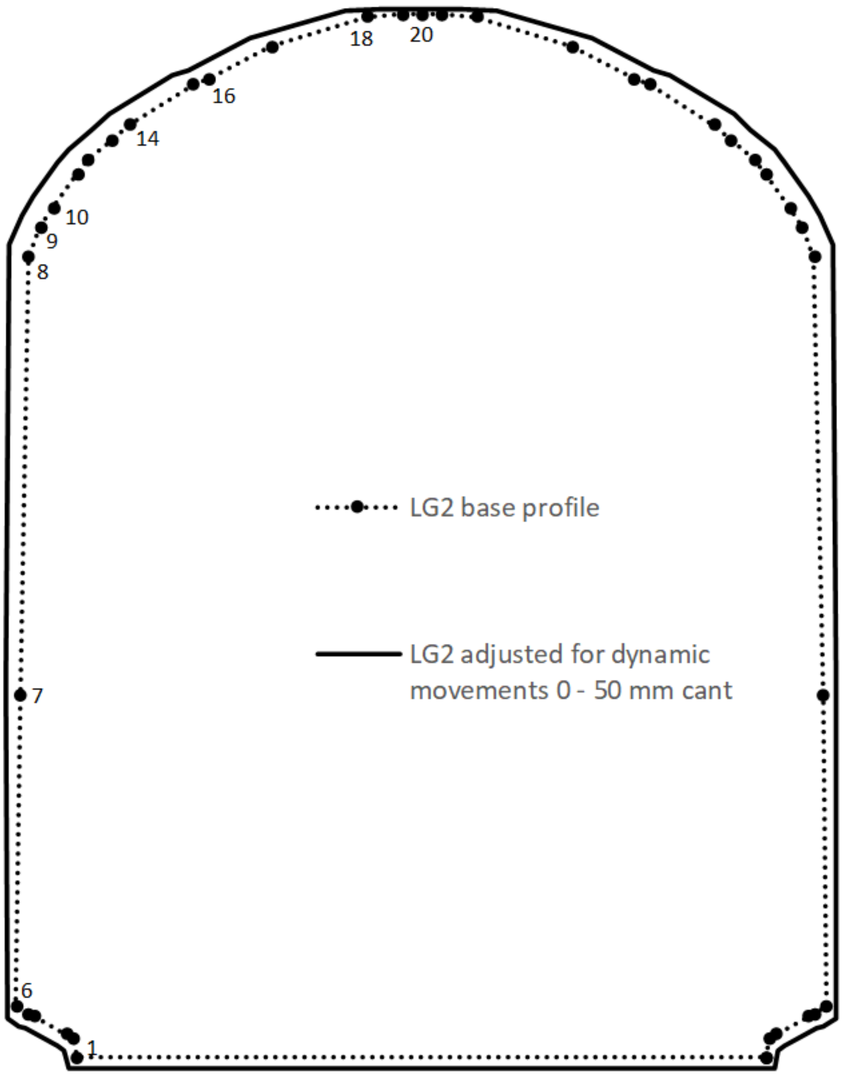


Figure 27: LG2 diagram

Point	X (mm)	Y (mm)
1	1201.1	949.7
2	1214.1	1003.6
3	1238	1017.7
4	1349.1	1068.3
5	1370.6	1074.2
6	1413	1098.9
7	1400.5	2000.1
8	1370.9	3267.5
9	1327.8	3354
10	1285.3	3408.4
11	1199.3	3507.8
12	1162.6	3548.3
13	1079	3604.7
14	1020.3	3650.2
15	797.3	3765.9
16	741.5	3783
17	524.7	3876.7
18	192	3961
19	68.1	3968.8
20	0	3968.8

Table 30: LG2 base profile co-ordinates

Rationale

G 7.2.1.2 Specific cases 7.3.2.2 of the LOC & PAS TSI and 7.7.17.1 of the INF TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 7.2.1.3 These requirements ensure that the largest possible swept envelope for the vehicle is accommodated within the gauge and is therefore compatible with infrastructure that has been declared compliant to the gauge.

G 7.2.1.4 The objective of developing LG2 was to reduce costs associated with gauging analysis for locomotive vehicle introduction and cascade, and at the same time, providing a good trade-off between maximising the size of the vehicle and recognising the constraints of the existing infrastructure.

Guidance

G 7.2.1.5 The gauge diagram shows the base profile with the dotted line; this is the profile to which the dynamic movements are applied. For illustrative purposes, the solid line shows the gauge line adjusted with movements applied for 0 mm to 50 mm cant in the crush-inflated condition.

G 7.2.1.6 There is no requirement to build to the base profile. Dynamic movements are applied in all cases, therefore the build profile can be larger than the base profile. Dynamic movements are applied in accordance with workbook 8073SVGD - LG2. See Appendix *B*.

G 7.2.1.7 Locomotive Gauge LG2 was developed under RSSB research project *T995 (2019)*.

G 7.2.1.8 In RSSB research project *T995 (2019)* the gauge is referred to as LG2019, for consistency for publication in this standard it has been renamed to LG2.

G 7.2.1.9 The previous locomotive gauge, LG1, is not compatible with LSVG. Furthermore, its derivation was potentially over-conservative for the calculation of compatibility with the infrastructure, and was thus unnecessarily restrictive on the route availability of the gauge. The *T995 (2019)* project set out to revise locomotive gauge to make it work better for both vehicles and infrastructure.

G 7.2.1.10 As part of *T995 (2019)* a series of comparisons between LG2 and existing locomotive gauging models have been undertaken using a 57-case virtual route, as developed for RSSB research projects *T978 (2013)* and *T1092 (2018)*. The following locomotive models have been analysed:

- Class 66.
- Class 68.
- Class 70.

G 7.2.1.11 The swept envelopes for each of these locomotives were generated across the 57 virtual route track cases and superimposed upon those of LG2. The results show that the swept envelopes of the Class 66, Class 68 and Class 70 remain within those of LG2 across all 57 track cases. Therefore, the Class 66, Class 68 and Class 70 are all compliant with LG2. An example of this is illustrated in Figure *28* for the Class 68 locomotive.

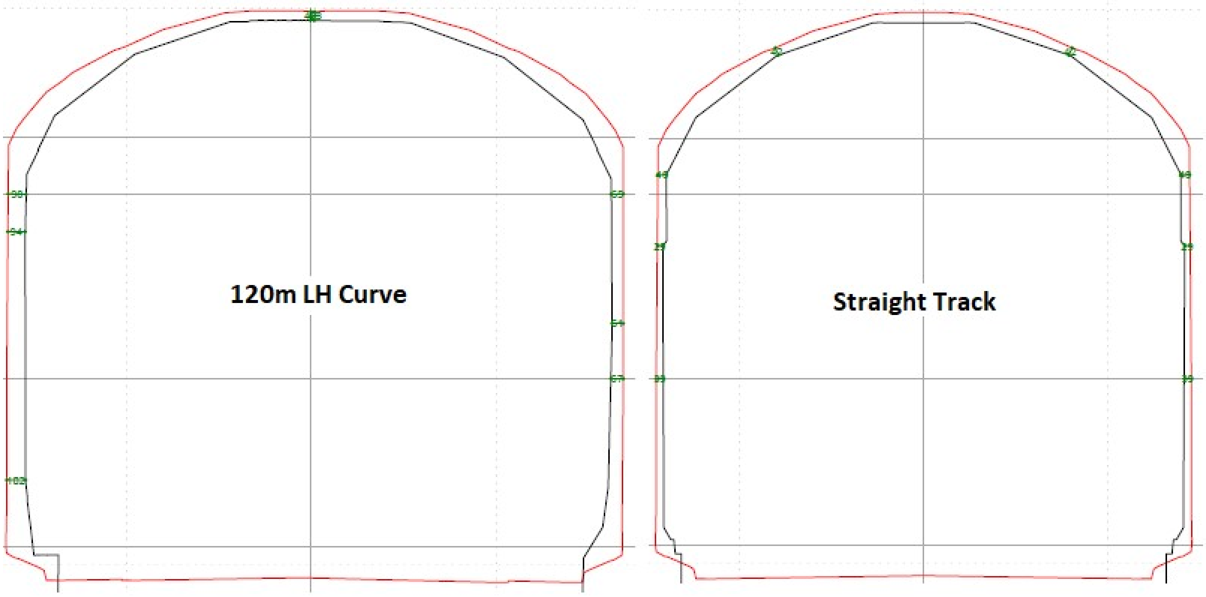


Figure 28: LG2 comparison with Class 68

G 7.2.1.12 LG2 is applicable to 2-axle or 3-axle bogie locomotives

7.2.2 Application of LG2 to rolling stock

7.2.2.1 The vehicle, including dynamic movements and tolerances, shall remain within the adjusted LG2 gauge line for all conditions and cant deficiencies as set out in Standard Vehicle Gauge Data workbook 8073SVGD – LG2.

Rationale

G 7.2.2.2 Specific cases 7.3.2.2 of the LOC & PAS TSI and 7.7.17.1 of the INF TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 7.2.2.3 These requirements ensure that the largest possible swept envelope for the vehicle is accommodated within the gauge and is therefore compatible with infrastructure that has been declared compliant to the gauge.

Guidance

G 7.2.2.4 The dynamic behaviour of the gauge is intended to be representative of a locomotive with suspension characteristics defined by existing rolling stock traveling up to 140 mph.

G 7.2.2.5 LG2 extends below 1,100 mm ARL down to 950 mm ARL to permit for an overlap with the Lower Sector Vehicle Gauge (LSVG)

G 7.2.2.6 For further guidance on the application of dynamic movements see Appendix *B*.

G 7.2.2.7 The following points should be noted in conjunction with LG2:

a) LG2 does not adjust for speed.

b) The dynamic movements associated with 50 mm cant are assumed to remain constant for cant inputs between 0 mm and 50 mm to accommodate new vehicles with softer suspensions.
c) The vehicle profile and all body side and roof projections, including Global System for Mobile Communications (GSM) antennae and Closed Circuit Television (CCTV) cameras are contained within LG2, for all suspension conditions and over the range of cant excess / deficiency cases.
d) At 150 mm cant deficiency / excess the dynamic gauge line is at maximum movements.
e) LG2 does not include provision for deployed pantographs. Stowed pantographs are included within the LG2 dynamic profiles.
f) LG2 does not include provision for rolling stock with opening windows.

7.2.3 Application of LG2 to infrastructure

7.2.3.1 The LG2 co-ordinates shall be adjusted for horizontal and vertical curve overthrow using the following formulae:

$$T_i = \frac{24204}{R},\ T_o = \frac{23625}{R}$$

7.2.3.2 The LG2 co-ordinates shall be further adjusted for dynamic movements relating to cant excess and cant deficiency and wheelset movements in accordance with the values set out in Standard Vehicle Gauge Data workbook 8073SVGD – LG2.

Rationale

G 7.2.3.3 Specific cases 7.3.2.2 of the LOC & PAS TSI and 7.7.17.1 of the INF TSI set out permission for defining the swept envelope of vehicles in accordance with national technical rules.

G 7.2.3.4 These requirements ensure that the largest possible swept envelope is considered in the assessment of gauge compatibility with the infrastructure.

Guidance

G 7.2.3.5 It should be noted that LG2 includes an allowance for flange / rail clearance; therefore these values are not added during clearance analysis.

G 7.2.3.6 For further guidance relating to overthrow on curves see Appendix *A*.

G 7.2.3.7 For further guidance on the application of dynamic movements see Appendix *B*.

Part 8 Application of this document

8.1 Scope

8.1.1 If a change to a vehicle or infrastructure is considered new, renewal or upgrade as defined in the Railways (Interoperability) Regulations 2011 (as amended), then all or part of the vehicle or infrastructure is required to comply with the LOC & PAS TSI or INF TSI, respectively, and other relevant TSIs and NTRs, unless given exemptions allowed for in the Regulations.

8.1.2 Where standard vehicle gauges are to be used for gauging compatibility, as permitted by RIS-8273-RST, the requirements of this document apply to all new and modified (excluding like-for-like replacement of components) vehicles and infrastructure where *8.1.1* applies to the subsystem.

8.1.3 Action to bring existing vehicles or infrastructure into compliance with the requirements of this document is not required.

8.2 Exclusions from scope

8.2.1 There are no exclusions from the scope.

8.3 General enter into force date

8.3.1 The requirements in this document enter into force from 03 December 2022.

8.4 Exceptions to general enter into force date

8.4.1 There are no exceptions to the general enter into force date.

8.5 Applicability of requirements for projects already underway

8.5.1 The Office of Rail and Road (ORR) can be contacted for clarification on the applicable requirements where a project seeking authorisation for placing into service is already underway when this document enters into force.

8.6 Deviations

8.6.1 Where it is considered not reasonably practicable to comply with the requirements of this document, permission to comply with a specified alternative should be sought in accordance with the deviation process set out in the Railway Group Standard Code.

8.6.2 In the case where NTSN compliance is required for a new, renewed or upgraded vehicle or structural subsystem, the exemption process to be followed is set out in the Railways (Interoperability) Regulations 2011 (as amended).

8.7 Health and safety responsibilities

8.7.1 Users of documents published by RSSB are reminded of the need to consider their own responsibilities to ensure health and safety at work and their own duties under health and safety legislation. RSSB does not warrant that compliance with all or any documents published by RSSB is sufficient in itself to ensure safe systems of work or operation or to satisfy such responsibilities or duties.

Appendices

Appendix A Method for calculating overthrow on curves and height and width reduction

A.1 **Important:** The content of this appendix is included for guidance

A.1 Calculating Overthrow

Guidance

G A.1.1 For each gauge, the overthrow at the reference radius has been provided for rolling stock. This is calculated using the method in this appendix based on the reference characteristics of the gauge (as defined with the definition of the gauge).

G A.1.2 For application to infrastructure, simplified formulae are provided to calculate overthrow on curves, which use the following nomenclature: T_i is the overthrow towards the centre (inside) of the curve in mm. T_o is the overthrow towards the outside of the curve in mm. R is the curve radius in m. These formulae are expressed using an overthrow coefficient and are derived using the overthrow at the reference radius.

G A.1.3 The distance between the axles of a railway vehicle may be considered as a chord placed on curved track. The body represents an extension of this chord. As the vehicle traverses the chord, the centre of the vehicle is thrown towards the inside of the curve, and the end of the vehicle is thrown towards the outside of the curve. The effect is greater for longer vehicles and on tighter curves. A bogie is simply a vehicle with centre throw only. Effects due to vertical curves are generally less significant than those due to horizontal curves.

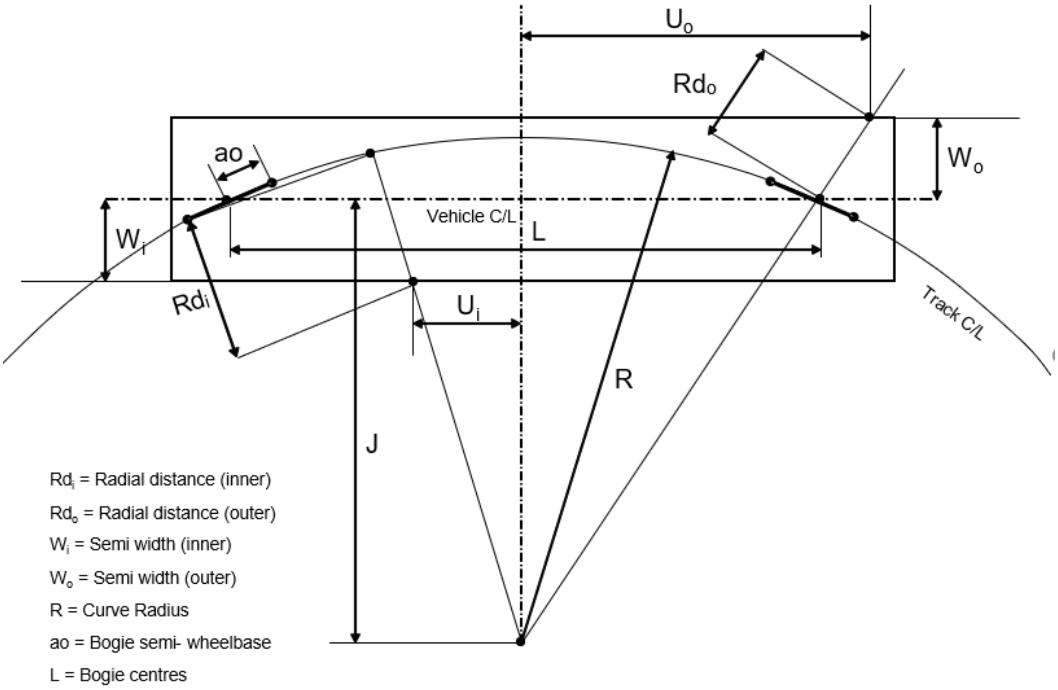


Figure 29: Diagram indicating vehicle body overthrow

G A.1.4 Considering Figure 29 , the overthrows at points on a vehicle body (U_o or U_i) are the differences between the radial distance from the track centreline to the point (Rd_o or Rd_i), and the lateral distance from the vehicle centreline to the point (W_o or W_i). These are calculated with the vehicle stationary.

G A.1.5 Consider a vehicle with bogie centres of L, and a bogie axle semi-wheelbase of ao.

G A.1.6 The inner overthrow of a point U_i from the centre of the vehicle is:

$$Overthrow_{inner} = R - W_i - \sqrt{(U_i^2 + (J - W_i)^2)}, \quad where \quad J = \sqrt{R^2 - ao^2 - \frac{L}{4}^2}$$

G A.1.7 The outer overthrow of a point U_o from the centre of the vehicle is:

$$Overthrow_{outer} = \sqrt{(U_o^2 + (J + W_o)^2)} - R - W_o$$

G A.1.8 All dimensions and values should be in mm.

G A.1.9 Co-ordinates for each of the vehicle gauges relate to the effective position of the track, as set out in GIRT7073. Co-ordinates, therefore do not include the effect of lateral and vertical track alignment tolerances, continuous cross-level error, wheel / rail clearance, rail sidewear, or any other infrastructure tolerances.

G A.1.10 This method can be used to calculate vertical overthrow, in this case the track centreline in figure 29 would become rail level and the vehicle body would sit above the track.

G A.1.11 The formulae apply to bogie vehicles with 2 axle bogies. More unconventional wheel arrangements may require bespoke mathematical expressions.

A.2 Height and Width reduction

Guidance

G A.2.1 Height and Width reductionrent bogie centres from the dimensions upon which a gauge is defined. These alternative configurations can generate larger overthrows. Height and width reduction can be used to help a vehicle with alternative lengths and bogies centres to comply with a gauge.

G A.2.2 Height and width reduction is calculated as the difference between the overthrow for the standard vehicle gauge configuration and the calculated overthrow for the vehicle configuration being assessed.

G A.2.3 $E_i = Tg_i - Tv_i E_o = Tg_o - Tv_o$ where:

- E_i is the inner reduction;
- E_o is the outer reduction;
- Tg_i is the inner throw of the standard vehicle gauge;
- Tv_i is the calculated inner throw of the vehicle;
- Tg_o is the outer throw of the standard vehicle gauge; and
- Tv_o is the calculated outer throw of the vehicle.

Appendix B Application of dynamic movements: worked example for PG2

B.1 **Important:** The content of this appendix is included for guidance

B.1 Introduction to the SVGD

Guidance

G B.1.1 RIS-2773-RST sets out a standard format for presenting vehicle gauging data. This gauging data include dynamic movements resulting from the inputs of curvature, cant and speed in a variety of loading conditions. The SVGD spreadsheets are set out in the RIS-2773-RST format.

G B.1.2 It is usual to calculate dynamic movements using approved computer software. However, formulae are provided to enable those without access to such software to undertake the necessary calculations

G B.1.3 The calculation of dynamic movements considers vehicle sway, roll and drop as a result of curving and dynamic forces, and the utilisation of wheel flangeway clearance as a result of curving.

G B.1.4 An example of the data set out in the RIS-2773-RST spreadsheet is shown in Figure *30*.

A	B	C	D	E	F	G	H	I
Dynamic Analysis								
Condition	Crush Inflated							
Track Quality	Limit State							
Wind	0 m/s							
Sign Convention								
Lateral	+ve	Outside						
Vertical	+ve	Down						
Roll	+ve	Outside						
Dimensions								
Datum Height	1600	mm	ARL		**Bogie 1 Load**			kg
Bogie Centres	16000	mm			**Primary Stiffness**		0	N/mm
Track Gauge	1435	mm						
			Wheelsets and Body at Bogie 1					
	Cant	**Speed**	**Lateral avg**		**Vertical avg**		**Roll avg**	
			Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**
Reference	mm	km/h	mm	mm	mm	mm	deg	deg
1	0	0.0	52.4	8.1	29.2	4.7	1.068	0.171
2	0	201.2	52.4	8.1	29.2	4.7	1.068	0.171
3	50	0.0	52.4	8.1	29.2	4.7	1.068	0.171
4	50	201.2	52.4	8.1	29.2	4.7	1.068	0.171
5	75	0.0	68.2	8.7	29.4	4.7	1.463	0.208
6	75	201.2	68.2	8.7	29.4	4.7	1.463	0.208
7	100	0.0	80.8	9.5	29.8	4.7	1.815	0.255
8	100	201.2	80.8	9.5	29.8	4.7	1.815	0.255
9	125	0.0	90.9	9.5	30.4	4.7	2.130	0.287
10	125	201.2	90.9	9.5	30.4	4.7	2.130	0.287
11	150	0.0	99.0	9.1	31.1	4.8	2.415	0.309
12	150	201.2	99.0	9.1	31.1	4.8	2.415	0.309

Figure 30: SVGD extract - PG2 - Crush-inflated condition

G B.1.5 Units used for the presentation of speed, cant, displacement and angle may vary. The example shows units of km/h, m and mm respectively for speed, cant and displacement, being standard units used in EN publications. In GB, it is usual to provide speeds in mph or km/h units, cant in mm units and displacement in mm units.

G B.1.6 Figure 30 shows, for a range of speeds and cants, the mean movements and standard deviations of lateral, vertical and roll movements about a datum point.

B.2 Calculating translation of base co-ordinates

Guidance

G B.2.1 Consider a vehicle travelling around a 400 m horizontal curve, which has a 0.09 m installed cant (90 mm) at 55 mph (90 km/h) and high track fixity. Cant deficiency is calculated using the formula: ,

$$I_{max} = C \times \sin\left(arctan\left(\frac{v^2}{R \times g}\right) - arctan\left(\frac{D - D_{tol}}{C}\right)\right)$$

- I is cant deficiency (m);
- C is rail centres (typically 1.5 m or 1.505 m is used);
- v is speed (m/s);
- R is curve radius (m);
- g is the gravitational acceleration (taken as 9.81 m/s^2);
- D is installed cant (m); and
- D_{tol} is cross level error (m) (dependent on track fixity, values provided in GIRT7073)

G B.2.2 This gives a cant deficiency of 0.147 m (147 mm). This value is used to calculate dynamic movements using the applicable SVGD workbook.

G B.2.3 The example shown refers to the crush inflated condition. To calculate the movements for this condition, values for each of the parameters of lateral, vertical and roll movements may be interpolated.

G B.2.4 At 147 mm cant deficiency (150 m approximated from Figure 30) and 90 km/h (55 mph), we get the following values:

- Lateral Mean = 99.0 mm
- Lateral σ = 9.1 mm
- Vertical Mean = 31.1 mm
- Vertical σ = 4.8 mm
- Roll Mean = 2.415˚
- Roll σ = 0.309˚

G B.2.5 It is presently custom and practice in absolute gauging to define a nominal maximum dynamic movement as the arithmetic summation of mean ± 2.12σ (where σ is the standard deviation) for lateral, vertical and roll movements. This gives movements to the outside of the curve (mean +2.12σ) and down (mean +2.12σ) of:

- Lateral (L) = 118.29 mm
- Vertical (V) = 41.28 mm
- Roll (θ) = 3.070˚

G B.2.6 For each point on the profile being considered, the transformed position is calculated using the following formula:

$$x' = x + L + (y - y_{datum}) \times \sin\theta, \quad y' = y + V + (x \times \sin\theta)$$

where:

- (x',y') is the transformed coordinate;
- y_{datum} is the height for the centre of rotation for transformation.
- For this worked example it can be seen that y_{datum} is 1600 mm (from Figure *30*)

G B.2.7 Movements for each point should be considered in both the upwards and downwards directions, and to the outside and to the inside of a curve.

G B.2.8 Where movements to the inside of a curve are considered, it should be noted that maximum movement will occur at an intermediate speed, which will be relatively low on tight curves. This critical speed (previously known as trundle speed) should be calculated by an iterative method, from the data provided.

G B.2.9 For equilibrium cant conditions lateral and rotational movements should be applied symmetrically about the vehicle centreline and datum point.

B.3 Illustrative Example with PG2

Guidance

G B.3.1 The standard vehicle gauge coordinates are base coordinates that are adjusted for dynamic movements, there is no requirement to build a vehicle to fit within the base profile.

G B.3.2 The base profile is always adjusted for dynamic movement for all conditions; crush-inflated, crush-deflated and tare-inflated.

G B.3.3 Figure *31* shows the base profiles for PG2 centre section and LSVG which are documented in their respective parts of the standard.

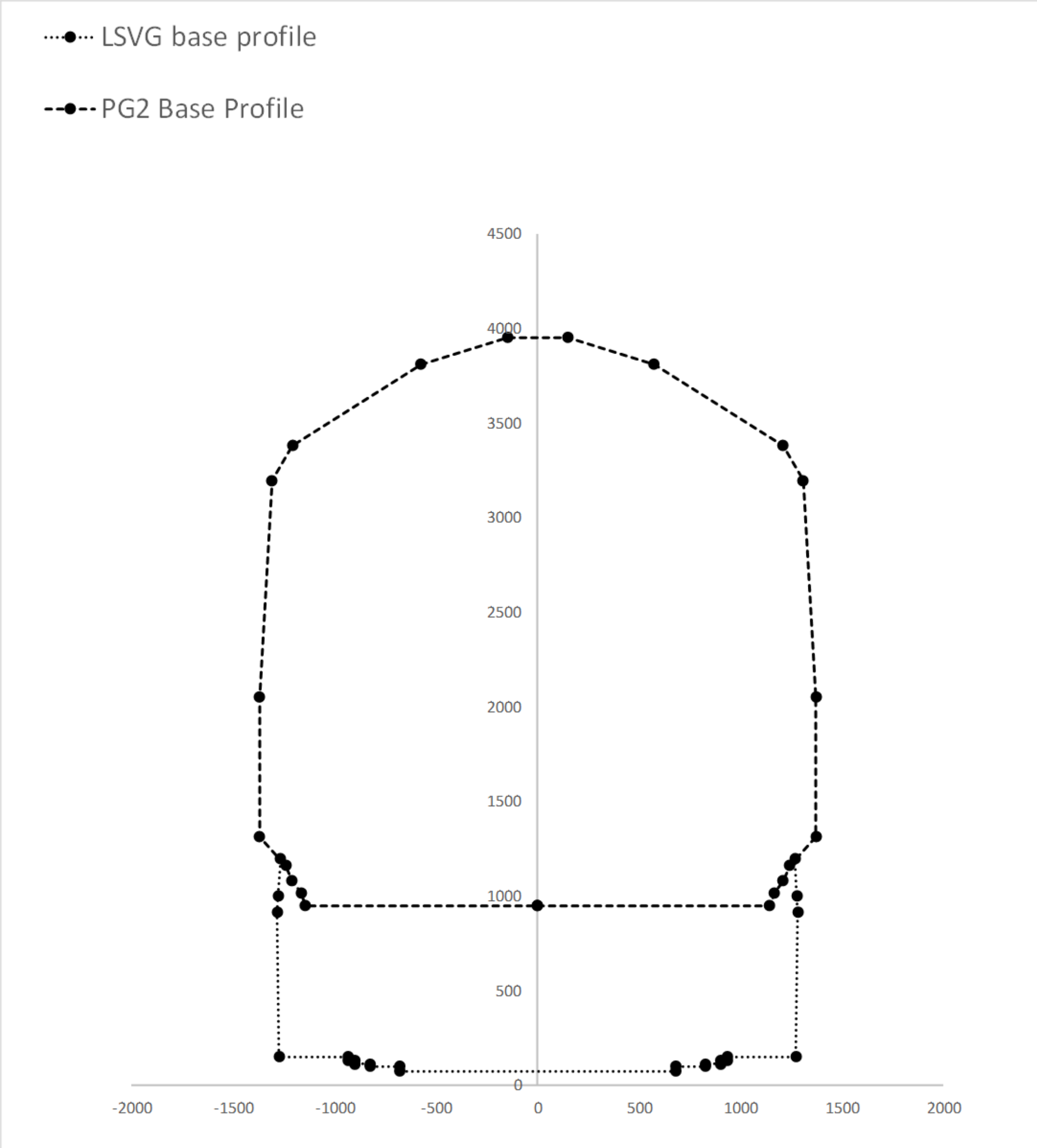


Figure 31: PG2 Centre section and LSVG base profile

G B.3.4 Figures *32*, *33* and *34* show adjusted profiles with movements applied for PG2 in crush inflated condition at 0 mm -50 mm, 100 mm and 150 mm cant deficiency.

G B.3.5 The profiles show how the profile is enlarged as cant deficiency is increased. For illustrative purposes, the adjusted profiles have been plotted along with the base profile

G B.3.6 LSVG is also included in the plots to show how that also enlarges with increased cant deficiency.

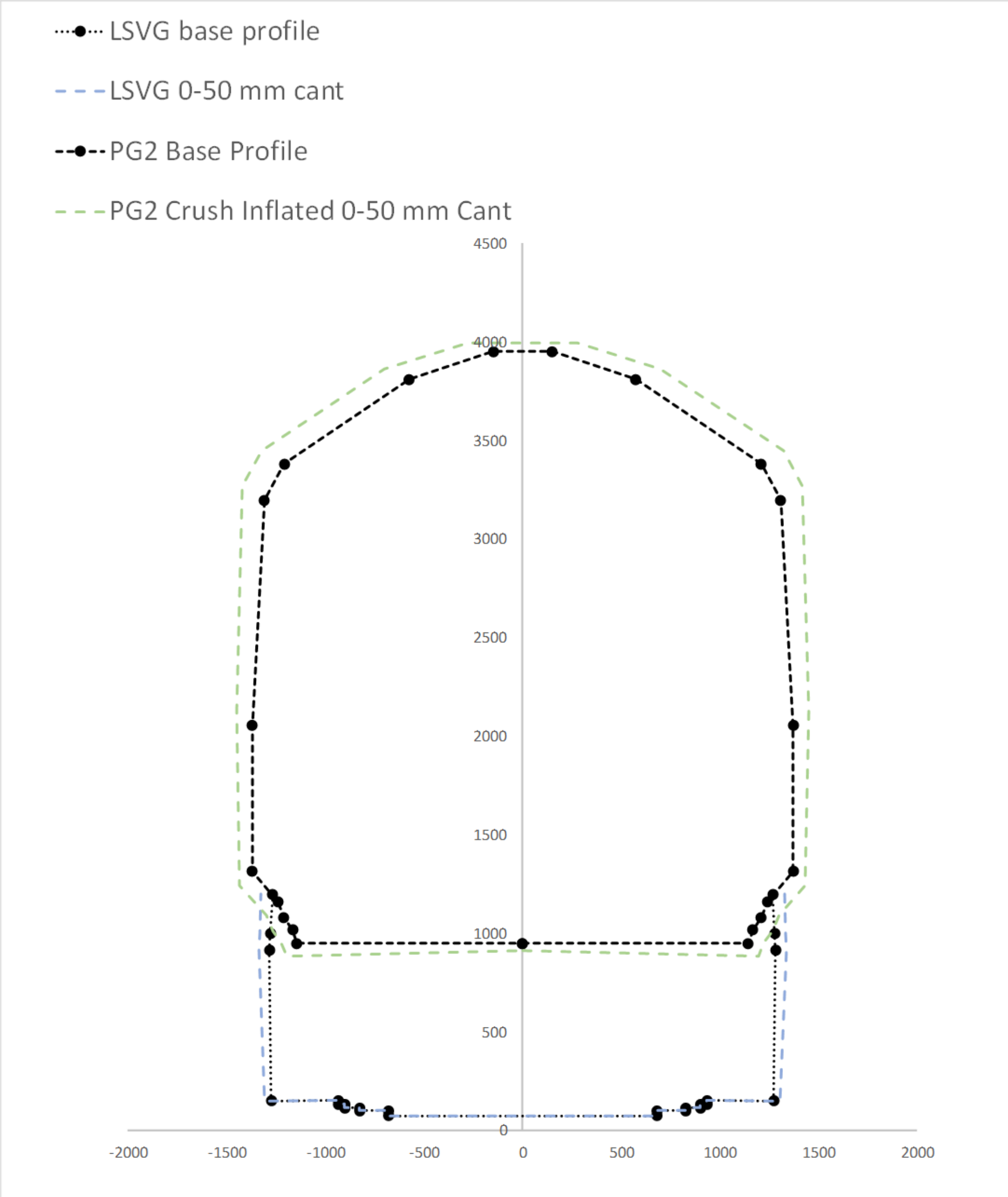


Figure 32: Dynamic movements applied 0 mm -50 mm cant PG2 centre section crush-inflated and adjusted LSVG

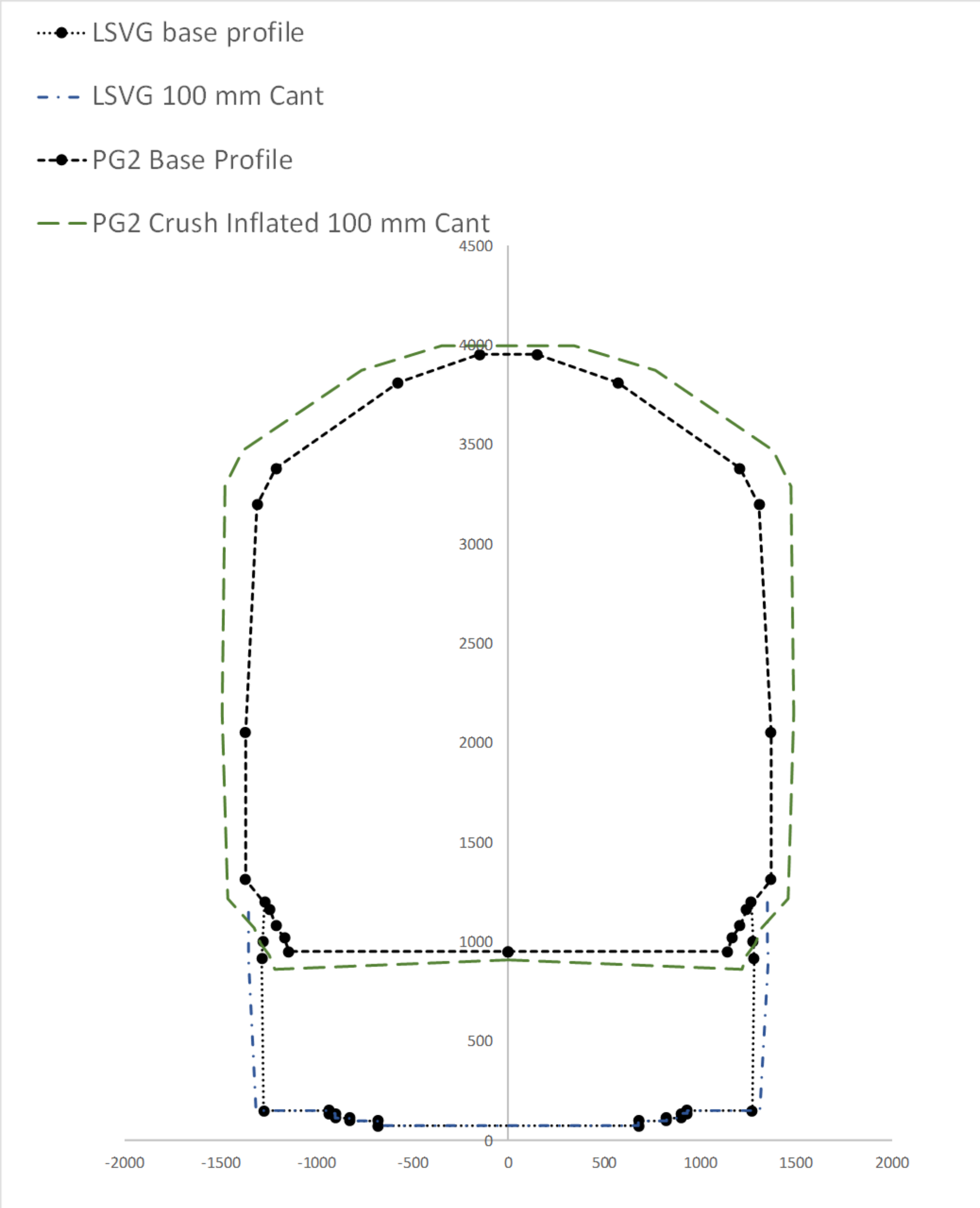


Figure 33: Dynamic movements applied 100 mm cant PG2 centre section crush-inflated and adjusted LSVG

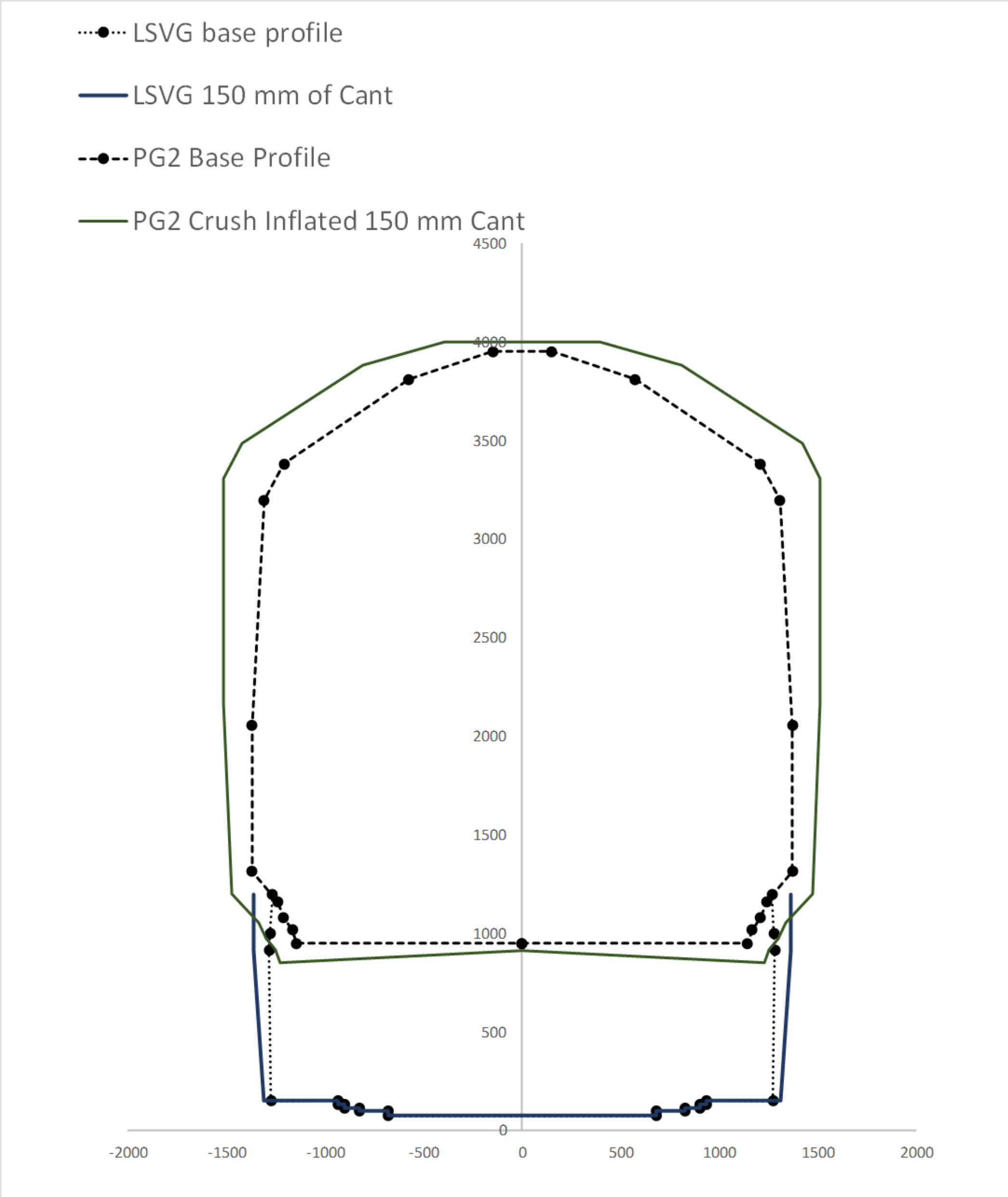


Figure 34: Dynamic movements applied 150 mm cant PG2 centre section crush-inflated and adjusted LSVG

G B.3.7 In order to show the difference in movements applied with cant deficiency, the profiles from the previous plots have been plotted as a series of nested profiles in figure *35*.

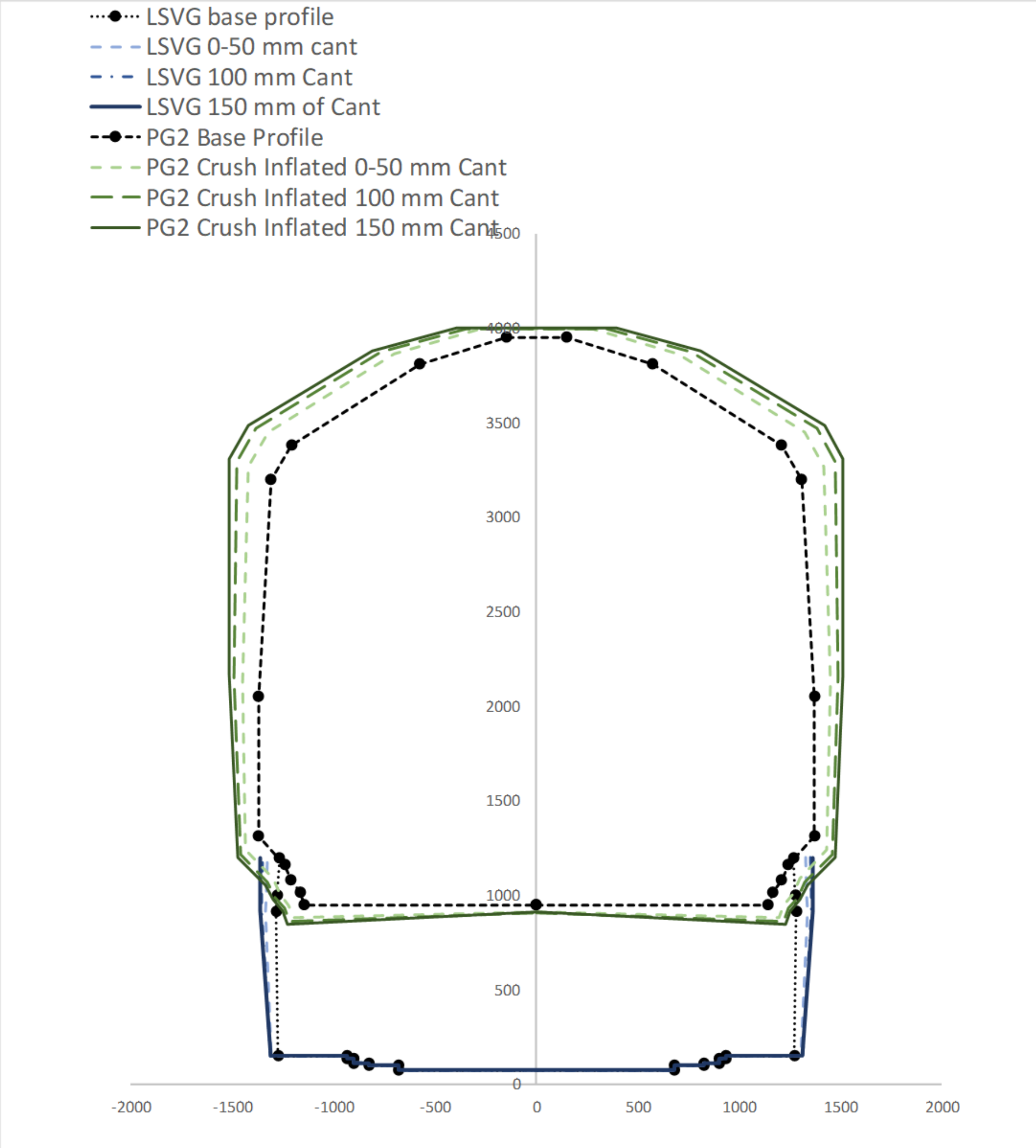


Figure 35: Nested profiles with dynamic movements applied at 0 mm - 50 mm, 100 mm and 150 mm cant for PG2 centre section crush-inflated and adjusted LSVG

G B.3.8 Consider now a vehicle seeking compliance to PG2. The shape of that vehicle and the characteristics of the suspension will generate a swept envelope for the vehicle. In accordance with GMRT2173, the absolute movements will be determined for the range of cant deficiencies in all conditions.

G B.3.9 Figure *36* shows a profile of a theoretical vehicle with its movements applied on straight and level track in crush-inflated condition. This profile is inside the adjusted profile for PG2 and LSVG, and therefore it is compliant with PG2 in this condition.

G B.3.10 For a vehicle to be compliant with the gauge, the vehicle swept envelope must be inside the adjusted profiles for the gauge for all cant deficiencies and conditions.

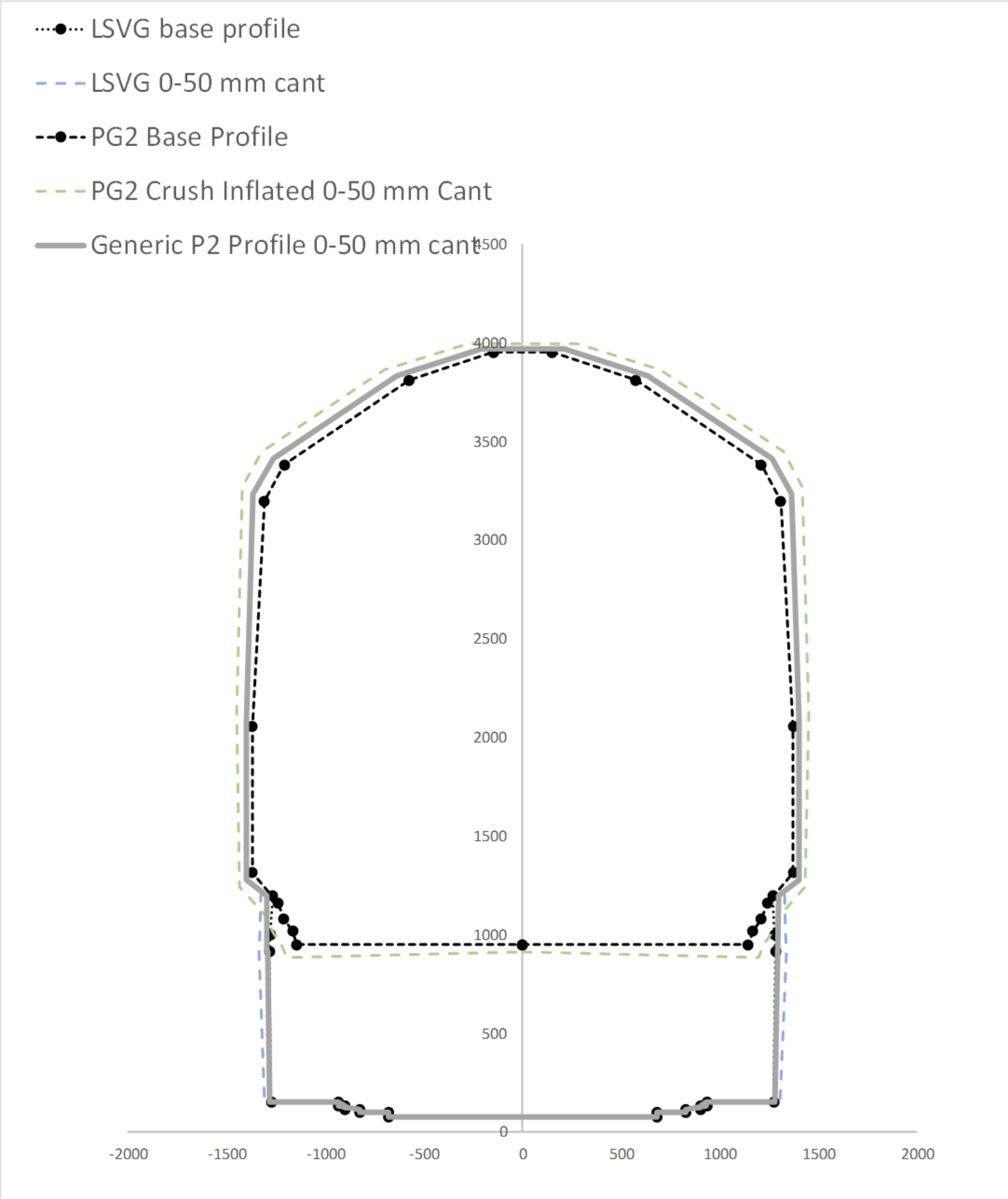


Figure 36: Example profile of a generic PG2 compliant vehicle centre section in crush-inflated condition with movements applied 0 mm - 50 mm cant.

Appendix C Method for freight bogie suspension benchmarking for W7a, W8a and W9a

Important: The contents of this appendix is included for guidance

C.1 Introduction

Guidance

G C.1.1 This appendix outlines the methodology for determining whether the dynamic gauging performance of a candidate freight bogie is compatible with the dynamic gauging performance of benchmark bogies, and is therefore able to apply the benchmark movements defined in Standard Vehicle Gauge Data workbooks 8073SVGD - W7a, 8073SVGD - W8a and 8073SVGD - W9a.

G C.1.2 The methodology was developed as part of RSSB research project *T1109 (2017)*. This appendix captures the methodology, in the full reports, which are available through *www.sparkrail.org*.

C.2 Background

Guidance

G C.2.1 Historically, railway vehicles were gauged using static principles. A static profile of a vehicle (or load) was adjusted for overthrow on curves and compared to the profile(s) of the infrastructure that it must pass through or by. An allowance, known as clearance, defines a space between the vehicle and infrastructure to ensure safe passage. This clearance considered various factors, often unknown but including suspension movements, and was generally around 200 mm – 250 mm.

G C.2.2 Railway Group Standard GCRT5212 (February 2003) differentiated between vehicle movements and the safety margin for unknowns. By allowing the calculation of vehicle movements relative to specific inputs, such as cant deficiency (or excess) and by providing a reduced allowance for remaining unknowns of 100 mm, unused space in the infrastructure could be released. However, where vehicle movements were not accurately defined (such as in freight gauges), it was necessary to continue using a 'flat' 100 mm allowance for vehicle movements, based upon custom and practice. In practice, the need to apply 100 mm movement was misunderstood by some, and resulted in situations where vehicle movements were not included in clearance calculations. GERT8073, Issue 1, specifically included a requirement to include suspension movements, which were based upon (then) current knowledge of maximum freight vehicle movements derived using the BASS501 modelling technique, the so-called second-generation freight gauges. However, the application of maximum movements did not allow the release of space enabled by simulation techniques, and a new set of third generation gauges were incorporated in Issue 3 of GERT8073. The third generation gauges used similar static profiles, but included dynamic movements that related to both speed and cant deficiency (or excess).

G C.2.3 These movement tables were based on the state of knowledge of the time, based on BASS501 models of particular wagons and bogies used for the absolute clearance of specific container traffic. In moving towards a numerate approach to freight gauges, GERT8073 Issue 3 attempted to characterise freight suspensions running on the network as either ‘benchmark’, where there was an understanding of movements, or ‘established’, where there was no known information, but a demonstrable safe history of running. This system works, in principle, where wagon builders use such suspensions to build new wagons, but will not work where new bogie designs need to be introduced.

C.3 Benchmarking Process

Guidance

G C.3.1 The benchmarking process is performed as follows:

a) Perform a multi-body simulation (MBS) for the candidate vehicle using benchmark loading conditions (see Table 31).
b) Compare movements generated with those of the standard benchmarks.

G C.3.2 Where the envelope of a candidate vehicle falls within that of the standard benchmarks, the bogie may be considered to be compliant with the benchmark suspensions associated with a given vehicle gauge.

G C.3.3 The comparison of dynamic movements relates to sway (a resolution of lateral and roll) movements and vertical movements, which consider vehicle bounce and the static drop due to load.

G C.3.4 Sway movements are important when considering lateral clearances to the infrastructure and passing vehicles.

G C.3.5 Vertical movements are important when considering (with lateral movements) clearances to platforms and overhead structures, such as bridges and tunnels. The static drop under load is also an important consideration for platform clearances.

C.4 Benchmark Bogie Suspensions

Guidance

G C.4.1 In defining the benchmark suspension characteristic, *T1109 (2017)* analysed by MBS, the following bogies:

- Y25;
- Y33;
- LN25;
- LTF13;
- BER20.5;
- FBT6;
- Swing Motion; and
- AMIII.

C.5 Dynamic MBS Analysis

Guidance

G C.5.1 RIS-2773-RST describes how MBS should be undertaken using Vampire® or similar software. This aligns with the recommended practice for dynamic gauging in Annex O of BS EN 15273-2:2013+A1:2016 (E).

G C.5.2 Track input files should be the 'Track for Gauging' (TfG) files described in RIS-2773-RST.

G C.5.3 For the purposes of benchmarking, bogies are considered to be either bulk or container. Simulation will be required for tare and laden conditions, (at maximum axle load for that bogie type). Note that in the case of container flats, the Tare condition is assumed to be wagon plus empty container.

G C.5.4 Simulations should be performed with the parameters set out in Table *31*.

Condition	Mass (kg) of wagon body	CoG (above Interface Height Note 1) (mm)	Roll inertia (Mgm^2)	Pitch and Yaw inertia (Mgm^2)	Bogie centre pivot spacing (m)
Tare	15000	+700	16000	320000	11
Tare Container	15000	+200	16000	320000	11
Laden	Max bogie capacity less weight of both bogies Note 2	+1,200	100000	1300000	11

Table 31: Benchmark Conditions

Note:

Note 1. Interface height for a freight wagon taken as the side bearer height or equivalent

Note 2. For example, a 25.4 t axle load rated bogie with a 5,000 kg mass would have a wagon body mass of 101,600 – (2 x 5,000) = 91,600 kg

C.6 Sway Analysis

Guidance

G C.6.1 Outputs from the MBS simulation should be converted into sways at heights of 3895 mm ARL (Upper Datum) and 1000 mm ARL (Lower Datum), and a semi-width of 1250 mm using the following formula:

$$\delta x = (x\cos\theta + y\sin\theta - H\sin\theta + L) - x$$

where:

- x = 1250 mm;
- y = 1000 mm and 3895 mm;
- θ = mean roll angle +2.12σ roll angle in degrees;
- H = Datum height of rotational transform in mm; and
- L = mean lateral displacement +2.12σ lateral displacement in mm.

G C.6.2 A typical set of sway results for a bulk laden wagon is shown in Figures *37* and *38*.

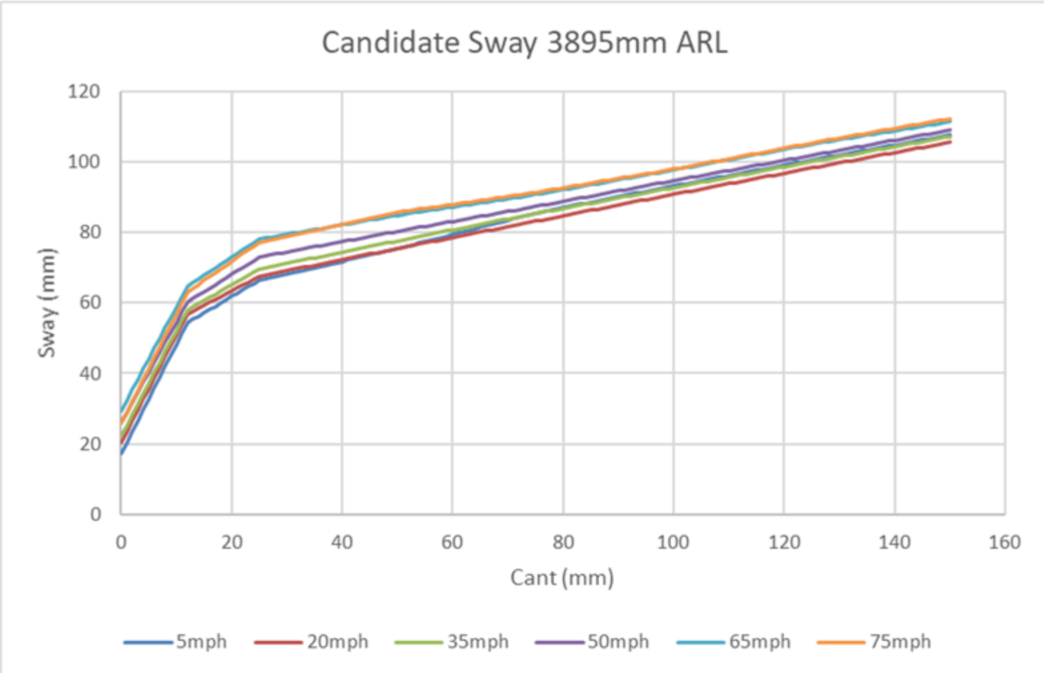


Figure 37: Typical Candidate Bulk Laden Sways at Upper Datum

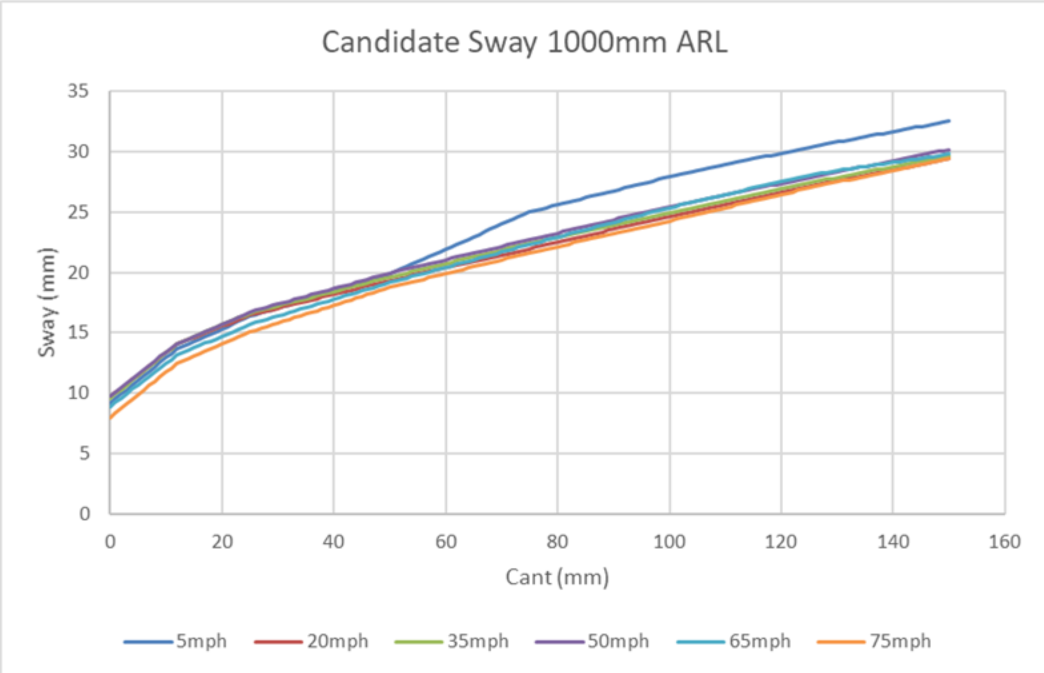


Figure 38: Typical Candidate Bulk Laden Sways at Lower Datum

C.7 Sway Benchmarks

Guidance

G C.7.1 Benchmark sway characteristics (mean + 2.12σ) are provided for Bulk Tare, Container Tare, Bulk Laden and Container Laden as shown in Figures *39* and *40*. These values enclose the sway envelopes for all of the bogies included in the benchmark suspensions.

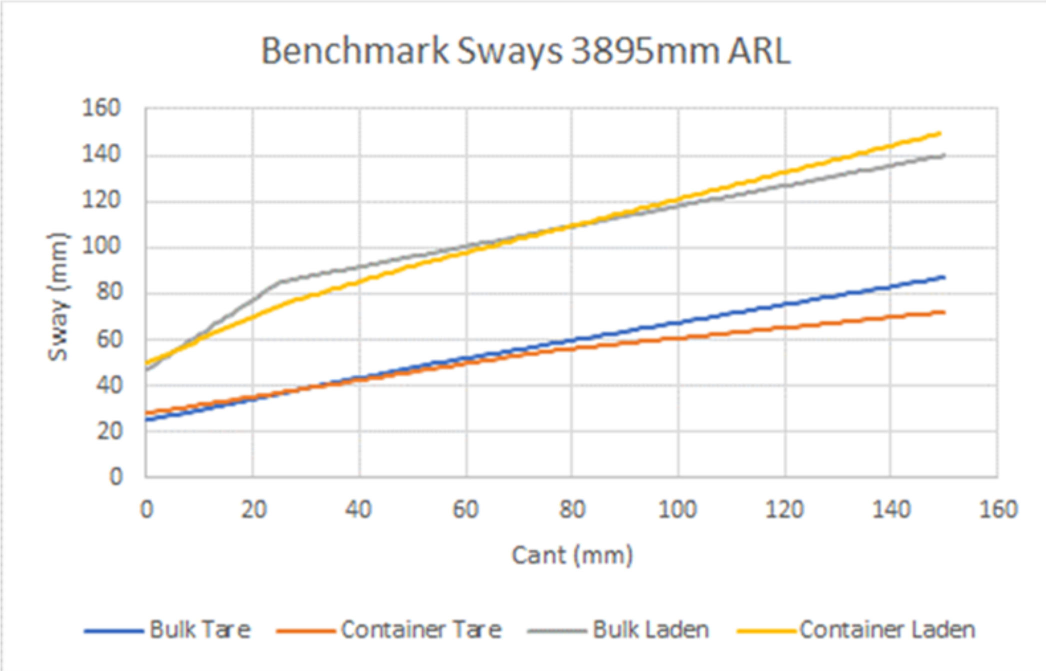


Figure 39: Benchmark Sways at Upper Datum

Figure 40: Benchmark Sways at Lower Datum

C.8 Sway Compliance

Guidance

G C.8.1 Considering the candidate sway characteristics shown in Figures *37* and *38* and the benchmark sway characteristics shown in Figures *39* and *40*, Figures *41* and *42* illustrate that, from a sway perspective, at no speed does the candidate vehicle's sway exceed those of the benchmarks. Note that, in this example, only the Bulk Laden benchmark has been illustrated. It is necessary to demonstrate compliance for the all appropriate cases.

Figure 41: Candidate Vehicle Sway Demonstration (Bulk Laden) Upper Datum

Figure 42: Candidate Vehicle Sway Demonstration (Bulk Laden) Upper Datum

C.9 Roll Analysis

Guidance

G C.9.1 In addition to an analysis of sway at two datum heights, it is necessary to characterise limits of roll angle, since this will affect the vertical clearances to platforms and the clearance to arched bridges on the inside of cant deficient curves.

G C.9.2 The roll angle characteristic of a typical Bulk Laden wagon is shown in Figure *43*.

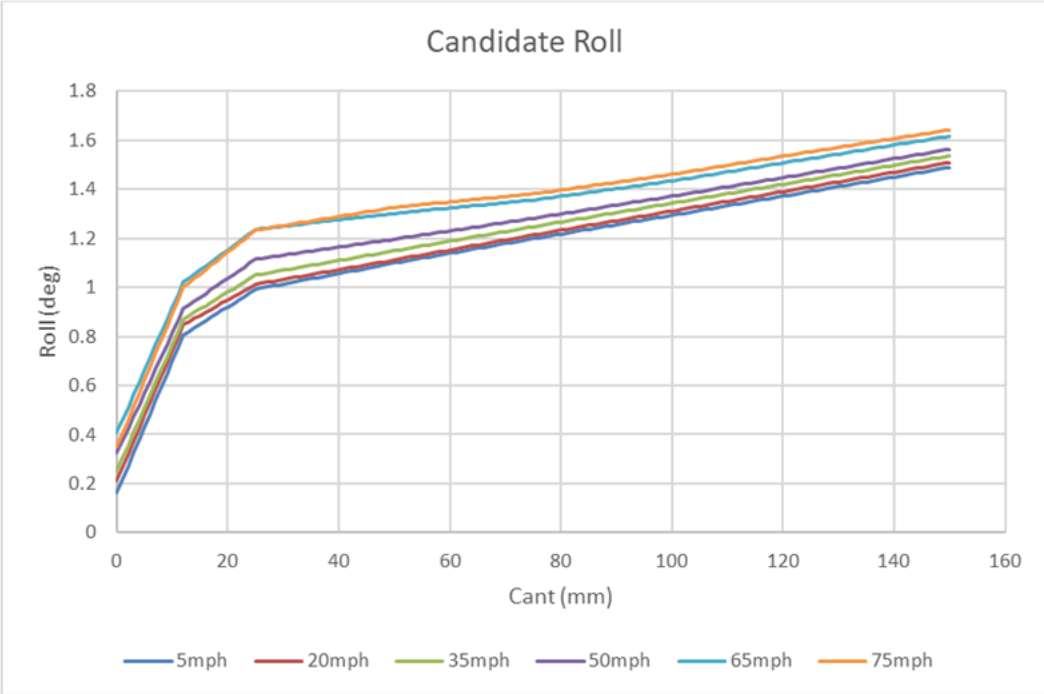


Figure 43: Typical Candidate Bulk Laden Roll Angle Characteristic

C.10 Roll Benchmarks

Guidance

G C.10.1 Benchmark roll characteristics (mean + 2.12σ) are provided for Bulk Tare, Container Tare, Bulk Laden and Container Laden, as shown in Figure 44. These values enclose the roll envelopes for all of the bogies included in the benchmark suspensions.

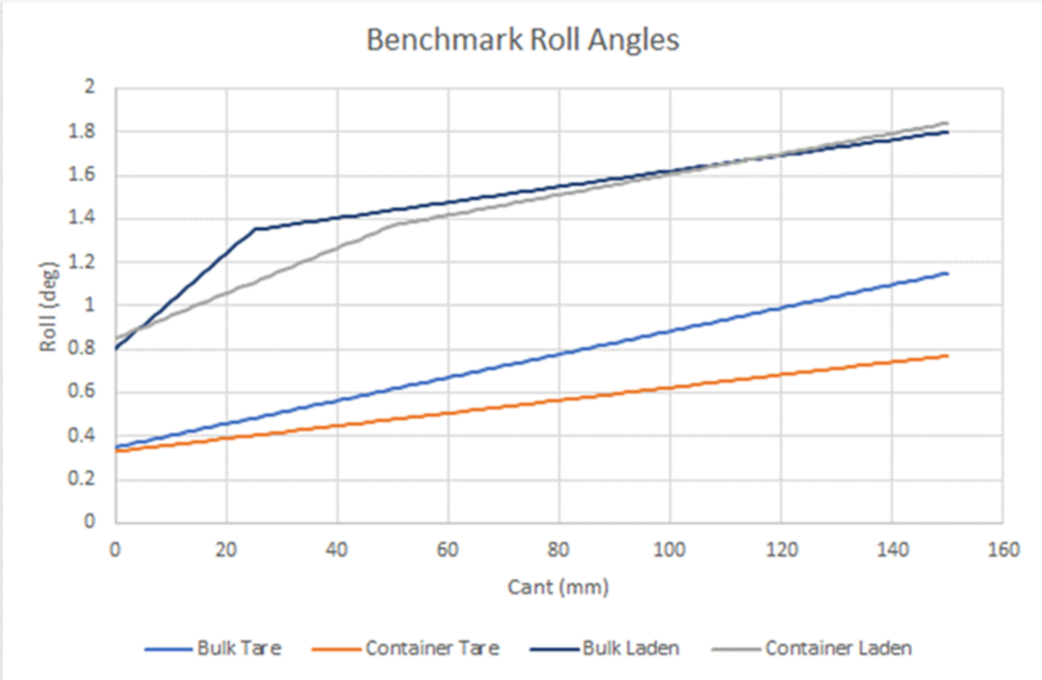


Figure 44: Benchmark Roll Angles

C.11 Roll Compliance

Guidance

G C.11.1 Considering the candidate roll characteristics shown in Figure 43 and the benchmark roll characteristics shown in Figure 44 , Figure 45 illustrates that, from a roll perspective, at no speed does the candidate vehicle's roll exceed those of the benchmarks. Note that in this example, only the Bulk Laden benchmark has been illustrated. It is necessary to demonstrate compliance for all the appropriate cases.

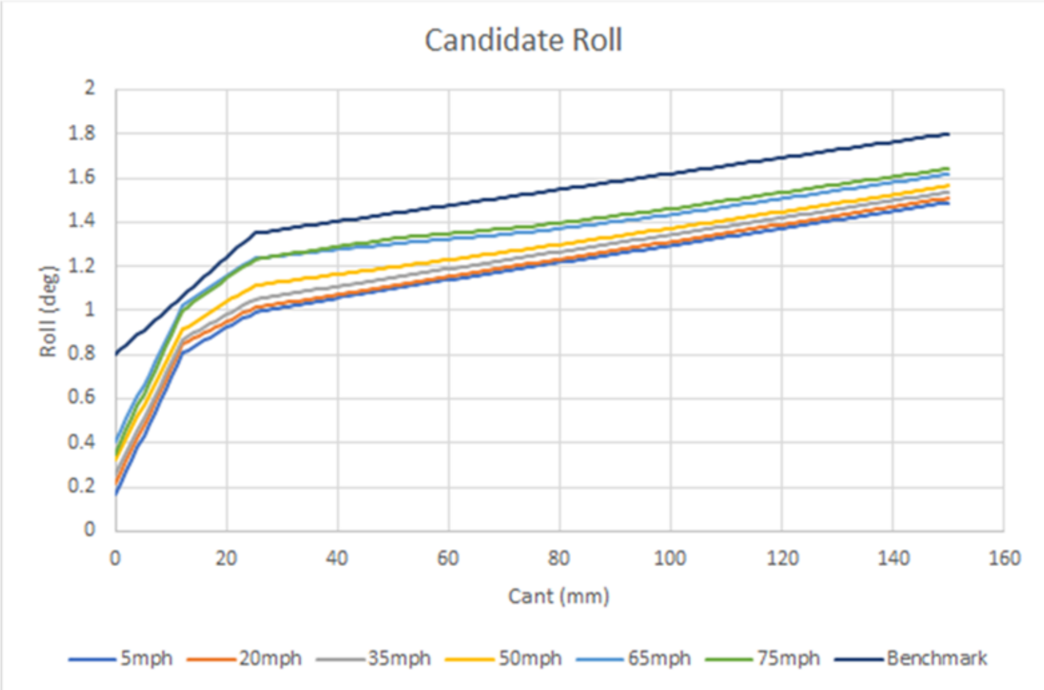


Figure 45: Roll Compliance Demonstration (Bulk Laden)

C.12 Vertical Analysis

Guidance

G C.12.1 Vertical bounce is calculated as 2.12σ vertical displacement. Generally, bounce relates to the track quality representative of the analysis speed. A typical bounce relationship for a Bulk Laden wagon is shown in Figure *46*.

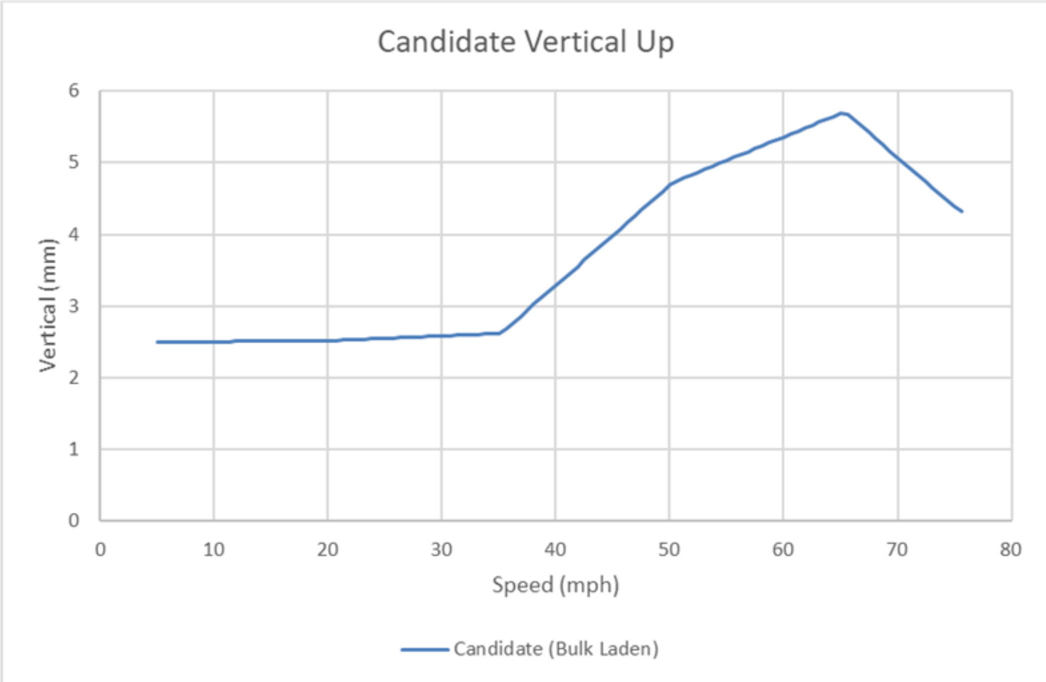


Figure 46: Typical Candidate Bulk Laden Bounce (mm)

C.13 Vertical Benchmarks

Guidance

G C.13.1 The vertical benchmarks are shown in Table 32.

Loading	Up	Down	Mean	Standard deviation (σ)
Container Tare	6.4	6.4	0	3
Container Laden	8.5	114.5	53	29
Bulk Tare	6.4	6.4	0	3
Bulk Laden	8.5	114.5	53	29
W10 Tare	4.2	4.2	0	1.98
W10 Laden	8.2	66.2	29	17.55

Table 32: Vertical Benchmarks

C.14 Vertical Upwards Compliance

Guidance

G C.14.1 Figure 47 demonstrates that, at no speed does the candidate vehicle bounce upwards more than the benchmark condition. Note that in this example, only the Bulk Laden benchmark has been illustrated. It is necessary to demonstrate compliance for all the appropriate cases.

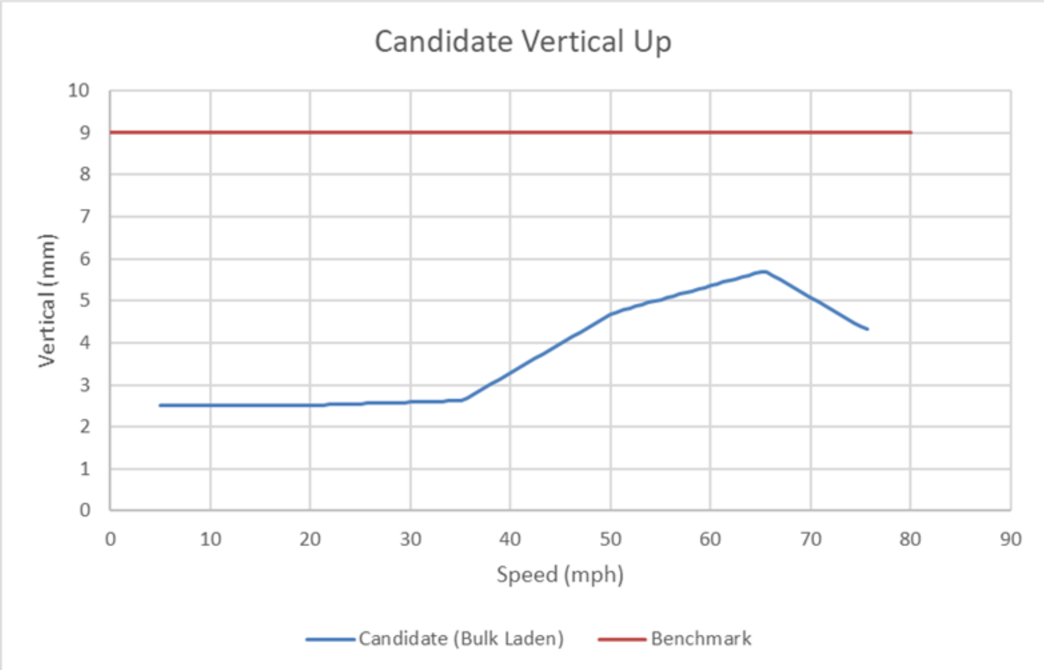


Figure 47: Vertical Upwards Compliance Demonstration (Bulk Laden)

C.15 Vertical Downwards Compliance

Guidance

G C.15.1 Figure 48 demonstrates that, at no speed does the combined candidate vehicle bounce downwards, static drop and radial wheel wear exceed that of the benchmark condition. Note that in this example, only the Bulk Laden benchmark has been illustrated. It is necessary to demonstrate compliance for all the appropriate cases.

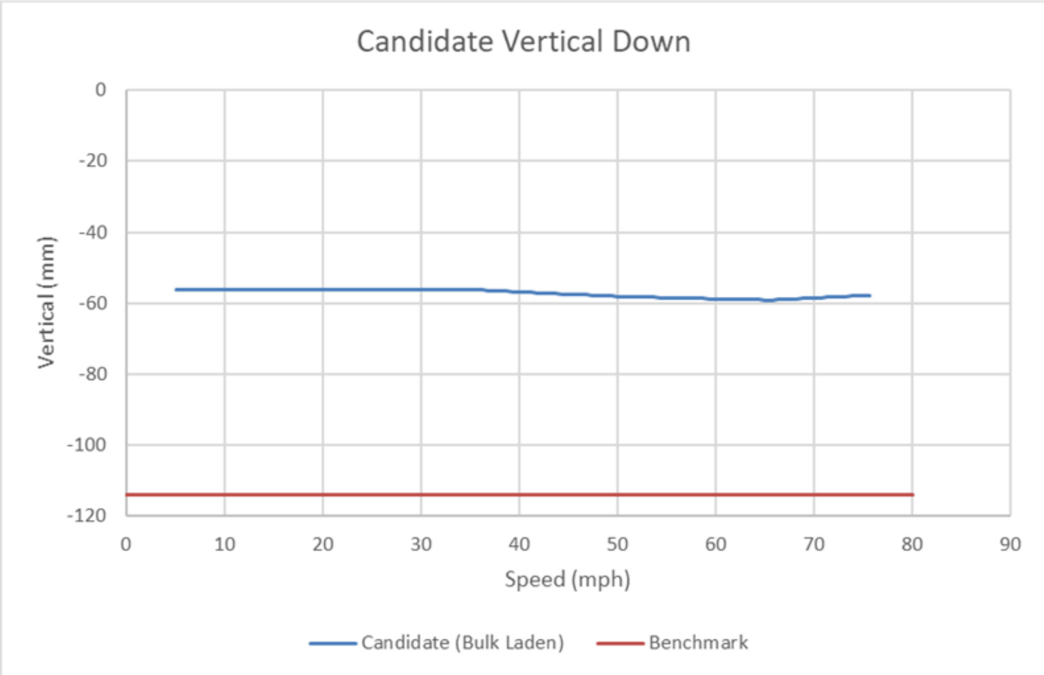


Figure 48: Vertical Downwards Compliance Demonstration (Bulk Laden)

Appendix D Guidance on developing new gauges

D.1 **Important:** The content of this appendix is included for guidance

D.1 Defining a new gauge

Guidance

G D.1.1 This part of this document sets out general guidance on the development of proposals for new vehicle gauges, the key information required to define a gauge is set out in Table *33*.

Item	Content
Purpose	States what the gauge is intended for.

Item	Content
Gauge diagram	Provides a base profile diagram of the gauge, together with a list of co-ordinates. The co-ordinates allow the gauge base profile diagram to be redrawn accurately from the information provided. The co-ordinates of the gauge include all protrusions, e.g. door indicator lights, push buttons, ventilation cowls and nameplates. The base profile is the profile of the gauge to which all movements and adjustments are applied as defined by the application rules. The base profile diagrams are presented as a series of points defining a polyline. Where a curved line is required, it is replaced with a series of chords having a deviation from the arc of no more than 1 mm. A maximum deviation of 0.5 mm provides a more accurate definition of the vehicle shape consistent with the point density of the technology used to measure the infrastructure. Where arcs have been used to define curved sections, the details of these are given (describing centre, radius and points linked) in order to preserve the basis of the original gauge. Co-ordinates are numbered and given in millimetres from the gauge centreline. Co-ordinates need only describe a semi-vehicle where the vehicle is symmetrical about the centreline.

Item	Content
RIS-2773-RST Format for Vehicle Gauging Data	Defines the parameters required and their presentation, such that gauging calculations may be undertaken using vehicle data conforming to a standard format, methodology and sign convention.
Infrastructure rules	Sets out the rules by which the infrastructure manager might determine the safe clearance for operation of the Gauge. In particular, the rules specify how the space occupied by the Gauge at each location is calculated.
Vehicle build rules	Sets out the rules used in building a vehicle to the prescribed envelope. In particular, the rules include: a) The standard vehicle arrangement dimensions (length, bogie / wheel centres). b) Any width / height reductions applicable as a result of a vehicle exceeding the standard arrangement dimensions. c) Limits of suspension movement and allowances included in the gauge, and expected exceedances beyond this that should be taken into account by the infrastructure manager. Allowances are those applicable to the vehicle, rather than the infrastructure, and could include wheel tread wear, suspension creep, wheel flange wear and other parameters affecting the relationship of the vehicle to the track. Likely suspension failure modes should be considered.

Table 33: Format for Specifying vehicles gauges

Definitions

ARL	Abbreviation for 'above rail level', measured perpendicular to the plane of rails.
Base profile	The base co-ordinates of the standard vehicle gauge to which adjustments for overthrow and dynamic movement are applied. The base profile has some reference characteristics such as bogie spacing, wheel-base and container fastening tolerance (fastening tolerance is relevant for freight gauges).
Benchmark suspension	A suspension for which 8073SVGD is available. It can be used to demonstrate compliance with a standard gauge.
Clearance	The minimum calculated distance between the vehicle's swept envelope(s) and fixed infrastructure or between two vehicles' swept envelopes on adjacent tracks.
Demountable load	A load attached to a rail vehicle by fastenings.
Dynamic Gauge Profile	The maximum gauge envelope that a vehicle swept envelope is permitted to occupy. The dynamic gauge profile includes effects of loading, gauge tolerances and allowances, specific to a particular cant/cant deficiency. It requires adjustment to include the effects of a geometric overthrow of the particular cross-section on curved track. A family of dynamic gauge profiles is required to define an allowable gauge on a route.
Effective position of the track	A position that the track could credibly occupy in relation to structures or an adjacent track at some point within its maintenance cycle, giving the smallest clearances. (See GI/RT7073).
Fastening fixity	The amount of free movement in the fastenings used to secure a demountable load, in relation to its central position.
Infrastructure	For the purpose of this document, track and structures in combination. Compare with 'structure'.
International Organization for Standardization (ISO)	No definition.
Load	For the purposes of this document, a load is defined as the physical size of the payload carried by a wagon.
Lower gauge	That part of the vehicle gauge for items adjacent to low-lying structures, such as platforms, with a requirement for proximity. The lower gauge is not limited to 1100 mm above the plane of the rails. See also 'upper gauge'.
Lower sector	The area up to and including 1100 mm above the plane of the rails. See also 'upper sector'.
Overthrow	A geometric projection of a vehicle when on curved track.

Plane of rail	An imaginary surface coplanar with the top of both rails of a track.
Route	The physical path of a journey to be undertaken by a vehicle or a collection of vehicles, where the path is comprised of a number of track sections, each of which has individually defined characteristics.
Standard Vehicle Gauges	The maximum envelope that a vehicle conforming to the gauge is permitted to occupy which prescribes maximum permissible vehicle and loading dimensions, certain suspension displacements, and certain curve overthrow limitations, for example, PG1 gauge.
Structure	An element of the infrastructure built to support or retain a railway traffic load including, but not limited to, bridges, culverts, cut and cover structures, structures over or adjacent to the track, earth retaining structures, and earthworks.
Swept envelope	A cross-sectional profile, taken at right angles to the track, enclosing all dynamic movements, static deflections, vehicle tolerances and overthrows of all points along the surface of the vehicle that can reasonably be expected to occur under the appropriate range of operating conditions as it sweeps past a theoretical track location. A family of swept envelopes is required to define a vehicle’s behaviour on a route.
Upper gauge	That part of the vehicle gauge for items above low-lying structures, which is not constrained by a requirement for proximity. See also ‘lower gauge’.
Upper sector	The area above 1100 mm above the plane of the rails. See also ‘Lower sector’.
Vehicle profile	The static cross-section of a vehicle (and its payload where applicable), taken at right angles to the longitudinal axis of the vehicle. The vehicle profile may have some reference characteristics such as build tolerances.
Width reduction	A reduction to the width of a vehicle gauge that is applicable to vehicles with a longer wheelbase than the reference vehicle on which the gauge is based. Width reduction compensates for the greater overthrows on curves due to the longer wheelbase than those already accommodated by the standard gauge.

References

The Standards catalogue gives the current issue number and status of documents published by RSSB: http://www.rssb.co.uk/railway-group-standards.

RGSC 01	Railway Group Standards Code
RGSC 02	Standards Manual

Documents referenced in the text

GMGN2688	Guidance on Designing Rail Freight Wagons for use on the GB Mainline Railway

Railway Group Standards

GMRT2173	Size of Vehicles and Position of Equipment
GIRT7073	Requirements for the Position of Infrastructure and for Defining and Maintaining Clearances
GLRT1210	AC Energy Subsystem and Interfaces to Rolling Stock Subsystem
GLRT1212	DC Conductor Rail Energy Subsystem and Interfaces to Rolling Stock Subsystem
GCRT5212	Requirements for Defining and Maintaining Clearances

RSSB documents

RIS-8270-RST	Assessment of Compatibility of Rolling Stock and Infrastructure
RIS-2773-RST	Format for Vehicle Gauging Data
RIS-8273-RST	Assessment of Compatibility of Rolling Stock and Infrastructure - Gauging and Stepping Distances

Other references

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8073SVGD-LG2	Dynamic movements for LG2 workbook, version 4 dated 05/12/2020 – Available at: www.rssb.co.uk
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T1092 (2018)	Development of a 26 m passenger vehicle gauge
T1109 (2017)	Freight suspension analysis (freight suspension gauging)
T1132 (2019)	Development of supplementary freight container gauges
T977 (2012)	Development of a revised lower sector vehicle gauge
T978 (2013)	Development of a Suburban vehicle gauge
T995 (2019)	Development of a new locomotive gauge
8073SVGD-LSVG	Dynamic movements for Lower Sector Vehicle Gauge workbook, version 4 dated 05/12/2020 – Available at: www.rssb.co.uk
8073SVGD-W10a	Dynamic movements for freight gauge W10a workbook, version 4.1 dated 13/12/2021 – Available at: www.rssb.co.uk
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