

Railway Group Standard

GM/RT2173

Issue One

Date December 2015

Requirements for the Size of Vehicles and Position of Equipment

Synopsis

This document mandates the methods of determining the swept envelope of rail vehicles. It mandates specific gauge requirements for the lower sector and specific items of equipment, and mandates minimum requirements for the recording of vehicle gauging data.

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Issue record

Issue	Date	Comments
One	December 2015	Original document. Supersedes GM/RT2149 issue three Requirements for Defining and Maintaining the Size of Railway Vehicles.

Superseded documents

The following Railway Group Standard is superseded, either in whole or in part as indicated:

Superseded documents	Sections superseded	Date when sections are superseded
GM/RT2149 issue three Requirements for Defining and Maintaining the Size of Railway Vehicles	All	05 March 2016

GM/RT2149 issue three Requirements for Defining and Maintaining the Size of Railway Vehicles, ceases to be in force and is withdrawn as of 05 March 2016.

Supply

The authoritative version of this document is available at www.rssb.co.uk/railway-group-standards. Enquiries on this document can be forwarded to enquirydesk@rssb.co.uk.

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Part 1 Purpose and Introduction

1.1 Purpose

- 1.1.1 This document mandates requirements for defining the swept envelope of rail vehicles.
- 1.1.2 This document also defines specific limiting swept envelopes for particular equipment that is required to interact with the infrastructure.
- 1.1.3 This document also supports the compatibility assessment process for vehicles built in accordance with the applicable Technical Specifications for Interoperability (TSIs), and existing routes.

1.2 Introduction

1.2.1 Background

- 1.2.1.1 The overall gauging compatibility process includes the following aspects:
 - a) With respect to gauging, the safe operation of a rail vehicle on the infrastructure. This is dependent upon maintaining adequate clearance between the vehicle and adjacent structures and on maintaining adequate passing clearance between the vehicle and other vehicles operating on adjacent tracks. The adequacy of the clearances is established by the determination of the proximity of structures or other vehicles on the route.
 - b) The characteristics of the route may be defined in absolute dimensional terms relative to the plane of the rails and the nominal centreline of the track, or by reference to a recognised gauge, or indirectly by reference to vehicles already operating along the route. GI/RT7073 sets out a suitable methodology, together with a standard infrastructure gauge for the lower sector.
 - c) The swept envelopes of the vehicle are determined by identification of the relative movements of all significant parts of the vehicle with reference to track, at various speeds and under conditions appropriate to the route(s) on which it is to operate.

1.2.2 Key requirements

- 1.2.2.1 The key requirements set out in this document are:
 - a) Identification of the parameters that are required to define the vehicle swept envelope containing all dynamic movements and static deflections relative to the track of a rail vehicle or combination of vehicles, over the permitted range of operating conditions.
 - b) Identification of the permissible processes by which the swept envelope can be defined.
 - c) Identification of the position for particular vehicle equipment that is required to interact with the infrastructure; these being:
 - i) Pantographs.
 - ii) Shoe gear.
 - iii) Tripcocks.
 - d) Identification of the position for footsteps.

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- e) Definition of the format of the data for gauging compatibility assessment.
- f) Continued conformance with the declared swept envelope throughout the operational life of the vehicle or combination of vehicles.

1.2.3 Related requirements in other documents

1.2.3.1 The following Railway Group Standards (RGSs) contain requirements that are relevant to the scope of this document:

- a) GE/RT8073 Requirements for the Application of Standard Vehicle Gauges – this document defines standard vehicle gauges and the associated application rules for rolling stock and for infrastructure. GE/RT8073 defines lower sector vehicle gauge (LSVG).
- b) GE/RT8270 Assessment of Compatibility of Rolling Stock and Infrastructure – this document sets out requirements and responsibilities for the assessment of compatibility of rolling stock and infrastructure.
- c) GE/RT8273 Assessment of Compatibility of Rolling Stock and Infrastructure - Gauging and Stepping Distances – this document sets out specific requirements and responsibilities for the assessment of gauge compatibility and stepping distances between rolling stock and infrastructure.
- d) GI/RT7016 Interface between Station Platforms, Track and Trains – this document sets out the target height for new, extended and altered platforms.
- e) GI/RT7073 Requirements for the Position of Infrastructure and for Defining and Maintaining Clearances – this document defines the lower sector infrastructure gauge (LSIG) and requires the infrastructure manager to keep, maintain and make available to railway undertakings and their suppliers, gauging capability information and generic track quality data.
- f) GL/RT1210 AC Energy Subsystem and Interfaces to Rolling Stock Subsystem – this document sets out the requirements for the AC energy system and the interfaces to rolling stock operating over the AC electrified railway.
- g) GL/RT1212 DC 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.

1.2.4 Supporting documents

1.2.4.1 The following Rail Industry Guidance Notes and Rail Industry Standard support this RGS:

- a) GE/GN8573 Guidance on Gauging – this document provides information and advisory material in support of the application of the various RGSs covering gauging. It also provides background material on the original derivation of the vehicle gauges in common use.
- b) GM/GN2615 Guidance on the Conventional Rail Locomotives and Passenger Rolling Stock TSI – this document gives guidance on interpreting the requirements of the Conventional Rail Locomotives and Passenger Rolling Stock Technical Specification for Interoperability (CR LOC & PAS TSI), including guidance on gauging requirements that apply in Great Britain (GB).

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- c) RIS-2773-RST Format for Vehicle Gauging Data – this document provides a standard format for defining the swept envelope of a vehicle for the purposes of compatibility assessment when undertaking absolute or comparative gauging. The data in this format can also be used for the purposes of assessment against standard dynamic vehicle gauges.

1.3 Approval and authorisation of this document

- 1.3.1 The content of this document was approved by Rolling Stock Standards Committee on 28 August 2015.
- 1.3.2 This document was authorised by RSSB on 09 October 2015.

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Part 2 Processes to Describe Vehicle Size

2.1 Introduction

- 2.1.1 There are three distinct processes available for the gauging of new or modified vehicles, with a fourth option being to use any combination of the first three:
- a) Use of a standard vehicle gauge.
 - b) Comparative gauging.
 - c) Absolute gauging.
 - d) Hybrid gauging.
- 2.1.2 The simplest process is to compare a vehicle with a standard vehicle gauge. Comparative gauging can be used to compare the swept envelopes of the new vehicle to an existing vehicle to enable the new vehicle to operate over the same routes as the existing vehicle. Absolute gauging involves comparing the vehicle swept envelopes to the measured infrastructure for a complete route. Hybrid gauging is when any combination of the previous three processes is used.
- 2.1.3 The vehicle profile is defined by an upper and a lower sector with respect to the plane of the rails.
- 2.1.4 The four processes listed in 2.1.1 are set out in GE/RT8273 in more detail.

2.2 Defining the vehicle swept envelope

2.2.1 General requirements

- 2.2.1.1 Whichever of the four processes set out in 2.1.1 has been chosen, the maximum movements of the vehicle under normal service and fault / failure conditions shall be determined in the form of swept envelopes.
- 2.2.1.2 For vehicles with established or benchmark suspensions, (as set out in GE/RT8073), it is permissible to declare the vehicle to be compliant with a standard vehicle gauge without determining a swept envelope.

2.2.2 Rules to determine the vehicle swept envelope

- 2.2.2.1 The swept envelope of the vehicle shall be determined to allow gauging compatibility to be assessed.
- 2.2.2.2 When the swept envelopes are determined by vehicle dynamic calculations the maximum movements shall be taken as the mean + 2.12 standard deviations of lateral, vertical and roll. These shall be derived by determination of the vehicle characteristics in absolute dimensional terms, as set out in 2.2.3.
- 2.2.2.3 The swept envelope shall be determined relative to the nominal centreline of the track and the plane of the rails. All infrastructure positional tolerances and allowances for rail wear are included in the calculation of clearances set out in GI/RT7073.
- 2.2.2.4 Where the vehicle can be operated either separately or when joined to other vehicles, the vehicle shall be considered in accordance with the requirements of this document both individually and when forming part of a train.
- 2.2.2.5 When the vehicle only operates joined to other vehicles forming an operationally inseparable rake, the rake as a whole and the rake as part of a train shall meet the requirements of this document.

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- 2.2.2.6 A process for generating the data and the associated level of detail required is set out in RIS-2773-RST for the rail industry to use if it chooses.

2.2.3 Vehicle swept envelopes

- 2.2.3.1 The following shall be taken into account when determining the vehicle's swept envelope:
- a) The full range of operating speeds and cant excess and deficiency for which the vehicle has been designed.
 - b) Aerodynamic loads experienced on the route(s) required for service caused by ten minute mean cross-wind speeds up to 22 m/s acting over the whole height of the vehicle, and any higher cross-wind speed limit for particularly exposed locations, as set out in GI/RT7073.
- 2.2.3.2 The range of track and rail configurations, features and track quality applicable to the route(s) required for gauging purposes shall be obtained from the infrastructure manager. The infrastructure manager has a set of track irregularity files, named 'Track for Gauging' (TfG) files. Details of how these files can be obtained are set out in RIS-2773-RST.
- 2.2.3.3 In determining the swept envelopes, the dynamic movement of points on the vehicle surface shall be defined in absolute dimensional terms relative to the plane of the rails and the nominal centreline of the track.
- 2.2.3.4 The swept envelopes shall take into account, as a minimum, the following factors:
- a) Vehicle cross-sectional profiles at significant planes along the vehicle length, including all protrusions.
 - b) Quasi-static sway, roll, drop and lift arising from steady-state curving forces (cant deficiency and cant excess).
 - c) Dynamic sway, roll, drop and lift in response to short wavelength track cross-level error.
 - d) Dynamic sway, roll, drop and lift in response to track irregularities.
 - e) Dynamic vertical suspension displacements in response to track irregularities.
 - f) Static vertical displacements caused by payload variations, wheel wear, and suspension stiffness tolerances.
 - g) Dynamic vertical deflections of the vehicle body or frame under all conditions of load, taking account of the factors set out in 2.2.3.4 f).
 - h) Vehicle displacements associated with likely suspension failure modes and other relevant factors, including hard over tilt failure or other system failures where applicable.
 - i) Vehicle overthrows on curves, laterally and vertically, including information to enable the calculation of overthrows on curve lengths shorter than the vehicle wheel base / bogie centres.
 - j) Wheel-rail clearance, including flange wear, but not rail wear.
 - k) Vehicles with unconventional wheel arrangements and / or articulation, on continuous, reverse and compound curvature.

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- l) Dynamic sway in response to the ten minute mean cross-wind speeds, as set out in 2.2.3.1 b). A suitable method for assessing this is given in GE/GN8573.

- 2.2.3.5 The swept envelopes shall take account of tolerances in vehicle dimensions, normal mass distributions and wheel loadings, suspension characteristics, normal variations in vehicle maintenance condition and wear, and any other relevant variables.
- 2.2.3.6 The swept envelopes shall also indicate the area swept by pantographs where fitted, in the lowered or locked down modes.
- 2.2.3.7 In determining the swept envelopes, the full range of all deflections and movements shall be determined. The worst case scenarios and their probabilities of occurrence shall then be identified taking account of normal and failure conditions of operation, and those having a statistically significant probability of occurrence shall be included in the swept envelopes. Such worst cases will not necessarily be failure cases or occur at maximum speed, and may be different for various speeds.

2.2.4 Requirements for the lower sector

- 2.2.4.1 For new build of an existing design (registered on the Rolling Stock Library in R2) it is permissible to use any of the lower sector gauges as defined in GE/RT8073, such as W6a.
- 2.2.4.2 For a new build or a new design of vehicle (not registered on the Rolling Stock Library in R2) not using an established or benchmark suspension, the swept envelope of the vehicle in the lower sector shall remain within the LSVG, as set out in GE/RT8073. This includes any elements (components) of the swept envelope that could go below a height of 1100 mm measured from the plane of the rails. Parts of the swept envelope, for example passenger footsteps, which exceed the LSVG, may be shown to be compatible by compliance with appropriate upper gauges, comparison with other vehicles or by absolute gauging.
- 2.2.4.3 For a new build or a new design of vehicle using established or benchmark suspensions it is permissible to use the W6a lower gauge. However, newly designed equipment positioned in the lower sector shall comply with the LSVG, as set out in 2.2.4.2.
- 2.2.4.4 It is permissible not to produce swept envelopes when assessing vehicles with an established or benchmark suspension (as set out in GE/RT8073) against a standard vehicle gauge.
- 2.2.4.5 New equipment fitted to existing vehicles which affects the swept envelopes shall remain within the LSVG or the existing vehicle's current lower sector gauge, such as W6a.
- 2.2.4.6 In a failure mode, such as suspension failure, it is permissible to exceed the LSVG, provided that a minimum of 25 mm clearance is maintained to LSIG, as set out in GI/RT7073.

2.2.5 Requirements for the upper sector

- 2.2.5.1 The swept envelope shall include any parts of the vehicle that could go above 1100 mm measured from the plane of the rails.

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2.2.6 Use of standard vehicle gauges

- 2.2.6.1 Where compatibility is to be shown by compliance to a standard vehicle gauge, the rules for the appropriate gauge are set out in GE/RT8073.
- 2.2.6.2 Where swept envelopes are used to demonstrate compliance with standard vehicle gauges, the same requirements shall apply as for absolute gauging, as set out in 2.2.8.

2.2.7 Use of comparator vehicle

- 2.2.7.1 The methodology used to determine the swept envelope of the comparator vehicle shall be the same as that used for the candidate vehicle or shall be demonstrated to be equivalent.
- 2.2.7.2 The vehicle loading calculation of the candidate vehicle shall be compared to that of the comparator vehicle to ensure that the gauging risk of the two are comparable. The loading conditions are set out in 2.3.1.
- 2.2.7.3 The candidate vehicle in normal operational mode shall not be compared to the comparator vehicle in any degraded or failure mode. Where the elements of the swept envelopes for the candidate vehicle fall outside those of the comparator vehicle, each individual excursion shall be documented in the gauging portfolio, and identified in the Technical File for subsequent evaluation of the consequences under the gauging compatibility process, as set out in GE/RT8273.

2.2.8 Use of absolute gauging

- 2.2.8.1 The swept envelope shall be determined by either calculations, dynamic simulations, experiments or tests.
- 2.2.8.2 The process and level of accuracy achieved shall be appropriate for the level of clearance to be determined, (such as normal, reduced or special reduced), and may vary for different locations along the route.

2.2.9 Use of hybrid gauging

- 2.2.9.1 Hybrid gauging may be used as an alternative to using a single defined process to demonstrate gauge compatibility. This is set out in GE/RT8273.

2.3 Vehicle loading

- 2.3.1 For the purposes of this document the loading terms 'tare', 'laden' and 'crush' shall be interpreted by use of the terms below, as set out in BS EN 15663:2009:
 - a) Tare: design mass in working order.
 - b) Laden: design mass under normal payload.
 - c) Crush: design mass under exceptional payload (passenger vehicles).