Requirements for Defining and Maintaining the Size of Railway Vehicles

Synopsis
This document mandates the methods of determining, and the requirements for maintaining, the operational envelope of rail vehicles. It mandates the format of the prescribed parameters for defining the size of railway vehicles.

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Authorised by
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Acting Controller, Railway Group Standards

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# Requirements for Defining and Maintaining the Size of Railway Vehicles

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Part A

A1 Issue record

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<th>Date</th>
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<tr>
<td>One</td>
<td>August 1994</td>
<td>Original Document</td>
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<td>Two</td>
<td>August 2000</td>
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<td>Three</td>
<td>February 2003</td>
<td>Replaces issue two Document updated to appropriately reference the new GC/RT5212 and GE/RT8270.</td>
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Amended or additional parts of revised pages have been marked by a vertical black line in the adjacent margin.

This document will be updated when necessary by distribution of a complete replacement.

A2 Implementation of this document

The publication date of this document is 1 February 2003.

This document comes into force on 5 April 2003.

The dates by which compliance with the requirements of this document is to be achieved are set out in Part B2. Where those dates are later than the date on which this document comes into force, this is to give Railway Group members additional time to plan and commence implementation so as to achieve full compliance by the dates set out in Part B2.

This document supersedes the following Railway Group Standards, either in whole or in part as indicated:

<table>
<thead>
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<th>Railway Group Standard</th>
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<th>Title</th>
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<td>GM/RT2149</td>
<td>2</td>
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GM/RT2149 issue 2 is withdrawn with effect from 5 April 2003.

A3 Scope of Railway Group Standards

The overall scope of Railway Group Standards is set out in Appendix A of GA/RT6001. The specific scope of this document is set out in Part B2.

A4 Responsibilities

Railway Group Standards are mandatory on all members of the Railway Group* and apply to all relevant activities that fall into the scope of each individual’s Railway Safety Case. If any of those activities are performed by a contractor, the contractor’s obligation in respect of Railway Group Standards is determined by the terms of the contract between the respective parties. Where a contractor is a duty holder of a Railway Safety Case then Railway Group Standards apply directly to the activities described in the Safety Case.
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* The Railway Group comprises Railtrack PLC, Railway Safety, and the train and station operators who hold railway safety cases for operation on or related to infrastructure controlled by Railtrack PLC.

Railtrack PLC is known as Railtrack.

A5 Health and safety responsibilities

In issuing this document, Railway Safety makes no warranties, express or implied, that compliance with all or any documents published by Railway Safety is sufficient on its own to ensure safe systems of work or operation. Each user is reminded of its own responsibilities to ensure health and safety at work and its individual duties under health and safety legislation.

A6 Technical content

The technical content of this document has been approved by:

Haydn Peers, Principal Traction and Rolling Stock Engineer, Railway Safety

Enquiries should be directed to Railway Safety – Tel: 020 7904 7518

A7 Supply

Controlled and uncontrolled copies of this document may be obtained from the Industry Safety Liaison Dept, Railway Safety, Evergreen House, 160 Euston Road, London NW1 2DX.
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the Size of Railway Vehicles

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Part B

B1  Purpose

This document mandates the methods of determining, and the requirements for maintaining, the operational envelope of rail vehicles. It mandates the format of the prescribed parameters for defining the size of railway vehicles.

B2  Application of this document

B2.1  To whom the requirements apply

This document contains requirements that are applicable to duty holders of the train operator category of Railway Safety Case.

B2.2  Compliance requirements

B2.2.1  Trains

This document applies to all vehicles intended to operate on Railtrack controlled infrastructure, except those set out in section B2.3.

The vehicle design requirements mandated in this document are to be complied with by all vehicles of previously uncertificated designs with a Certificate of Conformance for Vehicle Design signed on or after 5 April 2003. In addition to this the design requirements shall be complied with by any future vehicles, built to the same design as a vehicle already having Engineering Acceptance, which enter service on Railtrack controlled infrastructure on or after 1 August 2005.

All other requirements mandated in this document shall be complied with no later than 5 April 2003.

All of the requirements of this document are within the scope of Vehicle Acceptance Body approval.

B2.2.2  General compliance requirements

Until the compliance date, or the date by which compliance is achieved (if earlier), the applicable requirements of the predecessor documents shall continue to be met (see Part A for details).

After the compliance date, or after the date by which compliance is achieved (if earlier), Railway Group members shall not deviate from the requirements set out in this document.

Where it is considered not reasonably practicable, to comply with the requirements set out in this document, authorisation not to comply shall be sought in accordance with GA/RT6001, GA/RT6004 or GA/RT6006.

B2.3  Exclusions from the application of this document

This document does not apply to:

a) those shunting vehicles requiring limited access to Railtrack controlled infrastructure for the specific purpose of transit between sidings, as excluded from Engineering and Route Acceptance in GM/RT2000 and GE/RT8270 respectively

b) Road/Rail Vehicles (RRVs) and Rail Mounted Maintenance Machines (RMMMs), because these vehicles are only permitted within possessions.

B3  Definitions

Cant deficiency

The extent by which the cant on curved track is less than that required for the gravitational component acting parallel with the plane of the rails to exactly counterbalance the centrifugal forces acting on a vehicle in the same plane.
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Cant excess
The extent by which the cant on curved track exceeds that required for the gravitational component acting parallel with the plane of the rails to exactly counterbalance the centrifugal forces acting on a vehicle in the same plane. It equates to a negative value of cant deficiency.

Curve overthrow
The extent to which a transverse cross-section of a vehicle is displaced inwards or outwards from the track centreline on a perfectly aligned curve.

Engineering change
A change to a rail vehicle, whether hardware or software, in the area of design, construction or maintenance which affects conformance to the mandatory requirements.

Gauging
The process by which swept envelopes of a vehicle, or vehicle gauges are used to determine clearances on a section of track between the vehicle and fixed structures and between the vehicle and vehicles on adjacent tracks.

Gauging acceptance
The endorsement by the infrastructure controller that a vehicle has satisfactorily completed the gauging process for a route in accordance with GE/RT8270.

Lower sector
The area up to and including 1100 mm above the plane of the rail. See also ‘upper sector’.

Pantograph sway
The lateral and roll displacements of the pantograph position relative to the centre line of the track in response to the dynamic effects of vehicle sway, overthrow at the pantograph location, pantograph mounting tolerances and lateral flexibility.

Permissible or enhanced permissible speed
The maximum speed published in the sectional Appendix at which traffic is allowed to run on a line.

Plane of the rails
An imaginary surface coplanar with the top of the rails of a track.

Reference datum point
A single point within the vehicle from which all principal linear dimensions may be referenced longitudinally, laterally and vertically.

Standard vehicle gauge
An outline drawing or specification of a notional vehicle, which prescribes maximum permissible vehicle and loading dimensions, certain suspension displacements, and certain curve overthrow limitations (for example W6a).

Swept envelope
A cross-sectional profile, taken at right angles to the track, enclosing all dynamic movements, static deflections 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 performance on a route.

The swept envelope defined within this document excludes the effects of track tolerance and rail side wear which were included in issue one of this document.

Tilt hard over failure
A tilt system failure that causes the vehicle body to remain tilted at up to the maximum tilt possible.
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Upper sector
The area above 1100 mm above the plane of the rails. See also ‘lower sector’.

Vehicle sway
The lateral and roll displacements of a vehicle body and its bogies on their suspension systems in response to:

a) track layouts, discrete features and irregularities

b) vehicle speeds and cant deficiencies

c) wind forces

d) suspension performance and condition (including tolerances and wear of suspension components, and likely failure modes)

e) active suspension.

The terms ‘vertical’ and ‘lateral’ have been retained because of common usage to describe suspension deflections perpendicular to, and parallel with, the plane of the rails respectively, irrespective of the track cant.

B4 Introduction

B4.1 The overall process
The safe operation of a rail vehicle on the infrastructure is dependent upon maintaining adequate clearance between the vehicle and adjacent structures, and by 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 on the route (ie the size of the route), the dynamic size (swept envelope) of the vehicle and the clearance between the two.

The characteristics of the route may be defined in absolute dimensional terms relative to the plane of the rails and nominal centre-line of the track, or by reference to a recognised gauge, or indirectly by reference to vehicles already operating along the route. GC/RT5212 gives a methodology for this, and a standard structure gauge for the lower sector.

The swept envelopes of the vehicle are determined by identification of the relative movements of all significant parts of the vehicle, at speeds and under conditions appropriate to the route(s) on which it is to operate. It can be defined either in absolute dimensional terms relative to the plane of the rails and nominal centre-line of the track, or by comparison with a recognised standard vehicle gauge.

The adequacy of the clearances is determined by the gauging process defined in GC/RT5212. The alternative methods of assessment are summarised as follows:

a) relating a vehicle defined in absolute dimensional terms to a route defined in absolute dimensional terms

b) relating a vehicle, sufficiently defined in absolute dimensional terms, to a standard vehicle gauge for which a route is cleared

c) relating a vehicle defined in absolute dimensional terms to an existing vehicle known to be operating on each proposed route, defining the latter vehicle in a similar way to facilitate the comparison.

Use of method (a) requires that the infrastructure has already been appropriately defined. Use of methods (b) or (c) can result in vehicles that are smaller than would otherwise be possible.
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B4.2 This document within the process
This document describes the requirements for defining the swept envelopes of a rail vehicle appropriately for each of the alternative methods of gauging that can be adopted. It does not define the gauging process (defined in GC/RT5212) or the appropriateness of the respective gauging methods to particular routes.

It identifies:

a) the appropriate methods by which the boundaries of the vehicle's dynamic movements are to be defined for gauging purposes
b) the parameters normally required to adequately define the vehicle's dynamic movements
c) the compensation required for tolerances on the accuracy of calculated parameters
d) the format in which the information is to be presented for gauging acceptance.

The document mandates that those parameters affecting the swept envelopes of the vehicle are to be identified and the limiting values are to be included within the relevant maintenance specifications.

B4.3 Data usage
The data generated by definition of the vehicle swept envelopes is required for:

a) obtaining Engineering Acceptance for the vehicle concerned
b) obtaining gauging acceptance and, ultimately, route acceptance for the vehicle concerned
c) facilitating reviews by the infrastructure controller of the vehicle's compatibility with other vehicles subsequently being considered for operation on the same route(s).

B5 Principle
This document:

a) prescribes the parameters that are required to define the envelope containing all dynamic movements and static deflections of a rail vehicle or combination of vehicles, relative to the track, over the permitted range of operating conditions
b) identifies the permissible methods by which the magnitude of those parameters may be determined
c) defines the format of the data for gauging purposes
d) prescribes the maintaining of the envelope throughout the operational life of the vehicle or combination of vehicles.

B6 General requirements

B6.1 The envelopes defining the maximum movements of the vehicle under normal service and fault/failure conditions, shall, unless agreed otherwise with the infrastructure controller, be in the form of swept envelopes appropriately detailed to permit absolute gauging. These shall be derived by determination of the vehicle characteristics in absolute dimensional terms as defined in section B7 of this document.
The swept envelope shall be determined relative to the nominal centreline of the track and the plane of the rail, and shall assume a fixed track. The vehicle designer is not required to include any allowances for track tolerances and rail wear, except as specifically required by section B7.3. All positional tolerances and allowances for rail wear are included in the infrastructure’s calculation of clearances as required by GC/RT5212.

Where specifically agreed with the infrastructure controller, it is permissible to use one of the following methods as a substitute:

a) reference to a standard vehicle gauge as defined in section B8 of this document

b) reference to a comparator vehicle as defined in section B9 of this document.

Where either method a) or b) above are used to define the envelope of the vehicle, the clearance requirements shall be deemed to be implicit in the gauge or reference vehicle agreed.

Irrespective of the method used, except with the possible exception of the widely applicable W6a gauge, the train operator is advised (though not required) to define the vehicle in sufficient detail to facilitate subsequent transfer to routes where absolute gauging is required.

B6.2

The swept envelopes of the vehicle in the lower sector shall provide the following clearances:

a) 75 mm vertically above the plane of the rails between the rails under all conditions (the wheels excluded), taking account of all suspension movements and vertical curves

b) 50 mm from the structure gauges defined in GC/RT5212 Appendix 1 (standard case only) for all other areas in the lower sector, except in the case of c) and d) below

c) 25 mm is permissible under worst case conditions, such as suspension failure, in localised areas adjacent to the lower sector structure gauge provision for guard rails, conductor rails, guard boards and APC magnets (that is, that portion of the lower sector structure gauge defined in GC/RT5212 Appendix 1 (standard case only) up to a height of 110 mm above the plane of the rail)

d) 25 mm from any part of the lower structure gauge defined in GC/RT5212 Appendix 1 (standard case only), between heights of 110 mm and 1100 mm above the plane of the rails, in the case of suspension failure.

Where a standard vehicle gauge or a comparator vehicle have been approved by the infrastructure controller as an appropriate definition of the permissible envelope for a vehicle for a specific route or routes, the requirements defined in section B6.2 a) to d) shall not be separately applied unless specifically invoked in addition to the gauge or comparator.

B6.3

Footsteps for passenger use shall meet the following requirements relative to the dimensions for new platforms set out in GC/RT5161:

a) The stepping distance between the footstep and the edge of the standard platform shall be as small as practicable.

b) The stepping distance shall, for platforms on curves with radii down to 160 m, not exceed the parameters defined in Appendix A of this document.
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c) The swept envelope of the step, including that of its underside, shall maintain the minimum clearance defined in section B6.2 of this document.

d) The horizontal stepping distance shall be minimised by making maximum use of step overlap of the platform by up to 50 mm for platforms on curves. It is permissible for the 50 mm limit to be exceeded where steps are retractable provided that the steps are interlocked to prevent the vehicle moving with the steps in the extended position.

B6.4
The envelopes of the vehicle, by whichever method established, shall be maintained throughout its operational life by means of maintenance procedures that take full cognisance of the factors identified in section B6.6 of this document as influencing the swept envelopes of the vehicle and their limiting or maximum values for example limits of wear on suspension components.

B6.5
Where the vehicle can be operated separately or in multiple, the vehicle shall be considered in accordance with the requirements of this document both individually and when forming part of a train. Where the vehicle must be 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 the document.

B6.6
The mandatory limits of wear and maximum tolerances specified for all components, assemblies and systems influencing the degree of dynamic movement of the vehicle shall be reviewed, and those combinations identified as having a significant probability of occurrence shall be taken into account in the determination of each vehicle swept envelope.

B6.7
Vehicle swept envelopes shall be determined for:

a) the full permissible range of operating speeds and cant deficiencies for which the vehicle has been designed

b) the range of track and rail configurations, features and track quality appropriate to the route(s) for which gauging acceptance is required (this information is to be made available by the infrastructure controller in accordance with GC/RT5212)

c) peak cross wind speeds of 0 and 35 m/s, and any higher limit for particularly exposed routes as identified under section B12.1 of this document (the infrastructure controller will take account of the appropriate value(s) for the purpose of gauging clearance and route acceptance, whether within the range or above the range). It is permissible for the 35 m/s and higher wind speed data to be described relative to the 0 m/s case.

B6.8
The following limiting vehicle dimensions shall normally be respected for compatibility with train detection system requirements described in GK/RT0011:

a) maximum spacing between adjacent axles of 17.51 m

b) minimum bogie wheelbase of 1.6 m

c) minimum vehicle wheelbase of 2.6 m

d) maximum axle spacing for non-bogied vehicles of 11 m

e) maximum vehicle overhang of 3.226 m from the wheel centre of the first/last axle to the end of the vehicle.
Where it is anticipated that values are to be outside the limits indicated above (for example, in the case of an aerodynamically styled nose cone on high speed trains), agreement shall be obtained from the infrastructure controller that the vehicle dimensions are compatible with the train detection systems operative on the routes envisaged (see also GK/GN0611).

B7 Swept envelope for use with absolute gauging

B7.1
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.

B7.2
The swept envelopes shall be determined by calculations, dynamic simulations, experiments and tests as appropriate to the criticality of the determination.

a) Where the swept envelopes are maximised to the limit of the clearances that are to be maintained, the method used to determine the swept envelopes shall be rigorous and of proven accuracy. Where reduced clearance is operative, section B7.2 b) of this document applies.

b) Where the vehicle will operate with reduced or special reduced clearance at specific locations on the anticipated route(s), the vehicle swept envelopes shall be determined by full computerised modelling for the particular features at those locations. The model shall include the effects of yaw and pitch.

c) Where the swept envelopes are not close to the maximum possible for the proposed route(s) less rigorous analysis may be used to determine the swept envelopes.

A tolerance appropriate to the accuracy of the method used for determining the swept envelopes shall be applied and the full tolerance shall be included within the final swept envelopes. The appropriateness of the method used, and the tolerances applied, shall be endorsed by the Design Conformance Certification Body.

B7.3
The swept envelopes shall take into account at least the following factors:

a) quasi-static sway arising from steady-state curving forces (cant deficiency and cant excess)

b) dynamic sway in response to short wavelength track cross level tolerance

c) dynamic sway in response to track irregularities

d) dynamic vertical suspension displacements in response to track irregularities

e) static vertical displacements caused by payload variations, wheel wear, and suspension stiffness tolerances, etc

f) dynamic vertical deflections of the vehicle body or frame under any conditions of load, taking account of the factors in B7.3 e) above

g) vertical and sway displacements associated with likely suspension failure modes and other relevant factors, including hard over tilt failure or other system failure where applicable

h) vehicle overthrows on curves, laterally and vertically
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i) wheel-rail clearance (including flange wear), but not rail wear.

The swept envelopes shall also indicate the area swept by pantographs, where fitted, in the operational and locked down modes.

The swept envelopes shall take account of tolerances in vehicle dimensions, mass distributions and wheel loadings, suspension characteristics, normal variations in vehicle maintenance condition and wear, and any other relevant variables.

B7.4
In determining the swept envelopes, the full range of all relevant clearances, 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 appropriate swept envelopes. Such worst cases will not necessarily be failure cases, or occur at maximum speed, and may be different for various speeds.

B7.5
The swept envelopes shall be validated in accordance with section B11 of this document.

B8 Standard vehicle gauge

B8.1
Where it is desirable, or necessary, to define the size of the vehicle by reference to a standard vehicle gauge (for example W6a), sufficient items of the data required by sections B7.3 and B7.4 above shall be derived to demonstrate conformance in accordance with the sections B8.2 to B8.4 of this document. This method is only permissible where the vehicle’s dynamic behaviour, including sway, is contained within the limitations appropriate to the standard vehicle gauge; for example, certain freight gauges assume minimal lateral suspension movement and assume no sway.

B8.2
In applying a comparison with a standard vehicle gauge, steps shall be taken to ensure that the comparison is valid, particularly in terms of any novelty in the configuration of the vehicle under consideration, its operating speeds and cant deficiencies, and its suspension characteristics. The factors listed in section B7.3 shall be taken into account.

If there is doubt about the validity of the comparison, then the vehicle permissible envelope shall be determined in accordance with sections B7 or B9 of this document.

B8.3
The vehicle under consideration shall not infringe the standard vehicle gauge unless the requirements of section B8.4 are met. Where such infringements are accepted, operational restrictions may result. Vehicles of any type may be built to any of the standard vehicle gauges providing they fully comply with the requirements of the chosen standard vehicle gauge.

It is permissible for the infrastructure controller to develop additional gauges as circumstances necessitate and the requirements for the development of such standard vehicle gauges are set out in GC/RT5212.

B8.4
Where the vehicle concerned falls outside the standard vehicle gauge, each individual exceedence shall be documented in the gauging portfolio, and identified on the Design Conformance and Engineering Acceptance Certificates, for subsequent evaluation of the consequences under the gauging acceptance process.
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B9 Comparative vehicle definition

B9.1 Where it is desirable, or necessary, to obtain gauging acceptance by comparing the vehicle with a vehicle already operating on the proposed route(s), referred to hereafter as the comparator vehicle, sufficient data shall be derived under the requirements of section B6 of this document to form the basis of a sufficient comparison. The requirements of sections B9.2 to B9.4 of this document shall also be met.

B9.2 The swept envelopes of the comparator vehicle shall be determined in accordance with the requirements of section B6 of this document using the same input conditions as for the vehicle under consideration. Sufficient data shall be derived to permit valid comparison of the vehicle under consideration with the comparator vehicle and to demonstrate its conformance.

B9.3 Where the elements of the swept envelopes for the vehicle concerned fall outside those of the comparator vehicle, each individual excursion shall be documented in the gauging portfolio, and identified on the Design Conformance and Engineering Acceptance Certificates, for subsequent evaluation of the consequences under the gauging acceptance process.

B9.4 Differences of vehicle configuration or shape, rendering the comparison inexact, shall be identified. All measures taken to compensate for the differences shall be documented together with evidence demonstrating the validity of the compensation.

B10 Specific requirements for vehicle equipment

B10.1 Pantograph
The pantograph sway displacements shall not exceed the following values relative to the nominal centre line of the track at a height of 4.3 m above the plane of the rails:

a) \( \pm 130 \text{ mm} \) when running at all speeds up to the maximum vehicle operating speed and at maximum cant deficiency in still air

b) \( \pm 190 \text{ mm} \) when running at maximum vehicle operating speed and at maximum cant deficiency with a maximum wind speed of 35 m/s (126 km/h).

For heights greater than 4.3 m above the plane of the rails, the pantograph sway displacements shall not be increased by more than \( \pm 40 \text{ mm} \) for each metre increase in height above 4.3 m.

B10.2 Shoegear
Shoegear and associated equipment shall not infringe the limiting swept envelope prescribed in Appendix B of this document, when subject to the following two sets of conditions:

Case A: Displacements Towards the Outside of a Curve:

a) The curve overthrows resulting from a 160 m radius simple curve.

b) The kinematic displacements when operating at the speed which produces maximum design cant deficiency with an installed track cant of 150 mm.

Case B: Displacements Towards the Inside of a Curve:
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a) The curve overthrows resulting from a 160 m radius simple curve.

b) The kinematic displacements when operating at a speed of 5 km/h with an installed track cant of 150 mm.

Conditions a) and b) in each of the two cases are independent conditions and are not intended to be co-incident.

B10.3 Automatic Power Control receivers
Automatic Power Control (APC) receivers, provided to interrupt and re-establish the supply of AC current from pantographs before and after neutral sections respectively, shall be contained within the swept gauge prescribed in Appendix C of this document, with due regard to lateral curve overthrow and vertical static displacements.

B10.4 Tripcocks
Tripcocks, provided to initiate an emergency brake application in the event of the train passing a signal at danger, shall be contained within the swept gauge prescribed in Appendix D of this document. Account shall be taken of lateral curve overthrow, vertical static wheel wear and vertical displacements due to axlebox pitch movements (where of significance), but not of wheel/rail flangeway clearance and lateral wear of the wheel flange.

B10.5 Other equipment
The permissible swept envelopes for other specific equipment not listed in this section, which exceed the limits defined in sections B6 to B9 of this document, shall be agreed with the infrastructure controller and approved by Rolling Stock Acceptance Board for the route(s) for which special clearance is required.

B11 Validation

B11.1 The swept envelopes shall be validated by calculations, by comparisons with other vehicles, by testing or by other appropriate means commensurate with the level of risk, complexity and innovation in the vehicle design.

B12 Responsibilities

B12.1 The train operator shall obtain from the infrastructure controller appropriate data defining the routes for which gauging acceptance is required, including those routes required for movement to and from depots or maintenance and repair facilities, and critical features of those routes. The data shall include, but not exclusively:

a) the line speeds for each significant section of the route

b) the structure gauges applicable to the route, including those of platforms, or appropriate vehicle data where the comparison method is agreed

c) horizontal and vertical curve radii for the route

d) track quality values for the route

e) specific wind speeds above 35 m/s likely to be experienced, where the track is particularly exposed

f) any specific restrictions applying due to infrastructure or existing vehicles.

B12.2 The train operator shall identify the method(s) for determining the vehicle swept envelopes which are compatible with the existing definitions of the routes for which gauging acceptance may be required.
B12.3
The train operator shall produce a list of all tolerated vehicle parameters and wearing components influencing the swept envelopes, identifying the maximum tolerances and limits of wear considered in determining the swept envelopes.

B12.4
The train operator shall incorporate specific provisions in the maintenance procedures for the vehicle to ensure that the maximum tolerances and limits of wear, identified under section B12.3 of this document, are not exceeded.

B12.5
The train operator shall identify and justify the worst cases considered in determining the swept envelopes, supported by a probability analysis of the cases considered in selecting the worst case. It should be noted that failure conditions or maximum load case may not represent the worst case.

B12.6
The train operator shall define the vehicle swept envelopes in accordance with section B6 of this document.

B12.7
The train operator shall identify and justify all areas where comparison with an existing (comparator) vehicle is not exact, where the vehicle swept envelopes are identified by comparison with an existing vehicle.

B12.8
Where speculative vehicle design is carried out by a manufacturer, the manufacturer may initially undertake the work indicated in sections B12.1 to B12.7 above. The ultimate responsibility within the Engineering Acceptance process remains with the train operator seeking that Acceptance.

B12.9
The infrastructure controller is required by GC/RT5212 to supply on request the appropriate data defining the routes for which gauging acceptance is required, including those routes required for movement to and from depots or maintenance and repair facilities, and potentially critical features of those routes.

B13 Provision of vehicle data

B13.1 Data for conformance certification
The train operator shall submit the following to a Conformance Certification Body (CCB) under the process for obtaining a Certificate of Conformance - Design.

B13.1.1 Data for all vehicles
a) confirmation from the infrastructure controller that the method used for determination of the vehicle envelopes is compatible with the definition of the proposed route(s), as indicated in section B6.1

b) drawings, calculations, or other references, as appropriate, supporting the data

c) evidence that tolerances and limits of wear, beyond which the vehicle would cease to be compliant with the declared envelope, have been identified and recorded for incorporation in the Maintenance Plan for the vehicle under the requirements of GM/RT2000 and GM/RT2004

d) the mass of all principal vehicle components, broken down typically into such major items as vehicle body, bogie sprung mass, wheelset mass, as appropriate. Where appropriate, separate values shall be provided for all relevant operating and loading conditions.
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B13.1.2 Vehicles defined by swept envelopes for absolute gauging

The following data shall be provided:

a) a list of the critical features of the proposed routes influencing the accuracy and scope of the swept envelope determination

b) an indication and justification of the worst cases considered in determining the swept envelopes, supported by a probability analysis of the cases considered in selecting the significant worst case(s)

c) the swept envelope data relevant to the scope of required gauging acceptance as defined in section B13.2 of this document

d) a detailed listing of all vehicle parameters and vehicle characteristics which are capable of influencing the size of the swept envelopes of a vehicle, identifying the numerical value of each parameter, including:

   i) the nominal value
   ii) the tolerance band
   iii) probability distribution (if appropriate)

e) the inertias of the vehicle body, bogies (excluding wheelsets) and wheelsets in yaw, pitch and roll

f) the centre of mass of all principal vehicle components. Where appropriate, separate values shall be provided for all relevant operating and loading conditions

g) suspension system linear or rotational force generating elements which produce forces or torques directly proportional to the relative displacement or velocity between the end points of the element

h) suspension system linear or rotational force generating elements which produce forces or torques which are not directly proportional to the relative displacement or velocity between the end points of the element. Typical examples are bump and lift stops, dampers with blow-off characteristics, or hysteresis caused by friction

i) other vehicle specific parameter types where appropriate for specific vehicle configurations which incorporate such elements as:

   i) tilt systems
   ii) active suspension elements
   iii) articulation
   iv) hold-off devices
   v) other novel features.

In these cases, the data provider shall supply sufficient data to adequately describe the characteristics of the elements concerned, including those details indicated in Appendix E of this document.

B13.1.3 Vehicles defined by standard vehicle gauge

The following data shall be provided:

a) the standard vehicle gauge data where referenced, together with identification and justification of all areas where comparison with the comparator vehicle is not exact
b) confirmation that, where a standard vehicle gauge is used, the vehicle conforms with any underlying assumptions or limitations relevant to that gauge.

**B13.1.4 Vehicles defined by a comparator vehicle or vehicles**

The following data shall be provided:

a) the swept envelope data necessary to permit comparison between the vehicle and the comparator vehicle

b) the comparator vehicle data where referenced, together with identification and justification of all areas where comparison with the comparator vehicle is not exact

c) confirmation that, where a comparator vehicle is used, the characteristics of the vehicle being evaluated conform with the characteristics of that comparator vehicle.

**B13.2 For gauging acceptance**

The train operator shall submit to the infrastructure controller a vehicle gauging portfolio containing the swept envelope data or confirmation of the compliance of the vehicle with the standard vehicle gauge or comparator vehicle, as appropriate to the route(s) for which authority to operate is sought. The submission shall include:

a) a vehicle diagram, giving an overview of the vehicle concerned (all vehicles)

b) details of any non-compliance referred to in sections B8.4 or B9.3 (only for cases where a comparator vehicle or standard vehicle gauge are use)

c) a vehicle profile summary drawing, identifying the location of the body plan view and cross sectional profiles (for absolute gauging only)

d) vehicle body plan view profiles (for absolute gauging only)

e) vehicle cross sectional profiles (for absolute gauging only)

f) swept envelopes for each significant track configuration and location relevant to the route(s) along which the vehicle may be expected to operate (for absolute gauging only).

The above items are defined in sections B13.2.1 to B13.2.5 of this document. Each item shall have a unique identification reference number.

**B13.2.1 Vehicle diagram**

The vehicle diagram shall be clearly identified with the name of the vehicle manufacturer, vehicle class and any additional distinguishing mark.

The diagram shall comprise plan, side and end elevations of each vehicle. It shall include the principal dimensions on each elevation.

The diagram shall be submitted in a form suitable for print copying at A4 size, with the elevations at a maximised scale and with all data adequately sized to retain legibility at A4 size.

The dimensions shall include at least:

a) the maximum body length over headstocks

b) the body length over buffers and couplers

c) the maximum overhangs of the body outboard of the bogie pivots or axle centres
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d) the maximum body width

e) the bogie pivot spacings or, for two axle vehicles, the axle centres

f) the bogie wheelbase(s)

g) the wheel diameter(s)

h) the door positions.

The diagram shall also include a summary of key features of the vehicle (for example maximum design speed in tare and laden, whether tilting or not, the type of suspension, coupler type etc), space for the Conformance Body’s official stamp (signed and dated), and an indication of the standard vehicle gauge or comparator vehicle against which the swept envelopes have been determined where appropriate.

An illustration of the format is given in Appendix F of this document at reduced scale. Key data shall be on the front of the diagram for quick reference but it is permissible for additional data to be on the reverse side of the diagram.

B13.2.2 Vehicle summary drawing
The vehicle summary drawing, comprising plan and side elevations, shall contain the following information:

a) the location of the reference datum point longitudinally, laterally and vertically

b) the location of each longitudinal and lateral profile, cross-referenced to the appropriate drawing of that profile.

B13.2.3 Vehicle body plan view profiles
The body plan profiles shall contain dimensions of the vehicle and give sufficient detail to unambiguously define the longitudinal and lateral profiles. Details which define the limits of the swept envelope, such as body end tapers, the location of all roof equipment, and end profiles, including noses, etc shall be included. The vertical location of each profile shall be clearly stated and cross-referenced with the associated vehicle summary drawing.

B13.2.4 Vehicle cross sectional profiles
The cross sectional profiles shall contain dimensions of the vehicle and give sufficient detail to unambiguously define the cross sectional profile at significant points along the length of the vehicle. Typically, several separate drawings showing sections through the vehicle at these locations shall be provided. Details which define the limits of the swept envelope, such as footsteps, yaw damper brackets, roof equipment (including pantographs), nose end profiles, etc shall be included. The longitudinal location of each profile shall be clearly stated and cross-referenced with the associated vehicle summary drawing.

B13.2.5 Vehicle swept envelopes
A swept envelope shall be produced for each separate combination of track and environmental operating conditions as indicated in section B6.7 of this document and a) to c) of this section.

The vehicle cases considered shall include:

a) all vehicle types and variants (for units operating in multiple it is permissible to consider the single vehicle presenting the largest profile in all respects or a composite vehicle gauge representing the aggregate of the most significant features of all vehicle types and variants in a formation)

b) normal operating conditions, including at least:

i) tare and maximum load conditions
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ii) additional cases, where appropriate; for example, freight vehicles carrying empty containers

c) appropriate combinations of failure modes, including as appropriate:

i) deflated air suspension systems

ii) tilt failure modes

iii) active suspension system failures

iv) failures of other vehicle systems, which are capable of influencing the size of the vehicle swept envelopes.

Each swept envelope shall describe the outer boundary of all dynamic movements, static deflections and overthrow that may reasonably be expected to occur under its respective combination of track and environmental conditions. The drop and sway movements shall be clearly identified. The determining features shall be clearly referenced, and the related track and operating conditions shall be identified.

The format of the swept envelope shall be agreed with the infrastructure controller.

B14 Records

B14.1 The train operator shall arrange for auditable records to be kept of drawings, calculations and technical information used to evaluate and describe the swept envelopes of a vehicle.

B14.2 The train operator shall retain one copy of the vehicle gauging portfolio, reflecting the status at the time of obtaining gauging acceptance, for a period of seven years after cessation of the vehicle’s operation in that status on the defined route(s).

B14.3 The train operator shall in the event of relinquishing operation of the vehicles on the defined routes transfer such records to the succeeding train operator who is to operate the same vehicles on the same route(s).

B14.4 The train operator shall transfer such records to the infrastructure controller, who shall become the legal owner of the records, immediately upon becoming insolvent.
Appendix A

Stepping distances

For full requirements, see section B6.3 of this document

Examples of permissible step positions

- - - - - - -
the nominal footstep height to be achieved as far as is practical

* Dimensions are worst case maxima and shall be minimised as far as practicable

** Maximum overlap allowable for curves down to 160 m radius
Appendix B
Swept envelope for shoegear

All Dimensions in mm

Available Area
For Shoegear

RAIL LEVEL

TRACK

280
180
50
105
130

849
922
1032
1202
1287
Appendix C
Location of APC receiver

Minimum = 178 static, under all conditions of wheel wear suspension settlement etc.

Additional vehicle swept gauge for accommodation of APC receiver

railway
magnet
running rail
receiver

118

1263 to C
1222 to C
1175 to C
Appendix D
Location of tripcock

Note: Dimensions marked * shall be maintained for all conditions of wheel wear.
Appendix E
Requirements for parameter elements

When providing data on the following specific parameter types, the appropriate requirements for that type shall be complied with:

E.1 Damper elements
The following details shall be included in the parameter data:

a) Frequency range for which the damping characteristic is valid.
b) Damping characteristic.
c) Total Series Stiffness of the damper element and end mounting systems.
d) Positional data for each end of the element.

E.2 Stiffness elements
The following details shall be included in the parameter data:

a) Frequency range for which the stiffness characteristic is valid.
b) Stiffness characteristic.
c) Positional data for each end of the element.

The stiffness characteristics of elements can change, depending on the load, frequency and amplitude of the response. The effective values appropriate to the condition shall be used and the scope of applicability identified in the parameter record.

E.3 Airsprings
a) For kinematic gauging purposes, quasi-static stiffnesses shall be used.
b) For air springs which support a vertical load an allowance shall be made for the end moments exerted by the spring when it is sheared laterally. Also a representative distribution of the total moment between the top and bottom of the spring shall be made, depending upon the type of airspring.
c) Account shall be taken of the possible changes in the vertical and lateral air spring stiffnesses resulting from the applied vertical load.
d) Account shall be taken of the possible changes in the vertical and lateral air spring stiffnesses resulting from the displacements of the spring.
e) The effect of any stiffness modifying devices such as ‘skirts’ shall be included.
f) The effect of any air spring cross coupling shall be considered.
g) The effect of levelling valves shall be included if it is significant.

The following details shall be included in the parameter data:
i) supported load on each spring
ii) frequency range for which the stiffness characteristic is valid
iii) lateral stiffness characteristic
iv) vertical stiffness characteristic
v) amplitude and hysteresis effects
vi) effective height(s) – may be different for the upper and lower bodies; depending upon the vertical loading

vii) positional data for each end of the element

viii) the effect of levelling valves, if appropriate.

E.4 Swinglink suspensions
Depending upon the actual configuration, at least the following parameters shall be provided:

a) Effective swing link length, taking into account all aspects of the mechanical arrangement.

b) Resulting lateral stiffness for the supported load.
Appendix F

Vehicle diagram format

Vehicle Diagram For Class

<table>
<thead>
<tr>
<th>Vehicle Data Panel</th>
<th>Engineering Acceptance Panel</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1. Class of vehicle</td>
<td>Gauging Acceptance Panel</td>
</tr>
<tr>
<td>A2. Manufacturer</td>
<td>B1. Train Operator</td>
</tr>
<tr>
<td>A4. Maximum Design Speed</td>
<td>B3. Reference (if B2.2 or 2.3)</td>
</tr>
<tr>
<td>A5. Wheel Diameter (nominal)</td>
<td>B4. Routes:</td>
</tr>
<tr>
<td>A6. Particular Features: (e.g. tilting, active suspension)</td>
<td></td>
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<table>
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<th>Confirmation of Process</th>
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<tbody>
<tr>
<td>Gauging Acceptance Panel</td>
</tr>
<tr>
<td>B1. Train Operator</td>
</tr>
<tr>
<td>B2. Basis of Gauging</td>
</tr>
<tr>
<td>B3. Reference (if B2.2 or 2.3)</td>
</tr>
<tr>
<td>B4. Routes:</td>
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</table>

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<thead>
<tr>
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Requirements for Defining and Maintaining the Size of Railway Vehicles

References

GA/RT6001  Railway Group Standards Change Procedures
GA/RT6004  Temporary Non-Compliance with Railway Group Standards
GA/RT6006  Derogations from Railway Group Standards
GC/RT5161  Station Platform Design Requirements (planned to be superseded by GI/RT7016 for requirements relating to platforms)
GC/RT5212  Requirements for Defining and Maintaining Clearances
GE/RT8270  Route Acceptance of Rail Vehicles Including Changes in Operation or Infrastructure
GK/GN0611  Guidance Note: Train Detection
GK/RT0011  Train Detection
GM/RT2000  Engineering Acceptance of Rail Vehicles
GM/RT2004  Requirements for Rail Vehicle Maintenance


Other References

Related Documents