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

Railway

Issue Two: September 2013



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

Issue record

Issue	Date	Comments
One	December 2010	Original document Supersedes GM/GN2589 and parts of GM/RT2101
Two	September 2013	Replaces GM/GN2688 issue one Incorporates the output from a review of design guidance for wagons and how standard British practice meets the Wagon Technical Specification for Interoperability (WAG TSI). Inclusion of new guidance on the interpretation of the WAG TSI for wagons for use on the Great Britain (GB) mainline railway.

Revisions have not been marked by a vertical black line in this issue because the document has been revised throughout.

Superseded documents

The following Railway Group documents are superseded, either in whole or in part as indicated:

Superseded documents	Sections superseded	Date when sections are superseded
GM/GN2688, issue one, December 2010, Guidance Note: The Structural Design and Construction of Rail Freight Wagons including Rail Tank Wagons	All	September 2013

GM/GN2688 issue one ceases to be in force and is withdrawn as of 07 September 2013.

Supply

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Part 1 Introduction

G 1.1 Purpose of this document

- G 1.1.1 This document gives guidance on the design of rail freight wagons (including rail tank wagons).
- G 1.1.2 For wagons for use in Great Britain (GB), this document gives:
- a) Guidance on historical design solutions that have been successful in GB (see Part 2).
 - b) Guidance on the interpretation of the Technical Specification for Interoperability relating to the WAG TSI (see Part 3).
- G 1.1.3 The guidance provided in this document complements the Application Guide to the WAG TSI produced by the European Rail Agency (ERA).
- G 1.1.4 The guidance provided in this document is for the design of wagons and refers to standards where they have historically been found to be helpful. The list of standards complements the list of national technical rules published by the Department for Transport on their website.

G 1.2 The structure of this document

- G 1.2.1 All new freight wagons should be designed to conform to the WAG TSI. The guidance in Part 2 of this document is intended to facilitate this process for wagons used within GB. Part 3 sets out guidance on the interpretation and application of the WAG TSI, where the TSI wording could be ambiguous or open points or GB specific cases exist.
- G 1.2.2 Guidance is provided as a series of sequentially numbered clauses prefixed 'G' immediately below the greyed text to which it relates.

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G 1.4 Approval and authorisation of this document

- G 1.4.1 The content of this document was approved by Rolling Stock Standards Committee on 24 May 2013.
- G 1.4.2 This document was authorised by RSSB on 22 July 2013.

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G 1.5 Structure of the WAG TSI

- G 1.5.1 The WAG TSI is divided into seven chapters. The first three chapters are informative and contain no mandatory requirements. Chapter 1, the Introduction, sets out the technical and geographical scope of the WAG TSI, and describes its contents. Its geographical scope is the trans-European rail system as described in Directive 2008/57/EC Annex I, Chapter 1.1.
- G 1.5.2 Chapter 2 defines the wagon subsystem and its interfaces with other subsystems.
- G 1.5.3 Chapter 3 sets out how the WAG TSI has covered the essential requirements for the subsystem defined in the Railway Interoperability Directive 2008/57/EC.
- G 1.5.4 Chapter 4 sets out the main technical requirements in the WAG TSI and is dealt with in detail in this guidance note.
- G 1.5.5 Chapter 5 deals with interoperability constituents (ICs) (essentially components, sub-assemblies or complete assemblies of equipment intended to be incorporated into a subsystem). These ICs are assessed and certificated separately and then incorporated into the wagon sub-system.
- G 1.5.6 Chapter 6 deals with the assessment of conformity of interoperability constituents and the verification of the subsystem. Guidance supporting the assessment and verification requirements has been placed with the relevant technical requirements from the WAG TSI Chapter 4. The assessment modules to be used for assessment of conformity and European Commission (EC) verification are set out in Commission Decision 2010/713/EU.
- G 1.5.7 Chapter 7 deals with implementation of the WAG TSI and specific cases. Guidance on the specific cases has been placed with the relevant requirements from WAG TSI Chapter 4, see Part 2 and Part 3 of this document.

G 1.6 References to other standards

- G 1.6.1 References in the WAG TSI to existing standards (usually Euronorms (ENs)) or other documents could be either 'strict' dated references - whereby the reference explicitly identifies a particular version of the document (for example, with reference to the version number or date). Alternatively, a 'slipping' (generic) reference (that is with no explicit identification of a particular dated or version of the document) is made whereby the reference is to the version of the document in force at the time of adoption of the latest version of the WAG TSI in question.
- G 1.6.2 In both cases, the version of the standard (or document) referred to in WAG TSI is the binding one. If a new version of the standard (or document) referred to in WAG TSI is adopted, the 'old' version referred to in the WAG TSI is still the binding one. That is, in both cases nothing actually 'slips'.
- G 1.6.3 Where a TSI refers to an EN, standard or document, the complete EN, standard or document is mandatory. Where a TSI refers to part of an EN, standard or document, only the parts referred to are mandatory.
- G 1.6.4 Where an EN referred to in a TSI contains a reference to another EN, unless otherwise provided in the TSI, this second EN also becomes mandatory.
- G 1.6.5 The TSIs make no reference to standards or other relevant documents whose application is not mandatory.

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Part 2 Guidance for the Design of Rail Freight Wagons

G 2.1 Basic design concept

- G 2.1.1 As set out in G 1.2.1, all new freight wagons are designed to conform to the WAG TSI. The guidance for designs of wagons intended for use in GB is given in Part 2 of this document, the applicable TSI clause number is shown in brackets after the heading title.
- G 2.1.2 The WAG TSI has an optional Appendix C which gives details for wagons compatible with the former Union Internationale des Chemins de Fer (international union of railways) (UIC) / Regolamento Internazionale Vagoni (regulations governing the international exchange of railway freight wagons (RIV) rules). However, these could result in a sub-optimal wagon for use in GB. Where significant design experience for GB use is known, it is detailed in this guidance note.
- G 2.1.3 Early in the design phase the designer should consider if the vehicle being designed is a freight wagon or an on-track machine which would need to comply with GM/RT2400. If uncertain, the designer should seek guidance from the Department for Transport as the competent authority.

G 2.2 Compatibility

- G 2.2.1 Compliance with the WAG TSI does not guarantee compatibility with the route(s) that the wagon will travel over because it is unlikely that the route will be TSI conformant. Each railway undertaking using the wagon is responsible for ensuring compatibility with the routes to be used. The following clauses of Part 2 set out guidance for designing wagons to suit the GB railway, together with some historical solutions that have proven successful.

G 2.3 End coupling and buffers (WAG TSI clause 4.2.2.1.1)

- G 2.3.1 In order to avoid expensive testing for longitudinal compressive forces, buffer heads in GB should be designed such that the forces in the buffer head and drawbar do not exceed 250 kN. Historically, GB experience has shown that the 250 kN force should be met on the following track geometry:
- Straight track to 75 m radius - no transition.
 - Continuous curve of 75 m radius.
 - Reverse ('S') curve of 120 m radius with 3 m intermediate straight.
- G 2.3.2 The acceptance requirements of G 2.3.1 should apply with screw couplings adjusted such that the buffer faces are just in contact with the vehicle on straight and level track or with the Instanter coupling in the 'short' position.
- G 2.3.3 Guidance for conformance to the WAG TSI Appendix C requirement for standard UIC buffers and drawgear is set out in BS EN 15551:2009+A1:2010 and BS EN 15566:2009+A1:2010. A future issue of these ENs is likely to have a GB specific forward in the BS EN version giving guidance on the GB specific issues raised in Part 2 and Part 3 of this document.
- G 2.3.4 To achieve compatibility with all existing infrastructure, where necessary, the GB railway has traditionally used one or more of the following differences to the standard UIC dimensions for buffers and drawgear (see BS EN 15551:2009+A1:2010 and BS EN 15566:2009+A1:2010) to meet the requirements of its infrastructure:
- Buffer head radius: the UIC standard is 2750 mm. The GB railway has traditionally used a smaller buffer head radius of 1250 mm.
 - Buffer length: the UIC standard is 620 mm. The GB railway has traditionally used a shorter buffer length of 520 mm to meet certain infrastructure requirements for specific wagons (usually tank wagons).

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- c) Buffer stroke: the UIC standard is 105 mm. The GB railway has traditionally used a longer stroke of 114 mm to meet certain infrastructure requirements for specific wagons (usually tank wagons).

G 2.3.5 Traditionally GB has used Category C buffers to provide greater protection for the wagon and load with the track geometry set out in G 2.3.1.

G 2.3.6 UIC 527-1 sets out a method for assessing buffer head size. Guidance for reverse curve layouts is set out in UIC 530-2. However, 75 mm is considered to be the minimum overlap to prevent buffer locking. The nominal minimum value of 75 mm for the curves shown in G 2.3.1 has traditionally been calculated using nominal vehicle dimensions, and does not take into account any suspension movement tolerances.

G 2.3.7 For types of coupler other than standard UIC buffers and drawgear, GM/RT2100 issue five, Part 8 has typical GB requirements.

G 2.3.8 The maximum and minimum allowable buffer heights are set out in GM/RT2100 issue five, clause 8.3.2. The maximum height should be taken in the tare condition with new wheels and the minimum height with the wagon laden and minimum size wheels. The suggested target buffer height for new wagons is 1054 mm, to permit the upward adjustment which is sometimes necessary, and allows for some suspension settlement. Wagons intended for light payloads or which have a limited tare to laden deflection could be set at a lower new height provided that the fully worn laden height does not fall below the 940 mm minimum.

G 2.4 Inner coupling (WAG TSI clause 4.2.2.1.2)

G 2.4.1 GM/RT2100 issue five, Part 8 is the national technical rule (NTR) for mechanical coupling of rail vehicles.

G 2.4.2 It is good practice that the longitudinal strength of the inner coupling(s) is higher than the end coupling(s) of the unit.

G 2.5 Strength of unit (WAG TSI clause 4.2.2.2 and clause 4.2.2.3)

G 2.5.1 Load cases

G 2.5.1.1 The WAG TSI calls up EN 12663-2:2010, but as explained in BS EN 12663-2:2010 clause 6.1 (and also in clause 1), BS EN 12663-1:2010 can be used as an alternative method for freight wagons and the load cases from BS EN 12663-2:2010 are copied into BS EN 12663-1:2010 for this purpose. The alternative method shown in BS EN 12663-1:2010 is the traditional GB approach and should be used for GB wagons because the use of the approach set out in BS EN 12663-2:2010 Part 2 could lead to problems with compatibility with the GB infrastructure.

G 2.5.1.2 Some GB load cases have traditionally been more onerous than those prescribed in BS EN 12663-1:2010. The traditional GB load cases could be used as a more robust alternative. These load cases were specified in the historic version of GM/RT2100 issue three as detailed below:

- a) Vertical proof - clause 6.2 j).
- b) Fatigue load cases – lateral clause 7 p) and vertical clause 7 q).
- c) Fatigue standard for assessment - clause 7.
- d) Local lifting / jacking point load case - clause 13 (it should be noted that the traditional GB load cases do not include twist due to displacement of one of the supports as required in BS EN 12663-1:2010 and BS EN 12663-2:2010, which has the effect of increasing the load on the other jacking points and thereby increasing the apparent factor of safety).

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- G 2.5.1.3 GB wagons have typically used BS 7608:1993 or BS 8118-1:1991 for fatigue assessment, applying Miner's law to sum the damage from the different load cases. It is considered that the use of the Eurocode standards, BS EN 1993-1-9:2005 or BS EN 1999-1-3:2007, result in an acceptable fatigue assessment and should be used for future GB wagon design. However, the assessment method in BS EN 12663-2:2010 clause 6.2.3 is not considered to have been proven to be satisfactorily robust for the GB operating environment.
- G 2.5.1.4 For aluminium wagons the direct application of the fatigue curves for detail categories set out in BS EN 1999-1-3:2007, which permits higher stress levels than the previous version of the EN, could result in unsatisfactory or potentially dangerous structural defects. Reference should therefore be made to the UK national annex of BS EN 1999-1-3:2007 and PD 6702-1:2009 for detailed guidance. At the time of publication these documents are being further developed and therefore may be revised. As a result, the status of these documents should be checked before use.
- G 2.5.1.5 The service fatigue life for any given structural item is the combined effect of the appropriate analysis of loadings, stresses and fatigue together with its manufacture, assembly and operation. Therefore all these aspects should be dealt with in a mutually consistent manner.
- G 2.5.1.6 Care should be exercised when interpreting the results of detailed finite element calculations where localised high stresses occur. Many fatigue curves developed for classical calculation methods have already accounted for, either fully or in part, stress concentration effects.
- G 2.5.1.7 The standards set out in G 2.5.1.3 permit the development of fatigue curves from experimental data for particular design details and in some cases this will be highly beneficial in terms of structure weight and cost. Where experimental data is used to develop bespoke fatigue curves, the raw data and its post-treatment should be fully documented.
- G 2.5.1.8 Where BS EN 12663-1:2010 is used, it should be noted that additional guidance on the design of wagon equipment is given in BS EN 12663-2:2010 clause 7.
- G 2.5.1.9 For components that are not called up in other documents (for example brake beams), the load cases for equipment attachments set out in BS EN 12663-1:2010 or BS EN 12663-2:2010 should be applied, as appropriate, to the component centre of mass.
- G 2.5.1.10 Where the design of the wagon involves known additional vibration (for example loading of powders) or known shock loads (for example loading of hopper wagons, steel slab and steel coil carrying wagons), these should be taken into account.
- G 2.5.2 Full length sliding side doors (sliding walls)**
- G 2.5.2.1 With the sliding side doors in the closed position, experience has shown that a suitable test for transverse force simulating the shifting of the load should be applied to each of the doors in the following manner:
- 20 kN force uniformly distributed over a square surface of 1 m side length situated in the centre of the sliding side door.
 - 20 kN force uniformly distributed over a rectangular surface area equal to the full length of the sliding side door with a width of 1.2 m situated immediately above the top surface of the floor.
- G 2.5.2.2 The freight wagon should be designed so that no significant permanent deformation or deterioration occurs in elements of the sliding side door or its securing, rolling, sliding or guiding gear.
- G 2.5.2.3 Where the loads set out in G 2.5.2.1 produce deflections of the side door which causes gauge infringement, internal load restraints should be fitted.

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G 2.5.3 Hopper doors

- G 2.5.3.1 Fitting hopper doors with primary and secondary locking systems prevents a single point failure causing doors to open. Pneumatically powered doors could be supplied with air from the wagon's main reservoir pipe provided that it does not affect the wagon's braking performance.

G 2.5.4 Floors

- G 2.5.4.1 Floors should be designed to be suitable for the purpose intended. Floor loading specifications and tests are set out in BS 3951-2.1:1991 and ERRI DT 135 (B 12) section A.3 (currently only available in French and German).
- G 2.5.4.2 During floor design, consideration should be given to the additional loadings imposed by wheeled vehicles (fork lift trucks have been known to cause problems).

G 2.5.5 Load restraints

- G 2.5.5.1 The dimensional positions of load restraints are set out in UIC 571-4:2011.

G 2.5.6 Load restraints - fatigue loads

- G 2.5.6.1 Location devices and associated mountings should withstand fatigue loads resulting from the application of the following accelerations, applied to the maximum gross weight load unit capable of being conveyed. The derived load should be applied at the base plane of the load unit when restrained by the twist locks at four locations, these being assumed to share the load evenly:

- a) In longitudinal direction $\pm 0.2 g$.
- b) In transverse direction $\pm 0.2 g$.
- c) In vertical direction $\pm 0.4 g$.

- G 2.5.6.2 These should be considered by summing the damage from the three fatigue load cases for 10^7 cycles with a probability of failure of $\leq 2.5 \%$.

G 2.5.7 Load restraints - proof loadings

- G 2.5.7.1 The proof load requirements for load restraints are set out in BS EN 12663-2:2010 clause 7.6.2.

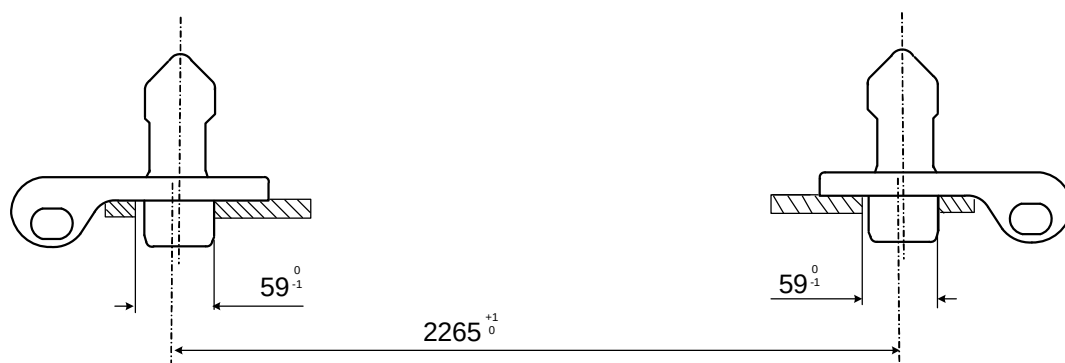
G 2.5.8 Load restraints - Holland auto locks

- G 2.5.8.1 The locations of Holland auto locks should be designed so that they withstand the same fatigue and proof loadings as twist locks (see 2.5.5).

G 2.5.9 Load restraints - UIC type spigots

- G 2.5.9.1 Spigots designed and located, as set out in the latest issue of UIC 571-4:2011, are suitable for use in GB. The operating rules are set out in GO/RT3056. Containers less than 1.6 tonne should not be carried on spigots because they are not heavy enough to ensure stability.
- G 2.5.9.2 It should be noted that spigots permit additional lateral movement compared to twist locks, this should be taken into account when gauging.
- G 2.5.9.3 The hinge action of 'fold-down spigots' should flip outward to secure the container, with the dimensions as set out in Figure G 1, that is the hinges are on the outer edge of the wagon as shown in Figure G 1. Spigots are designed to provide retention against the overturning of containers. Containers will slide laterally and the corner castings will engage with the spigot heads. Excess inward tilting of the spigots (for example, due to wear and clearances) beyond the limit of 2° as set out in UIC 571-4:2011 could reduce container security.

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Note that the dimensions shown are for fold-down spigots only, the full set of dimensions are set out in UIC 571-4:2011

Figure G 1 Orientation of fold-down spigots.

G 2.5.10 Winches and webbing

- G 2.5.10.1 Load restraint winches for use with load restraint webbing should comply with that depicted on drawing C1-A1-9013025. The attachment of the winch and fastening points should have a rating of 76 kN.
- G 2.5.10.2 Load restraint webbing should conform to BS EN 12195-2:2001, having a strength rating of at least 45 kN.

G 2.6 Gauging (WAG TSI clause 4.2.3.1)

- G 2.6.1 Wagons for use in GB are traditionally built to comply with gauges described in GE/RT8073 using the method described in GM/RT2149. In most cases the wagons are built to W6a, with other gauges W7 to W12 for specific payloads.
- G 2.6.2 Network Rail has produced guidance on gauging 'The Use of Standard Gauges for Non-passenger Rail Vehicles', which can be obtained from their website (www.networkrail.co.uk).
- G 2.6.3 The under-clearance requirements of the wagon should be considered at all times. In this respect, bottom doors of empty wagons should be within gauge when in the open position, thus permitting wagons with defective door gear to pass on the mainline railway. Wagons that fail this requirement should have a warning label to show that they are not suitable to run on the mainline railway when the doors are open.
- G 2.6.4 The effect of vehicle body deflections under all load conditions, new and fully worn wheels, new and worn suspension should be taken into account. This is to prevent body deflections causing underframe equipment to infringe the declared gauge. It should be noted that standard static wagon gauges are assumed to include an allowance for normal underframe deflection. Conversely, vehicle bodies and loads could be foul of the upper gauge due to insufficient deflection of the wagon frame and its suspension. In particular, care is required where a wagon has a built in camber or 'hog' that a lightweight payload does not infringe the gauge.

G 2.7 Compatibility with load carrying capacity of lines (WAG TSI clause 4.2.3.2)

- G 2.7.1 GE/RT8006 sets out the GB route availability regime.
- G 2.7.2 Design guidance for freight wagons for use on the mainline railway is given in Appendix A of this document.

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G 2.8 Compatibility with train detection systems (WAG TSI clause 4.2.3.3 and clause 4.2.6.2.1)

- G 2.8.1 The maximum dimensions set out in Appendix A of this document for bogie wagons covering overhang and inner wheelbase are those specified to avoid infringement of track circuit and signalling train detection compatibility.
- G 2.8.2 The WAG TSI clause 4.3.3 lists the clauses in the Control, Command and Signalling (CCS) TSI applicable to the various types of train detection systems. Meeting the values shown in the CCS TSI could be taken as a presumption of compatibility with the signalling system. If the wagon does not meet these requirements, compatibility will have to be demonstrated.
- G 2.8.3 GM/RT2304 sets out the requirements for equipotential bonding of wagons. Additional information is set out in GM/RC2514, BS EN 50153:2002 and UIC 533-0.
- G 2.8.4 Historically, industry practice is to provide 95 mm² cable for vehicles that travel over lines supplied with 750 V d.c. third rail, and 35 mm² for other vehicles for equipotential bonding.

G 2.9 Safety against derailment running on twisted track (WAG TSI clause 4.2.3.5.1)

- G 2.9.1 The testing regime is described in the WAG TSI clause 6.2.2.2 which calls up the use of BS EN 14363:2005. The $\Delta Q/Q$ test carried out in accordance to Method 3 in BS EN 14363:2005 is equivalent to the traditional GB method set out in GM/RT2141.
- G 2.9.2 The calculation of packing sizes for use during the test is set out in Appendix F of this document.
- G 2.9.3 GM/GN2641 provides further guidance on static vehicle testing to Method 3 for $\Delta Q/Q$ and bogie rotation tests.
- G 2.9.4 Meeting the tests in Method 3 is sufficient for demonstrating compatibility with the GB mainline railway twisted track.

G 2.10 Running dynamic behaviour (WAG TSI clause 4.2.3.5.2)

- G 2.10.1 The minimum dimension of 4572 mm (15' 0") for the wheelbase of two-axle wagons having axle loads of 20.5 tonne and above, set out in Appendix A, has been found to be a wheelbase dimension susceptible to riding problems on jointed track and the effects of cyclic top. Careful selection of the suspension is important for the design of a wagon which has a wheelbase that is a sub-multiple of rail lengths (normally 60 ft). Further guidance is set out in Appendix A of this document and in UIC 530-2.
- G 2.10.2 Wagons have traditionally been designed such that the ratio of wheelbase to length over buffers is not less than 0.54. It has been found that the risk of derailment due to end loads significantly increases with lower values.
- G 2.10.3 Care should be taken in designing two-axle wagons so that the wheelbase is not too long in view of the problems that it presents in negotiating small radius track curves.
- G 2.10.4 The WAG TSI clause 6.2.2.3 requires the running dynamic testing to be carried out in compliance with BS EN 14363:2005 Chapter 5. However as a result of the wording in this clause of the WAG TSI, and also a GB specific case, there are significant modifications to the requirements within BS EN 14363:2005 to enable the dynamic testing to be carried out in a reasonable manner. A clause by clause summary of BS EN 14363:2005 Chapter 5 is set out in Appendix G of this document.

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G 2.10.5 The test route chosen to comply with G 2.10.4 should also be representative of the track that the wagon is intended to run on in order to prove compatibility with the infrastructure. Historically, the use of the freight acceptance curves, in GM/RT2141 issue three, Figure D.1.a, Figure D.1.b and Figure D.2, has been used to show this compatibility. It is envisaged that to meet the mandatory requirements of the WAG TSI (by compliance with BS EN 14363:2005) and the compatibility requirements of the NTR, GM/RT2141, that both standards should be met. Therefore, the testing should consider meeting the requirements of both standards, and it is acceptable for the same test to be used.

G 2.10.6 A vehicle dynamic model allows for simulation to be used to check for greater variety of track conditions, minor variations in suspension parameters or failed components. The validation of the simulation, is based on accelerations predicted for a particular track condition, compared against actual acceleration measured on that condition on a representative selection of track conditions. This validation method is considered an acceptable alternative to that described in BS EN 15827:2011 Annex G (which is called up in BS EN 15827:2011 clause 9.3). The validated model could be utilised to show compliance with GM/RT2141 and BS EN 14363:2005 zone 1 only. It should be noted that a model validated for accelerations can only be used to predict accelerations (for example, validation cannot be used to predict forces).

G 2.10.7 To allow for dynamic displacement caused by track irregularities, the suspension should be designed to cater for full load $\pm 30\%$ and $\pm 50\%$ in tare.

G 2.11 Characteristics of wheelsets (WAG TSI clause 4.2.3.6.2)

G 2.11.1 There is a GB specific case which permits the use of a NTR. The NTR for this purpose is GM/RT2466. Further guidance on the historical application of wheelsets is given in G 2.12, G 2.13 and G 2.14 of this document.

G 2.12 Characteristics of wheels (WAG TSI clause 4.2.3.6.3)

G 2.12.1 The application of the appropriate wheel tread profile is essential to ensure satisfactory ride performance with the chosen suspension arrangement. The suitability of a tread profile and suspension arrangement combination on a vehicle is able to be demonstrated by a dynamic study. Guidance on the suitability of tread profiles can be obtained from a technically competent authority.

G 2.12.2 To assist in selection of the most suitable tread profile for a suspension arrangement, historically the combinations set out in Table G 1 for profile and suspension type have been found to give satisfactory performance for freight wagons.

Profile	Description	Example applications
P1	The 1 in 20 coning of the P1 profile is required to ensure the lateral stability of the older types of wagon with simple suspensions.	The use of this profile on new designs is now discouraged, because modern profiles result in better ride quality.
P5	The P5 profile, with a 60° flange angle and a thicker flange, when compared with the P6 profile, gives a reduced wheelset / track lateral clearance which has been found to promote improved lateral ride.	Wagons fitted with Y25 type bogies and derivatives of this bogie for example FBT6, Y33, and the AM3 bogie has used this profile successfully.
P6	The flange of the P6 profile incorporates a 68° flange angle, important on torsionally stiff wagons with positively located wheelsets. Use of the 68° flange angle means that a higher lateral / vertical wheel force ratio can be sustained before flange climbing occurs. The problem of poor lateral ride quality, found when this profile has been used with certain types of suspension, has prevented its widespread use.	This profile was extensively used in the past for wagons up to 60 mile/h. For bogie wagons, which operate at speeds in excess of 60 mile/h, the use of P5 profiles is recommended.

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Profile	Description	Example applications
P8	The P8 profile has a worn (hollow) tread in addition to a worn flange (68°) and thus during service the profile changes shape very little. This profile with suitable wheelset yaw stiffness ensures good curving performance with a resultant reduction in flange wear on large and medium radius curves and also gives vehicle stability over very high mileage when applied to appropriate suspension types.	New suspensions specially designed to accept high conicity wheel tread profiles, for example 25.4 tonne axle load taperleaf and cross-braced bogies, LTF and TF 25 bogies.
P10	The P10 profile is derived from the standard UIC profile detailed in leaflet UIC 510-2. It has a thick flange combined with a 70° flange angle.	Two-axle and bogie wagons in international traffic having a wheel diameter in the range 760 mm - 1000 mm. Also as an alternative to P5 for Y25 type bogies in domestic traffic only.
S1002SW	Modified version of P10 profile with larger flanges, to assist negotiation of obtuse crossings.	UIC profile used by vehicles with small wheel diameters, that is to say below 760 mm.

Table G 1 Historical performance of tread profiles

G 2.12.3 All the wheels on a vehicle should have the same profile.

G 2.13 Characteristics of axles (WAG TSI clause 4.2.3.6.4)

G 2.13.1 Historically the journal size has been designed to suit the load applied. As a guide the journal size and load in Table G 2 have previously been successfully used.

Journal diameter	Load on rail / axle
120 mm	18 tonne
130 mm x 217 mm long Type A	20.5 tonne
130 mm x 191 mm long Type B	22.5 tonne
140 mm	23 tonne
150 mm	25.4 tonne

Table G 2 Historical data of journal size and load applied

G 2.14 Characteristics of axle boxes / bearings (WAG TSI clauses 4.2.3.4 and 4.2.3.6.5)

G 2.14.1 The use of inboard bearings increases the size of bearing needed. Guidance on axle design is set out in BS 8535:2011 and BS 5892-8:2012.

G 2.14.2 Inboard bearings are not visible to existing trackside hot axle box detectors and therefore an alternative means of bearing temperature monitoring should be provided.

G 2.15 Brakes - general functional requirements (WAG TSI clause 4.2.4.3.1)

G 2.15.1 GM/RT2045 provides further clarification on the definitions of continuous and automatic brake.

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- G 2.15.2 For compatibility with existing GB wagons, the vehicle end air brake couplings should be coloured as shown in Table G 3.

Pipe	Valve and handle / colour	Coupling head / colour
Train brake pipe	RED	RED (BS EN 15807-2011 Figure 2)
Air reservoir pipe	YELLOW	YELLOW (BS EN 15807-2011 Figure 8)
Through air pipe	WHITE	RED (BS EN 15807-2011 Figure 2)

Table G 3 Colour codes of air pipes

- G 2.15.3 Goods release timings for compatibility with existing GB wagons is 30 - 45 seconds. Further information on brake application and release timings is set out in GM/RT2045.
- G 2.15.4 GB has used a wide range of composite brake blocks which are considered acceptable when used within the same operational criteria that it has historically been used. The brake blocks shown in Table G 4 have been authorised for use in GB. Table G 4 is not necessarily complete and is for guidance purposes only.
- G 2.15.5 The UIC Design Guide for the use of composite blocks does not allow the use of R8 wheel material, whereas this is common in GB (R7 is the UIC standard wheel material which is also used for GB applications).

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Manufacturer	Block designation	Nominal (new) diameter of wheel [mm]	Speed of operation [km/hr]	Axle load [t]	Brake configuration				Wheel material	Certificate of Engineering Acceptance issued
					Bg		Bgu			
					1	2	1	2		
TMD Friction	TBL 804	840	100	25.4	✓	✓			R8	1999
		840	120	20.5		✓			R8	1985
		920	100	22.5	✓	✓			R8	1985
		840	120	22.5			✓		R8	1996
Becorit	929-1	840	120	18	✓				R7	2000
		760	120	18	✓				R7	2000
		920	100	22.5		✓			R7	2000
	K961	920	120	22.5	✓				R8	2001
		920	100	25.4	✓				R7	2006
		840	100	25.4	✓				R8	2002
		840	120	20.5	✓				R8	2002
		840	120	22.5			✓		R8	2002
Futuris	HA30	920	100	25.4	✓				R8	2000
		838 (33")	100	25.4	✓				Cast. Grade	2000
		840	120	20.5	✓				R8	2000
		730	120	20.5						
Cobra	W539	1120	120	21	✓				R7	1996
	W573	920	100	25.4	✓				R8	2000
Ferodo	3325	920	100	22.5	✓				R8	2007
Jurid	816	760	120	18	✓				R7	2000

Table G 4 Composite brake blocks with a history of use in GB

1Bg One block per wheel, on one side of the wheel (push).

2Bg Two blocks per wheel, one on each side of the wheel (clasp).

1Bgu Two blocks per wheel, two on one side of the wheel (push).

2Bgu Four blocks per wheel, two on each side of the wheel (clasp).

G 2.16 Brake performance (WAG TSI clause 4.2.4.3.2)

G 2.16.1 Further guidance on braking performance requirements and testing for GB can be found in GM/RT2043 and GM/RT2045.

G 2.16.2 BS EN 14531-6:2009 provides a common harmonised method of brake force calculations across Europe. The calculation method to determine the brake force data for inclusion in the Rolling Stock Library for use with the Total Operations Processing System (TOPS) is set out in GM/RT2040.

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- G 2.16.3 ENs (for example BS EN 14198:2004) can be used as codes of practice within the limit of their scope. The braking standards applicable to wagons used on the GB mainline railway are GM/RT2043 and GM/RT2045. These standards are considered satisfactory to meet the requirements of the common safety method (CSM) 352/2009/EC.

G 2.17 Parking brake (WAG TSI clause 4.2.4.3.2.2)

- G 2.17.1 Guidance on the historic requirements of parking brakes in the GB is set out in GM/RT2043.
- G 2.17.2 When designing parking brake systems the following factors should be considered:
- a) Potential for compounding with the power brake.
 - b) Changes in load state of the vehicle after the parking brake has been applied:
 - i) Effect on parking brake performance.
 - ii) Ability to release the parking brake after load change.
 - iii) Potential damage to the brake components.

This list is not exhaustive.

- G 2.17.3 It is permitted for consideration to be given to fitting parking brake interlocks with the power brake and associated isolating devices.
- G 2.17.4 Particular operational rules may apply (for example, if no parking brake is fitted). Further information is set out in the Traffic Operation and Management TSI (OPE TSI).

G 2.18 Brake thermal capacity (WAG TSI clause 4.2.4.3.3)

- G 2.18.1 The suggested reference case in the WAG TSI is derived for pan European operation. Historic GB parameters for thermal capacity have traditionally been by the drag braking requirements of maintaining a speed of 60 mile/h on a gradient of 1 in 70 for a distance of 22 miles (Perth - Inverness).

G 2.19 Wheel slide protection (WAG TSI clause 4.2.4.3.4)

- G 2.19.1 Where wheel slide protection (WSP) is fitted, compliance to BS EN 15595:2009+A1:2011 is generally considered not sufficient for GB low adhesion conditions. Further guidance for GB assessment can be found in GM/GN2695.

G 2.20 Environmental conditions (WAG TSI clause 4.2.5)

- G 2.20.1 Where other environmental conditions need to be considered, other than the nominal (temperature) one, (for example, wind speed ranges) an appropriate range should be selected for the design of the rolling stock.
- G 2.20.2 The requirements to resist the overturning of railway vehicles in extreme wind conditions are set out in GM/RT2142. Consideration should be given to keeping the vehicle centre of gravity as low as possible to assist resistance to overturning.
- G 2.20.3 GM/RT2045 gives further information on the operational environmental conditions for the brake function.

G 2.21 Fire safety flammable liquids (WAG TSI clause 4.2.6.1.2.4)

- G 2.21.1 The requirement of WAG TSI clause 4.2.6.1.2.4 could be applicable to wagons incorporating service modules and flammable liquid tanks for fuelling auxiliary equipment as well as tank wagons.

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G 2.22 Tank wagons

- G 2.22.1 Specific guidance for all tank wagons is given in Appendix B of this document.
- G 2.22.2 Guidance for the design and construction of tanks for rail wagons for the carriage of dangerous goods is given in Appendix C of this document.

G 2.23 Miscellaneous

- G 2.23.1 The requirements for wagons which are intended to be compatible with mechanical handling or lineside equipment, for example merry-go-round trains, are set out in CP-PM-2 and CP-PM-1 respectively.
- G 2.23.2 Note that lineside equipment associated with mechanical handling could be closer to gauge than normal and care should be taken to assess each location at which the wagon is likely to be used. Particular attention is drawn to the possible conflict between the under-clearance requirements of W6a gauge and the mechanical handling equipment gauge. Any advice concerning static structures should be obtained from the infrastructure manager of the location.
- G 2.23.3 When considering the design of coil springs, historically satisfactory results are obtained when the coil springs are designed to BS 1726-1:2002. There is also a European standard, BS EN 13906-1:2002 (formerly DIN 2089-1) which has been successfully used for calculation and design of coil springs. The use of steel to BS EN 10089:2002 has been found to give satisfactory performance.
- G 2.23.4 The designer should consider the potential damage caused to other vehicles in the event of a collision, and where possible, sharp edges and rigid protrusions should be avoided.

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Part 3 Guidance on the Application of the Conventional Rail Freight Wagons TSI for use in GB

G 3.1 Basic guidance format

- G 3.1.1 Part 3 of this document reproduces the text of the WAG TSI Chapter 4 followed by guidance after each clause on its application for wagons designed for use in GB.
- G 3.1.2 Compliance with the WAG TSI is achieved by compliance with WAG TSI Chapter 4, Chapter 5 and Chapter 6 (and with conditions from clause 7.3). There is no requirement for compliance with the Appendices in the WAG TSI (especially as wagons built for use within GB do not need to comply with the WAG TSI Appendix C and Appendix G).

G 3.2 Clause by clause guidance for Chapter 4 of WAG TSI

Extract from WAG TSI

4. CHARACTERISATION OF THE SUBSYSTEM

4.1. Introduction

- G 3.2.1 No GB specific guidance for interpretation of the text of this clause is offered here.

Extract from WAG TSI

4.2. Functional and technical specifications of the subsystem

4.2.1. General

In light of the essential requirements in Chapter 3, the functional and technical specifications of the subsystem 'rolling stock - freight wagons' are grouped and sorted out in the following points of this Chapter:

- Structures and mechanical parts
- Gauging and vehicle track interaction
- Brake
- Environmental conditions
- System protection.

Except where this is strictly necessary for the interoperability of the rail system and to meet the relevant essential requirements, the functional and technical specifications of the freight wagon and its interfaces do not impose the use of any particular technical solutions.

Innovative solutions, which do not fulfil the requirements specified in this TSI and / or which are not assessable as stated in this TSI, require new specifications and / or new assessment methods. In order to allow technological innovation, these specifications and assessment methods shall be developed by the process 'innovative solution' described in Chapter 6.

When the functional and technical specifications that are necessary in order to achieve interoperability and to meet the essential requirements, have not been developed concerning a particular technical aspect, this aspect is identified as an open point in the relevant point. As required in Article 5(6) of Directive 2008/57/EC all open points are listed in Appendix A.

In Appendix C a set of conditions is specified. The conformity with this set of conditions is optional. If this option is selected, the conformity shall be assessed by a notified body within the EC verification procedure.

In accordance with Article 5(5) of Directive 2008/57/EC, provision may be made for specific cases for each TSI. Such provisions are indicated in Chapter 7.