MEETING:	Rolling Stock Standards Committee (RST SC) Control Command and Signalling Standards Committee (CCS SC) Plant Standards Committee (PLT SC)
DATE:	9 September 2022 (RST SC) 22 September 2022 (CCS SC) 15 September 2022 (PLT SC)
SUBJECT:	Five-year review of GMRT2045 issue four - Compatibility Requirements for Braking Systems of Rail Vehicles (Post-consultation)
SPONSOR:	Mark Oakley
AUTHOR:	Robert Shemilt

1. Purpose of the paper

1.1 This paper sets out the assessment of the five-year review of GMRT2045 issue four - Compatibility Requirements for Braking Systems of Rail Vehicles. It seeks Rolling Stock Standards Committee approval and Command Control and Signalling, and Plant Standards Committees support on the recommendation and way forward.

1.2 This paper replicates the content of the five-year review paper submitted to the RST SC in March 2022, CCS SC in April 2022 and PLT SC in May 2022, with additional description of the outcome of the consultation added as section 4.2 and revision of the recommendations in section 5 to reflect the current status. This revised content is indicated with a black bar to the left of the relevant paragraph.

2. Background

2.1 GMRT2045 issue four amalgamated the National Technical Rules (NTRs) relating to braking which were previously included in a number of separate Railway Group Standards (RGSs). These requirements were redrafted to align with the Locomotive and Passenger Technical Specification for Interoperability (LOC&PAS TSI) and Wagons TSI (WAG TSI). Requirements that were considered to be outside the scope of NTRs were either withdrawn or retained as guidance.

2.2 GMRT2045 issue four thus became the sole RGS setting out braking system NTRs for all rail vehicles on the GB railway. The only exceptions were:

a On-track machines when in working mode, these being covered by RIS-1702-PLT (and thus by reference BS EN 14033-2:2017)

b General Contract of Use (GCU) international wagons, defaulting to the requirement set out in the WAG TSI.

2.3 GMRT2045 issue four was published in March 2016. In 2017 a twelve-month review of the standard was undertaken, with no amendment found to be required at that time. When the list of notified NTRs was updated in January 2018, only the requirements in part two of the standard were found to meet the criteria of NTRs. Those requirements that are out of scope of railway group standards will be withdrawn. If the requirements are valid and useful to industry they will be retained in a Rail Industry Standard (RIS).

3. Impacts of the document(s) following publication/entering into force

3.1 Consideration has been given to the following during the assessment:

a Business case for change – The primary motive for change, amalgamation of the suite of GB braking requirements into a single RGS, was achieved.

b Deviations – The following deviations have been raised against GMRT2045 issue four:

- 18-037-DEV - Class 717 Enhanced Emergency Brake Rate. This deviation covers a particular issue with this family of units, since EB is not load-weighed (unlike service brake) and the tare - crush mass difference is high. Since load-weigh of EB should always be an aspiration to normalise adhesion requirements / stopping distances, the requirement still stands.
- 18-064-DEV - Class 221 Parking Brakes Isolation Switch. This deviation relates to a non-compliance when the vehicle is in a degraded condition only. The requirement against which the deviation was granted assumes the vehicle is operating at full performance. The disparity was identified on submission of a new deviation to replace this time limited deviation. As a result the new deviation application was rejected, since it was not required, and this time limited deviation has been withdrawn.

There are no issues raised by these deviations that require addressing in a revision to GMRT2045 issue four.

c Current projects or proposals being processed – 18-028 - Standardisation of Faster Freight Movement proposes modifications to R2 and TOPS to support use of the true (or calculated) Lambda values for a train made up of arbitrary vehicles when running under ERTMS. This would amend requirements in part three of GMRT2045 with regards to provision of data, and allow the open point in appendix E (calculation of Lambda for vehicles where brake force varies in proportion with load) to be closed.

18-028 is currently proposed to be closed due to the scope being encompassed by RSSB research project T1266 and a Network Rail led project to replace the 2/3 differential speed rule for freight operation applied to Southern Region lines. These will, in combination, cover the same areas related to the standard detailed above.

d Limited change release – No limited change release has been published for GMRT2045 issue four.

e Amendments and clarifications – Four amendments have been issued against GMRT2045 issue four:

- AM001 – This corrects an omission relating to advisory brake release timings for GB wagons in twin pipe mode. It also emphasises the GB specific release timing for both single and twin pipe modes over the international timing. Non-conformance to these release times represents a small risk of new wagons being configured for international (longer) release times in GB trains and thus over-braking during the brake release period.
- AM002 – This highlights the need to consider common mode failures of the braking system generated by external events (particularly obstructions on the track) in the light of the runaway at Markinch, additional guidance being provided for the existing requirement clause.
- AM003 – This addressed an issue whereby service brake failure indications on certain new fleets were not displayed to the driver by the TCMS until a delay time had elapsed (as with general faults, to prevent spurious indications), nor

was suitable action taken (application of the emergency brake). The need to take a risk-based approach to the delay time is highlighted, additional guidance being provided for the existing requirement clause. This is related to request for help 17-REQ-075.

- AM004 – This clarifies that the formula developed for conversion between 'brake force' (GB) and 'braked weight' (EN/UIC) is applicable for hauled vehicles only, not self-propelled. The opportunity is also taken to acknowledge the issue of the relevant EN standard in the intervening period since issue four of GMRT2045. This is relevant to request for help 21-REQ-036.

The content of these amendments will be incorporated in the standard at the next revision.

f Enquiries – Two enquiries have been received against GMRT2045 since issue four was published. The first pertains to braking requirements for vehicles operating up to 350 km/h - GMRT2045 covers up to 250 km/h, although provides guidance for up to 300 km/h. There is no proposal to increase this at this time due to infrastructure limitations.

The second, case CAS-02908-Q4F9G7, pertains to calculation of braked weight. This enquiry indicates that GMRT2045 should be updated to refer to BS EN 16834 instead of UIC leaflet 544-1 at the next issue.

g Research projects – Research projects relevant to the content of GMRT2045 have been reviewed. The only one of relevance is T1099 - Enabling Magnetic Track Brakes on GB Mainline Railway. The output of this research is embodied in RIS-2710-RST, which should be referenced against clause F.11.1 of GMRT2045.

h Changes in regulations – Since the publication of GMRT2045 issue four the United Kingdom (UK) has exited the European Union (EU). There is no direct effect on the technical content of the interoperability National Technical Specification Notices that replace the Technical Specifications for Interoperability.

i Changes in technology – No innovations or novel uses of technology have been identified that need to be addressed in GMRT2045 issue four.

j National Technical Specification Notices (NTSNs) and European standards – All TSIs referenced in the standard are those transposed into the NTSNs as of 31 December 2020; as such updates should reference to NTSNs rather than TSIs.

A number of the European standards referenced have been updated since issue four. In addition, the EN standards covering the topics covered by UIC leaflets 541-3 and 544-1 have now been issued – these are BS EN 15328:2020 and BS EN 16834:2019 respectively. Subject to review these should now be the primary reference, with equivalence to the UIC being explained in guidance to ensure continuity of interpretation.

k Published list of national technical rules (NTRs) – GMRT2045 issue four includes requirements which do not meet the criteria for NTRs and are not included on the latest list of notified NTRs published December 2021. Requirements that do not meet the NTR criteria should be removed from the RGS and published in a RIS.

l Any other observations

- Request for help 20-REQ-006 is currently open against GMRT2045 issue four. This requests guidance on reliability and safety assurance to be achieved by the service braking system. This information may not be appropriate to include in the standard. Performance levels are more suitable for inclusion in the train

specification, having been determined by a common safety method approach. This is already set out by the standard.

- There are a number of appendices in GMRT2045 (F to K) which are not directly referenced by requirements in the main body of the standard, but rather provide supplemental guidance or descriptions of systems. The content provided requires review to determine if it remains pertinent to include in the RGS, or (if deemed worthwhile to retain) in another document.

4. Discussion

4.1 Review assessment

4.1.1 This five-year review has identified that GMRT2045 issue four is not fit for purpose as the RGS contains requirements that are not NTRs. It is therefore recommended that a standards project is established to revise GMRT2045. It is proposed that this project will perform the following:

a Withdraw the requirements that are not NTRs and associated guidance from the standard. Those that are deemed worthwhile to retain will be incorporated into a new RIS

b Review the additional guidance in appendices F to K to determine if it is to remain in GMRT2045 or be otherwise retained in another document

c Incorporate the amendments issued against GMRT2045 issue four (AM001 to AM004)

d Update references to TSIs to NTSNs to reflect the post-Brexit legislative environment

e Review all references to EN, UIC leaflets, RGS, RIS and guidance documents and update as required. This will include enhancing guidance on magnetic track brakes by reference to RIS-2710-RST

f Incorporate the findings of research project T1266 if available to close the open point; these are currently expected mid-2023 and could therefore be included in this update

g Incorporate the conclusions of the Network Rail 2/3 Rule Working Group if available relating to additional braking data to be provided; these could be incorporated in this update if dependent upon timescales for that work (including implementation of changes to R2 and TOPS)

4.2 Consultation

4.2.1 The five-year review of GMRT2045 was presented to RST SC on 11 March 2022, CCS SC on 14 April 2022 and PLT SC on 4 May 2022. The recommendations of the assessment and the action to consult with industry on the findings was approved by RST SC and supported by CCS SC and PLT SC respectively.

4.2.2 Consultation with industry took place during June 2022. Responses were received from three organisations, with a total of fourteen comments being returned. No comments disputed the assessment given in clause 4.1.1 of this review, but several topics to consider while redrafting the standard were highlighted, including:

- The impact of blend between modes of braking on overall brake efficiency
- The performance requirements pertaining to the holding brake function
- The continued use of clamp force to specify enhanced emergency brake (EEB)

- The application of EEB to disk braked fixed formation units of >5 cars
- The application of curve D1 for operation of trains in excess of 125 mile/h (200 km/h)
- The continued use of imperial units as the primary definition of speed
- The reserve of brake energy required following a full brake application with WSP

4.2.3 These points will be considered during the review and redrafting of the document. The collated comments as received and the proposed responses are included in appendix C.

5. Recommendations

5.1 The Rolling Stock Standards Committee is asked to:

a DISCUSS the outcome of the consultation with industry on the findings of this five-year review and the following proposed recommendations:

i Respond to the industry consultation as indicated in this document.

ii Initiate a standards change project to revise GMRT2045, withdrawing the requirements which are not NTRs and reviewing for relevance to incorporate into a RIS and considering the observations raised by industry.

b APPROVE:

i The recommendations.

5.2 The Control Command and Signalling, and Plant Standards Committees are asked to:

a DISCUSS the outcome of the consultation with industry on the findings of this five-year review and the following proposed recommendations:

i Respond to the industry consultation as indicated in this document.

ii Initiate a standards change project to revise GMRT2045, withdrawing the requirements which are not NTRs and reviewing for relevance to incorporate into a RIS and considering the observations raised by industry.

b SUPPORT:

i The recommendations.

RSSB completion: [do not delete]

Lead Standards Committee	*Meeting date*	*Recommendation approved*	*Minute numbers*		*Next review date*
			Pre-consultation review	*Post-consultation review*	
Rolling Stock					

Appendix A Disposition table for document recommended for withdrawal

A.1 GMRT2045 issue four - Compatibility Requirements for Braking Systems of Rail Vehicles

Clause number	Clause title	Proposed Way forward	Comments
Part one	Purpose and Introduction	Retain in GMRT2045 issue five	Standard RGS template - updated as required
Part two	Requirements for Brake Systems	Retain in GMRT2045 issue five	As-per the list of UK (GB) NTRs for vehicles, December 2021, this part is exclusively formed of requirements that are NTRs
Part three	Braking Data for Train Operation	Withdrawing and review for relevance to incorporate into a RIS	The requirements in this part do not qualify as NTRs
Part four	Application of this document	Retain in GMRT2045 issue five	Standard RGS template - updated as required
Appendices A-C		Retain in GMRT2045 issue five	These appendices support specific requirements in part two
Appendices D-E		Withdrawing and review for relevance to incorporate into a RIS	These appendices support specific requirements in part three
Appendices F-K		To be determined	These appendices are noted as being provided for guidance. They are only directly referenced from the guidance clauses in the main body of the standard. It will be determined where this might best be located (if still deemed useful). This might necessitate the creation of one or more new railway industry guidance notes to accommodate the information contained in them.

Appendix B Associated information to support the review

Deviations	List current deviations: - Issue 1: 99-205-DGN, 99-265-DGN. - Issue 2: 00-098-DGN, 01-253-DGN, 02-307-DGN, 08-010-DGN. - Issue 3: 15-050-DEV, 18-020-DEV. - Issue 4: 18-037-DEV.	List deviations in progress: Nil.
Request for Help	Open Requests for Help: - 17-REQ-075 (need to work with Industry before it is translated into a project). - 20-REQ-006 (MO to pass on to R&D for further research to be done before taking forward as a proposal). Outcome of resolved Requests for Help: N/A	
Proposals	List approved proposals: 15-017 & 15-017b.	List proposals not yet approved by the standards committee: Nil.
RSSB Standards Programme	This document is currently not on the RSP.	
Amendments or clarifications	2045 Iss 4 AM001; 2045 Iss 4 AM002; 2045 Iss 4 AM003; 2045 Iss 4 AM004.	
Limited change releases	None	
Enquiries	Cas-02908-Q4F9G7 dated 16/02/2021 from VTG The requester is working for VTG on their new Ecofret 2 wagons and a question has come up on braking relating to the RSL data. GMRT2045 clause 3.4 requires the lambda value to be calculated. This requires a braked weight. Clause 3.4.2 requires that this is calculated in accordance with UIC 544-1 but also mentions a draft EN. The calculations are not carried out in accordance with UIC 544-1 but using EN 14531-6 (as permitted by the WAG TSI), and VTG understands that EN 16834 (now issued) aligns better with EN 14531-6 than the UIC. Therefore, VTG proposes to calculated the braked weight in accordance with EN 16834 rather than UIC 544-1. This is strictly a non conformance against clause 3.4.2, noting that this clause is not mandatory but as part of an RGS is a license condition. VTG is not keen to apply for a deviation (and the project timescales will not permit this) but some confirmation on the view of RSSB on this issue would be helpful. RSSB's response on 17/02/2021: The current consolidated text of the WAG TSI (NTSN in GB) clause **4.2.4.3.2 Brake Performance** includes	

	The brake performance of a unit shall be calculated in accordance with one of the following documents: *— EN 14531-6:2009, or* *— UIC 544-1:2014* You've advised that you will be using EN 14531-6:2009 for the Ecofret 2. But if you were using UIC 544-1:2014, clause **2.2.2.2 Determining the braking performance of wagons**… also states that for wagons that are not fitted with cast iron brake blocks the calculation methods are described in EN 14531-6 (and in 14531-1). So assuming the new Ecofret 2 wagons are not being fitted with cast iron brake blocks, the two options in the WAG TSI / NTSN both point to the same calculation methods. The text in UIC 544-1:2014 clause 2.2.2.2 is the same as that in UIC-544-1:2013, which is mentioned in GMRT2045 issue 4. So the WAG TSI and GMRT2045 (via UIC 544-1) both point to the braking performance stopping distance calculations to be performed using EN 14531. (However CEN has subsequently withdrawn both EN 14531-1:2005 and EN 14531-6:2009 and replaced them by EN 14531-1:2015 and EN 14531-2:2015 respectively.) The 'Braked Weight' value of a vehicle was originally established by the UIC and is published in UIC 544-1 (it is a derived value using vehicle/train stopping distances). The UIC 544-1 methods to establish 'Braked Weight' values have subsequently been published as a European standard in EN 16834:2019. In recognition of their origins EN 16834 also copied the UIC terms 'Braked Weight and 'Braked Weight Percentage' (Lambda). The method (and results) of calculating the braked weight according to UIC 544-1 or EN 16834 should therefore be the same. EN 16834 was not yet complete when GMRT2045 issue 4 was published, and so could not be included in the requirement 3.4.2 alongside UIC 544-1. The next WAG TSI / NTSN revision should include updating the references in clause 4.2.4.3.2 to the current EN 14531-1:2015, EN 14531-2:2015 and EN 16834:2019. The references in GMRT2045 will also be updated when the standard is updated. The future requirement in GMRT2045 would only refer to EN16834, not to UIC 544-1, as that is RSSB's general policy, although the guidance on that requirement may include something similar to what the origins of EN16834 referred to.
Business case for change	16-IA01
Information from RMDB Note: update RMDB to reflect action/decision	The 'Considerations for revisions' file is blank, please confirm with the TS/PM if there is anything to record. Otherwise this can be marked Nil.

Appendix C Consultation Comments and Responses

Document Title: Five-year review of Compatibility Requirements for Braking Systems of Rail Vehicles
Document number: GMRT2045 Issue 4
Consultation closing date: 29 July 2022

1. Responders to consultation

No	Name	Company
1	**Keith Mack**	LNER
2	**David Bridges**	Angel Trains
3	**Andy Nicholas**	Knorr-Bremse Rail Systems

2. Summary of comments

Code	Description	Total
-	Consulted	
CE	Critical errors	
ED	Editorial errors	
TY	Typographical errors	
OB	Observations	14
-	Total comments returned	14

Classification codes for a way forward:

- DC – Document change
- NC – No change

3. Collated consultation comments and responses

No	Page	Clause	Comment	Suggestion	By	Way forward	Page	Clause	Response
1				Would it be possible to consider the effects of power change over systems and the potential for small periods of brake loss especially if it occurs at slow speed See NIR 3641.	1	DC	TBC	TBC	Fundamentally NIR 3641 was a result of a brake control software not functioning as intended; the fact it occurred during end-of stop blend is not causal. Ultimately compliance with the stopping distances is required, the standard is silent on how to design the brake control system with the particular exception of needing to mitigate against single point failures (see guidance in F.3). However, it is acknowledged that the need to achieve: • The level of brake force / deceleration demanded at the control position (subject to adhesion conditions and jerk rate limited transitions), and • A satisfactory quality of blend and overall brake effort between varying brake energy types / modes of application as external circumstances (for example speed, line receptivity) change Are both fundamental principles to be embodied in a braking system. The need to incorporate requirements pertaining to these aspects (which could cause stopping distance issues when traversing neutral sections, for example, and thus compatibility issues) will be determined during redrafting.
2	3	g	In the 60m review, it states that T1099 is the only relevant previous research.	All Electric Braking T860 I would have thought to be relevant?	2	NC	N/A	N/A	The final report of T860 was consulted during the review process. Provision of all-electric braking is already covered by the standard, insofar as the motive power and the means (tread, disc, rail or other) of a braking system is not pre-supposed. As-per the conclusions of the T860 report: *A key constraint to the adoption of all-electric brakes is the expectation defined by existing TSIs and standards for a safety critical friction brake. […] However, the standards do not specifically exclude the use of dynamic braking during an emergency brake application, nor do they require the dynamic brake to be isolated during wheel-slide protection activity*. The supplier of an all-electric brake would need to comply with NTSN safety requirements in 4.2.4.2. Also, from a performance point the electric brake would need to be capable of operating on the variable low adhesion conditions regularly experienced on the UK (GB) mainline railway. To date this has not been demonstrated and under low adhesion conditions the brake control systems generally revert to using friction braking. Guidance on the application of eddy current track brakes as an adhesion-independent means of overcoming the latter point, as suggested in T860, is included in GMRT2045 issue four (F.11.2).

No	Page	Clause	Comment	Suggestion	By	Way forward	Page	Clause	Response
3	8	G2.1.1.6	The guidance note states that the brake system provides a holding brake, but there are no requirements in the document for the holding brake performance.	Holding brake should at least be designed to hold a train on a 1 in 37 gradient in all load conditions. System isolations and tolerances should also be considered.	3	DC	10	2.3	A clause to define the holding brake function is to be provided (tentatively 2.3.6). The suggested parameters will form a starting point for discussion, although the required performance capability of the holding brake will depend on the architecture of the brake system (more of an issue with combined traction brake controllers), the routes on which the train is intended to operate and the traction capability to restart the train. As such there will always be aspects that should be set out as part of the procurement specification, but inclusion of a 'baseline' minimum performance for holding brake functionality in railway group standards could ensure that vehicles have as wider route conformity as practical in this regard.
4	11	2.3.1	Guidance clause G2.12.1.2 says stopping performance tests should take into consideration a number of factors including equipment tolerances, fade of the friction material etc. However, there is no reference to this being a performance requirement.	Add a clause in the general requirements of clause 2.3.1. to point to these considerations and stating that a train must meet the performance requirements even with all system tolerances at their extremes most detrimental to the performance, unless this can be accommodated by the control system in some way.	3	DC	21 11	G 2.12.1.2 G 2.3.1.1.5	Clause G2.12.1.2 is taken to refer to the effect the factors described have on braking distance during testing, as opposed to the assumed values used for the nominal braking distance calculation. An appreciation of this is necessary to verify the latter, since equivalent stopping distances have to be demonstrated between calculation and testing. Since this clause is evidently confusing, it will be rephrased as part of the redrafting exercise. The braking curves in Appendix A are reductions from the minimum level track stopping distances permitted by the signalling standard GKRT0075. An explanation of these factors is set out below figure 4. These safety factors help to mitigate against the extreme conditions cited, also noting that the actual signalling distances are generally longer than the minimum permitted. As such, to meet the stopping distance performance specified in the standard with all extremes of tolerance incorporated would effectively be a form of 'double counting'. Clause G 2.3.1.1.5 will be redrafted to emphasise this. With the introduction of ERTMS, the extreme are dealt with by a Monte-Carlo analysis of the tolerances and failure modes to generate the Gamma data that is then used to calculate the guaranteed braking curves for ERTMS operation. The need for guidance on the development of guaranteed emergency brake rates and brake build up times will be reviewed as part of the redrafting exercise.

No	Page	Clause	Comment	Suggestion	By	Way forward	Page	Clause	Response
5	12	2.3.2.2	Although this clause has been in this format for years, it has always seemed illogical to me that it specifies an increase in clamp load for the enhanced EB. Maybe that was the best that could be specified for older units that were modified, but a 15% increase in clamp load doesn't necessarily lead to a 15% increase in deceleration.	Provide a range of figures that define the increase in achieved deceleration that should be achieved in EB. Say the clamp load increase only refers to existing trains. This also helps on trains where the brake force is balanced between cars, when it is possible that each car doesn't see an increase of at least 15% in clamp load, but the overall braking performance of the train still increases by the required amount.	3	DC	10	2.3.2.2	The definition of Enhanced Emergency Brake (EEB) by clamp force was logical while the focus was on retrofit of existing classes, where the critical factor was the stresses set up in the brake system and supporting structure (although even the latter would be subject to the change in coefficient of friction at high block loads resulting in a non-linear relationship of torsion reaction to block force). Now that EEB is instead considered at the design stage of rolling stock, it seems advisable (in line with the suggestion) to specify the performance of EEB in terms of the required TPWS brake rate, i.e. 12%g overall for a multiple unit (30% above the nominal 9%g full service). The minimum 15% increase requirement is so the driver can perceive an increase in brake rate over full service, in the event that the latter significantly over-performs the nominal 9%g. As such, undertaking this on a multiple unit rather than individual vehicle level is plausible, and supports balancing of brake force between vehicles such that the adhesion demand during EEB on any one vehicle / wheelset does not exceed the NTSN emergency braking limit.
6	12	2.3.2.2	The clause asks for a nominal of 30% brake force increase, with a minimum of 15%. Does this mean that the 15% has to be achieved even when the full service BCPs are on their maximum tolerance and the Emergency BCPs are on their minimum?	The minimum increase should be a nominal of 15%, i.e. considering FS and EB BCPs at their nominal values. If the train deceleration proposal is taken on board as suggested above, then the deceleration increase should be at least 15%, based on nominal values achieved during testing.	3	DC	10	2.3.2.2	As noted above, the 15% requirement relates to a perceivable difference in brake effort. The requirement will be reviewed as part of the redrafting, for example making the requirement a perceivable difference in effort, citing the minimum 15% figure in guidance as that typically employed.
7	12	2.3.2.2	The requirement for an enhanced EB is only applicable to multiple units. Fixed formations of >5 cars can meet the requirements of either MUs or loco-hauled trains (Definitions on P63). Hence there are differences in performance across the network on fixed formation trains in EB, depending on the choice of the original customer for the trains.	New fixed formations trains generally have an enhanced EB. Why doesn't the standard specify this.	3	DC	TBD	TBD	The original decision to restrict mandating of EEB to multiple units of five vehicles or fewer was based on the relative risk of station overruns occurring. Short multiple unit trains are likely to be forming local services, stopping frequently, while longer units will generally be used for inter-city services with infrequent station stops. The longer fixed formation trains, such as HSTs, also at that time tended to employ brake systems using distributors, which would not have been practicable to retrofit for enhanced emergency brake. As related in the suggestion, there is a tendency for disc braked new build fixed formation trains to have EEB regardless of length; the exception for longer multiple units, in the case of new build, will therefore be reviewed as part of the redrafting of the standard. This would then also allow the vehicle definitions used in GMRT2045 to be harmonised with those applied by the LOC & PAS NTSN, subject to review of the other clauses where multiple units are cited.

No	Page	Clause	Comment	Suggestion	By	Way forward	Page	Clause	Response
8	14	2.3.3.10	There are no requirements for trains that run in excess of 250km/h in the text, although the figures provided in Appendix A Figure 4 cover up to 300km/h.	Performance requirements for trains travelling up to 360km/h need to be included to cover HS2. Hence clause wording needs revision and the data in Fig. 4.	3	DC	14	2.3.3.10	Figure 4 arises from the development of the Class 91 and Mk4 coaches, these being designed to operate at 140mph (225km/h) on the existing signalled railway utilising an additional flashing green signalling aspect. Operational measurements had shown the available adhesion reduces with increasing speed so above 125mph the Full-Service braking rate was reduced from 9%g to 6%g. Figure 4 reflected this change in performance, and (when later introduced) the maximum operating speed of the Class 373s that also braked at 6%g above 125mph. The NTSNs now specify for operation above 125mph the train needs to be equipped with ERTMS and braking intervention curves will be calculated from the Gamma data entered into the DMI. Consequently Figure 4 is no longer needed for compatibility and the train specification can choose the braking performance for ERTMS operation provided the adhesion limits set out in LOC&PAS NTSN are not exceeded with an emergency brake application. As such, figure 4 and the clauses that refer to it will be reviewed and are likely to be withdrawn in the redrafting of the standard.
9			A general comment is that this document quotes speeds in mile/h but distances in metres. We should be consistent with units and quote speed in km/h (miles/h can be provided in brackets in the text if necessary) but tables should use metric units consistently.	Use consistent units throughout the document, e.g. speed in km/h primarily.	3	DC	General	General	The definition of speed in mph comes from compatibility with signalled railway, that is still signed in mph. As such GMRT2045 sets out the Full-Service stopping distances for compliance with lines signalled to GKRT0075 in mile/h exclusively, and elsewhere uses mile/h with km/h in brackets. This is the opposite of the current standards style guide, which indicates the metric value should be primary with the imperial in parenthesis. The suitability of adopting this mode of reference will be reviewed during the redrafting process, however it should be noted that, in an operational context, ERTMS was originally going to use km/h but there have been requests for the ETCS DMI to display speeds in mph to avoid confusion running on and of ERTMS routes and signalled lines.
10	16	G2.4.1.3	Should we now be referencing EN15595:2018? It's acknowledged that the LOC&PAS TSI and hence NTSN still refer to the 2011 version, but shouldn't we stay up to date?	Refer to EN15595:2018.	3	DC	16	G2.4.1.3	The update to GMRT2045 will reflect the updated text of the NTSN following the updates made subsequent to the 2022 TSI update. The latest draft of the latter cites EN 15595:2018+AC:2021, and it is likely this update will be retained in the final vote on the TSI and transposed into the NTSN.
11	22	G2.12.1.4	BS EN 16834:2019 is now released.	Replace reference to prEN 16834	3	DC	22	G2.13.1.3	Review of all reference documents and update as required will take place as part of general standards update, although in this instance the comment is addressed in amendment four (AM004) to issue four of GMRT2045, published 26/10/2021. All amendments to issue four of the standard will be incorporated as part of the redrafting process. [Note this comment pertains to the previous clause; G2.12.1.4 does not contain reference to prEN 16834]

No	Page	Clause	Comment	Suggestion	By	Way forward	Page	Clause	Response
12	23	G2.12.4.2(b) and (c)	Should we clarify what is an acceptable difference between vehicles for them to be considered to be similar, e.g. +/-5% of brake force, mass etc.	Clarify ‘similar’, say ‘for example within +/-5%’.	3	NC	N/A	N/A	The difficulty here would be that ‘similar’ may not be the same in all circumstances, in the case of vehicle design masses depending on things like the presence of load / weigh systems (and how close such a system is to saturation), where the mass is located (for example rotating mass) and so on. It must also be considered if the vehicle barely passed stopping distance tests previously, and is likely to be sensitive to any change, or passed with significant margins. Given such questions as these it would be inadvisable to codify hard-and-fast limits. The default will remain to conduct stopping distance tests, the onus being on the proposer to justify to the approval bodies that new vehicles are sufficiently similar to an existing design that the previous results can apply.
13	24	G2.12.5.5	This clause requires the energy stored in the BSR after WSP activity to be sufficient to provide an EB application. Appendix K is referenced, but in Appendix K, clause K.1.7 it says the pressure should be sufficient to provide a FS application.	Consistency between the clauses. Would recommend there is sufficient to provide a FS application	3	DC	TBD	TBD	The anomaly will be reviewed and the correct state adopted in both instances it is called up in the standard. As compatibility with the signalled railway is on the basis of Full Service brake applications, it would suggest that this should be the minimum target. However variation in adhesion, and thus air-usage rates, through a stop may have to be considered and some margin allowed for the effects of this.
14			A general comment is that there are no longer requirements for sizing the BSR, which used to be covered by section 6 of the previous release. Nor is there a requirement pointing to the provision of a Low BSR governor, as in section 7.2 of the previous release.	Reinstate these requirements as it clarified the rules to be followed for sizing of the BSR.	3	DC	N/A	Appendix F	Sizing of BSR is taken to be covered by clause 4.2.4.2.1 point (9) of the LOC & PAS NTSN (TSI) in the first instance, with specific functional requirements with regards to volume of energy storage to be determined in accordance with clause 4.2.4.2.2 point (2) and the WSP air consumption assessment. Appendix F will be updated with some guidance to support 4.2.4.2.1 (9) with regards to ‘required brake forces’ and ‘stored energy’. Inclusion of a Low BSR Governor is covered in issue four of GMRT2045 in clause F.12.2. The brake interlock is now guidance rather than being a requirement, in accordance with the general principle adopted by the TSI (and now NTSN) of indication only (clause 4.2.4.9) but otherwise the content of issue 3 is largely intact.