OFFICE OF **RAIL REGULATION**

5th December 2014

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Dear Sir/Madam

**Recent freight derailments: The interaction of track, vehicles and freight container loads, and potential areas for improvements.**

In recent years there have been several freight container wagon derailments that have exhibited a number of common factors relating to track condition, in particular track twist; vehicle sensitivity to track geometry; and asymmetric loading of containers. None of these derailments have realised the full potential consequences; to date these have been limited to infrastructure and vehicle damage, by chance no injuries or fatalities have been sustained.

These derailment incidents demonstrate the potential for a "perfect storm" scenario where a train derails even though the current track, vehicle and load industry standards are not individually compromised.

ORR has identified common issues from these incidents, and I am writing to you to highlight that this is a system risk where control is shared by a number of duty-holders and to encourage you to work together to seek improvements.

Although there may not be a single dominant solution to reduce this derailment risk, I believe there are a number of areas for improvement across the industry, dealing with the three elements of track, vehicle and load which, when taken together, will deliver a significant reduction in derailment risk.

Whilst both the vehicles and the infrastructure are subject to standards which aim to ensure that individual and system risk is managed around the vehicle -

track interface, there are two areas that I consider the industry needs to fully address:

a) Are the standards correct; how effective is their implementation; can they be improved upon; and do they work together to enable system risk to be managed so far as reasonably practicable?

b) Are there other actions the infrastructure manager and freight industry can take (beyond the controls enacted through the standards regime) to reduce system risk as low as reasonably practicable?

Whilst I understand that the industry is undertaking some work in relation to these issues I think there needs to be a co-ordinated approach focussed on <u>fully</u> addressing the system risk.

Consequently I invite the infrastructure manager and freight industry to work together with RSSB and others, to:

a) define the current track, vehicle and load system;

b) define how these three elements interact;

c) describe the current risk controls in place;

d) detail the gaps in those risk control systems; and

e) specify the measures required in the short, medium and long term to reduce those risk gaps so far as is reasonably practicable, and then

f) implement those measures.

I will be playing my part in bringing the industry players together by inviting you to an industry meeting early in 2015 to discuss these issues. An invitation will follow, but in the meantime I would welcome an indication from you about your views on these issues and any action you intend to take now. Please send your replies to Richard Thomas at richard.thomas@orr.gsi.gov.uk so that we can make sure the agenda for the industry meeting covers all points of view.

Further detail and background to the issues can be found in the attached ORR position document that will soon be posted on the ORR website.

I would welcome your response to the issues raised by 9 January 2015.

I attach a list of all the recipients of this letter.

Yours sincerely

Ian Prosser

HM Chief Inspector of Railways.

This letter has been sent to:

<u>Network Rail</u>

David Godley - Professional Head of Track

Gareth Llewellyn - Safety, Technical and Engineering Group Director

Paul McMahon – Director, Freight

<u>Freightliner</u>

Russell Mears - CEO

<u>GBRF</u>

John Smith - Managing Director

<u>DB Schenker</u>

Geoff Spencer - CEO

<u>DRS</u>

Neil McNicholas - Managing Director

<u>Colas</u>

Stephen Haynes - Managing Director

<u>RSSB</u>

Colin Dennis - Technical Director Rail Safety and Standards Board

<u>RAIB</u>

Carolyn Griffiths - Chief Inspector of Rail Accidents

<u>HSE</u>

Vince Joyce HM Principal Inspector of Health and Safety, Head of Transportation Manufacturing, Transportation & Utilities Sector Operational Strategy Division.

This letter has been cc'd to

<u>Freightliner</u>

Tim Shakerley - Engineering Director

<u>GBRF</u>

Ben Andrew - Professional Head

<u>DB Schenker</u>

Paul Antcliff - Professional Head

<u>DRS</u>

Andy Martlew - Engineering Standards Manager

Colas

Gareth Houghton - Engineering Standards Manager

RSSB

Mick James – Principal Plant Engineer

Gareth Tucker - Vehicle Track Interface Engineer

Bridget Eickhoff - Principal Infrastructure Engineer

## ORR Position Document

**Date:** 12 November 2014

**Subject:** Recent freight derailments: The interaction of track, vehicles and freight container loads, and potential areas for improvements.

# Recent freight derailments: The interaction of track, vehicles and freight container loads, and potential areas for improvement.

## Summary

1. In recent years there have been several freight container wagon derailments[1] that have exhibited a number of common factors relating to track condition, in particular track twist; vehicle characteristics; and asymmetric loading of containers. None of these derailments have realised the full potential consequences; to date these have been limited to infrastructure and vehicle damage, by chance no injuries or fatalities have been sustained.

2. The common derailment cause is wheel unloading: although the track, vehicle and load industry standards are not individually compromised the vehicle suspension is unable to keep one or more of the wheels firmly in contact with the rail, particularly over a section of the track where the level of one rail relative to the other changes over a short length (a track twist).

3. RAIB have investigated 13 incidents that have featured track, vehicle and loading factors. The intent of this paper and the proposed actions are complimentary to the recommendations from the RAIB reports.

4. This paper identifies the system risk that is shared by a number of dutyholders and summarises the common issues from these incidents. It highlights the action we are taking to influence better coordinated action on this system risk. Whilst the industry is undertaking some work in relation to these issues there appears to be a lack of co-ordinated approach focussed on addressing the system risk. The paper identifies areas where the industry should seek improvements.

## Introduction

5. This paper focuses on the derailment risk relationship between the track (specifically track twist as this is the predominant track precursor event), the vehicle, and the impact of asymmetric loading of the vehicle. Other track geometry conditions such as cyclic top can result in other derailment risks, this paper does not examine these.

6. Both the vehicle and the infrastructure are bounded by standards providing governance which aims to ensure that individual and system risk is managed around the vehicle - track interface.

7. There are two questions:

[1] Washwood Heath (2006), Duddeston Junction (2007), Marks Tey (2008), Wigan NW (2009), Reading West (2012), Camden (2013).

a) Are the standards correct; how effective is their implementation; can they be improved upon; and do they work together to enable system risk to be managed so far as reasonably practicable?

b) Are there other actions the infrastructure manager and freight operating companies can take beyond the standards regime to reduce system risk as low as reasonably practicable?

8. Using the 13 RAIB reports featuring track, vehicle and loading factors RSD and RPP analysed the key causal factors and common threads from them. The table at annex 1 summarises the issues relating to the track, vehicle and loading and forms the basis of this paper. Using bow tie [2]assessment we identified potential areas for the industry to develop further risk controls. A copy of the bow tie diagram is at annex 2

**Track aspects**

9. The key track element in the incidents has been track twist[3] (Annex3 provides more information on track twist) that can lead to wheel unloading due to the vehicle suspension being unable to cope with the change in the track geometry.

10. It is unclear whether the current 3 metre twist measure provides the infrastructure manager with the best indication as to whether they are managing the risk arising from twist faults for modern rolling stock.

11. The infrastructure manager can demonstrate they understand the risk posed by isolated track geometry issues; however the derailment risk arising from a combination of track faults at the same location is less straightforward to understand as this can result in complex track/vehicle interaction. For example where a horizontal track fault combines with a vertical or twist fault, the resulting wheel unloading and associated lateral forces can result in a derailment risk.

12. Railway Group Standard GC/RT5021 and Network Rail company standard NR/L/TRK/001/mod11 set out the Infrastructure Manager's arrangements to manage track geometry risk. These include inspection arrangements, maintenance, intervention, and safety limits, and minimum actions when responding to faults.

13. Euro Standard EN:13848 lays down 'Immediate Action' limits that are roughly comparable to those used by the infrastructure manager.

14. Track geometry in the UK is measured dynamically by a fleet of specialist trains periodically, generally based on line speed and traffic loading. This approach should take account of track condition, predicted deterioration rates, and intervention limits to prevent the track creating a safety risk. This can however result in a considerable number of unidentified twist faults developing in the track between track geometry runs. RSD identified issues with the

[2] Bow Tie analysis is an established tool that enables a clear visualisation of the potential causes of accidents and the controls in place to prevent and mitigate them

[3] where the level of one rail relative to the other changes over a short length

management of twist faults and served an Improvement Notice in November 2013 requiring Network Rail to improve its management of them (see paras 30 and 36 for more detail).

**Vehicle aspects**

15. The key issue for vehicle is the ability of the suspension system to keep the wheels firmly in contact with the rail and particularly the ability to cope with sections of the track where the level of one rail relative to the other changes e.g. a track twist.

16. The principal standard that provides governance of compatibility of rail vehicle dynamic stability is GM/RT 2141. 'Resistance of Railway Vehicles to Derailment and Roll Over'. This standard defines the criteria by which derailment resistance of vehicles needs to be demonstrated.

17. The standard allows different methods of testing depending upon the novelty of the suspension or running gear and the configuration of the bogie and axle and also makes assumptions about the infrastructure particularly track twist that the vehicle needs to be able to cope with.

18. It is unclear if this standard adequately addresses and defines the infrastructure geometry particularly combined track faults which feature in some derailments.

19. GM/RT 2141 has a European equivalent in EN 14363. RSSB has reviewed and compared the two standards and conclude that the assessment used in EN14363 is broadly similar to GM/RT2141. However, results for both can vary and they have made a number of recommendations aimed at bringing the two standards into closer alignment.

20. RSSB concludes from their review that if a vehicle is likely to be susceptible to derailment, then a dynamic assessment should be included in its assessment. What constitutes 'susceptible' isn't defined. The incidents identified in this paper indicate that partial loads, asymmetric loading and load shift within the container during transit need to be addressed.

**Load aspects**

*21.* The nature of the load and its distribution across the rail wagon will influence derailment risk. A higher degree of offset or asymmetric loading will reduce the vehicle suspension's ability to maintain sufficient wheel loading on the rail. Two aspects influence loading:

*The positioning and mixing of different size containers on a single wagon*

22. Containers primarily come in 20ft and 40ft combinations. These are carried on either 60ft (e.g.FEA type) or 40ft (e.g.ECOfret type) container wagons. Where multiple containers are carried the longitudinal asymmetric load is more at risk due to the configuration of the container distribution. This is a particular risk on 60ft wagons, where a combination of wagon load distribution and container load distribution can increase derailment risk

23. Through guidance and company procedures, which are now becoming established practice, the industry has controls in place to address this risk.

*The weight distribution within a container and the potential for the load to shift during transit and alter the distribution.*

24. The controls on weight and packing of containers are largely outside the direct control of the railway sector and ORRs regulatory vires, with containers being weighed (& weight declared), packed and sealed by the consignor of the goods being transported before entering a multimodal transportation chain typically involving boats, trains and lorries. Goods are often consigned from outside the UK making the packing etc. further remote. Containers for rail transport are not mandated to be weighed prior to departure and rely on self-declaration of weights without verification.

25. To assist consignors the United Nations Economic Commission for Europe (UNECE) with the International Maritime Organization (IMO) and the International Labour Organization (ILO) published (January 2014) updated international guidelines[4] for the safe packing of containers. This provides detailed, guidance on loading and securing of cargo in containers taking account of the requirements of all sea and land transport modes. The code is based on best practices and internationally agreed technical provisions but is not mandatory.

26. In the UK the HSE is the safety enforcing authority for most, non rail, goods transportation and has a logistics strategy covering ports, road haulage and domestic delivery services, but at present this has no links to rail transport. There is scope for ORR and the rail sector to work with HSE to raise awareness of railway issues with containers and seek improvements in container loading.

27. Whilst the rail sector has limited influence over the packing and weight distribution of a container there is potential to do more to identify, prevent and mitigate the impact of adversely loaded containers on the rail network. For example:

a) Defining what asymmetric load tolerances the rail system can accommodate.

b) Weighing containers prior to loading on to rail wagons to confirm the weight and the distribution of weight. This would then enable any containers outside acceptable asymmetric tolerances to be quarantined from entering the rail system.

c) Use of Wheel Load Impact Detectors – such as the Gotcha[5] system – to identify in-traffic container wagons that are showing asymmetric loadings

[4] IMO/ILO/UNECE Code of Practice for Packing of Cargo Transport Units [CTUs]

[5] Network Rail is partway through a programme of installing Gotcha systems across the network and undertaking development work on the detection of offset loading. It is understood they are considering the installation of these systems at locations near freight terminals etc.

outside acceptable tolerances. Once identified action could be taken to reduce derailment likelihood e.g. impose a speed restriction on the train and remove them from traffic etc.[6]

## Proposed action

*Industry*

28. The infrastructure manager and freight operating companies working together should define the current track, vehicle and load system; how the three elements interact; describe the current risk controls in place; detail the gaps in those risk control systems; and specify the action required in the short medium and long term to reduce those risk gaps so far as is reasonably practicable. RSSB or other suitable research and testing organisation (e.g. the Transport and Technology Centre Inc. - TCCI) may be useful in facilitating this work. Areas to consider are given in annex 4

*ORR*

29. ORR to raise the issues identified in this paper and the need for action, with the industry.

30. ORR to continue to drive the work with Network Rail to address underlying track geometry issues leading to twist and other faults and to reduce the number of faults in the system.

31. ORR with the rail sector to work with HSE to raise awareness across the logistics sector of the risks asymmetric and poor loading of containers imports on to the railway.

## Related ORR and industry work

32. In 2003 RSSB had research undertaken regarding derailment mitigation[7] -. The research identified similar issues to those covered in this paper and made recommendations which RSSB raised with the industry. It also led to the 2006 research referred to below.

33. In 2006 RSSB had research undertaken on derailment risk[8](This followed on from the 2003 work) which looked at a number of derailments where track and vehicle standards appeared to be compliant. The research identified issues regarding track, vehicle load interaction but made only one recommendation: *"Our analysis does not suggest that a change to mandatory standards would be effective in managing the residual derailment risk and therefore no action to amend Railway Group Standards is proposed.".* However the research does identify that the issues could be more effectively controlled by appropriate operational and management processes. Railway Group standard GC/RT5021 appendix C (copy at Annex 5) provides commentary on this.

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[6] It is understood the Austrian Railways (OBB) are operating this type of system and have set asymmetric load parameters. The UK Freight Technical Committee (FTC) have also done some initial work on this.

[7] RSSB Research Project T078 'Derailment mitigation – categorisation of past derailments 2003.

[8] RSSB Research Project T357 'Cost-effective reduction of derailment risk' 2006

34. Freight Technical Committee (FTC) in conjunction with Network Rail have reviewed GOTCHA wheel impact load detection system and believe it can potentially provide a method of measuring offset loading of freight wagons. Although further work is required to refine the measurement/data analysis process they are considering the introduction of preliminary limits based on those used by the Austrian railways.

35. ORR served an Improvement Notice in Scotland in November 2013 requiring Network Rail to improve its management of track twist. Network Rail complied with this notice by the due date of 3 October 2014; ORR are undertaking assurance work to ensure the new processes become fully embedded, and that Network Rail roll out the principles to other relevant routes. We also served an Improvement Notice in Western Route in June 2014 requiring Network Rail to establish the required resource levels to manage maintenance.

36. As a result of our track geometry improvement notice Network Rail has set reduction targets by line of route for a number of track geometry fault type. The intent is to reduce the number of higher risk track geometry faults (twist & cyclic top) by 50% by the end of CP5.

**Relevant legal provisions**

37. Health and Safety at Work Act 1974 Sections 2 & 3

38. Railways and Other Guided Transport Systems (Safety) Regulations 2006 (As amended in 2013)

a) Regulation 5 – requirement to have a safety management system (SMS). Schedule 1 (1d) requires continuous improvement of the SMS Schedule 1 (2f) requires provision of information between transport operators.

b) Regulation 19 – requirement to undertake a risk assessment to identify control measures, review if no longer valid or there has been significant changes, and put in place arrangements to implement, monitor, and review the measures.

c) Regulation 22 – requirement for transport operators to co-operate with each other to deliver compliance with these regulations.

**Relevant industry forums**

39. RSSB - Vehicle/Track Systems Interface Committee (V/TSiC).

40. FTC.

41. HSE logistics forum.

**Conclusions**

42. The derailment incidents identified in this paper demonstrate the potential for a “perfect storm” scenario derailment where although the current track, vehicle

and load industry standards are not individually compromised, they can collectively put the rail system at risk of a derailment.

43. Whilst the paper doesn’t identify a single dominant solution to reduce the freight container train derailment risk, it identifies a number of areas for improvement across the three elements of track, vehicle and load which together could deliver a significant reduction in derailment risk.

44. The nature of these issues and their close interrelationship mean they need to be addressed as a system risk and reasonably practicable solutions developed by a cross industry approach. Some forums that may be useful in developing these solutions have been identified above.

**Annexes**

1. Table of incidents and key causal factors
2. Bow Tie diagram
3. Track twist
4. Suggested industry action
5. Railway Group Standard GC/RT5021 - Explanatory Note: Twist faults

**Annex 1**

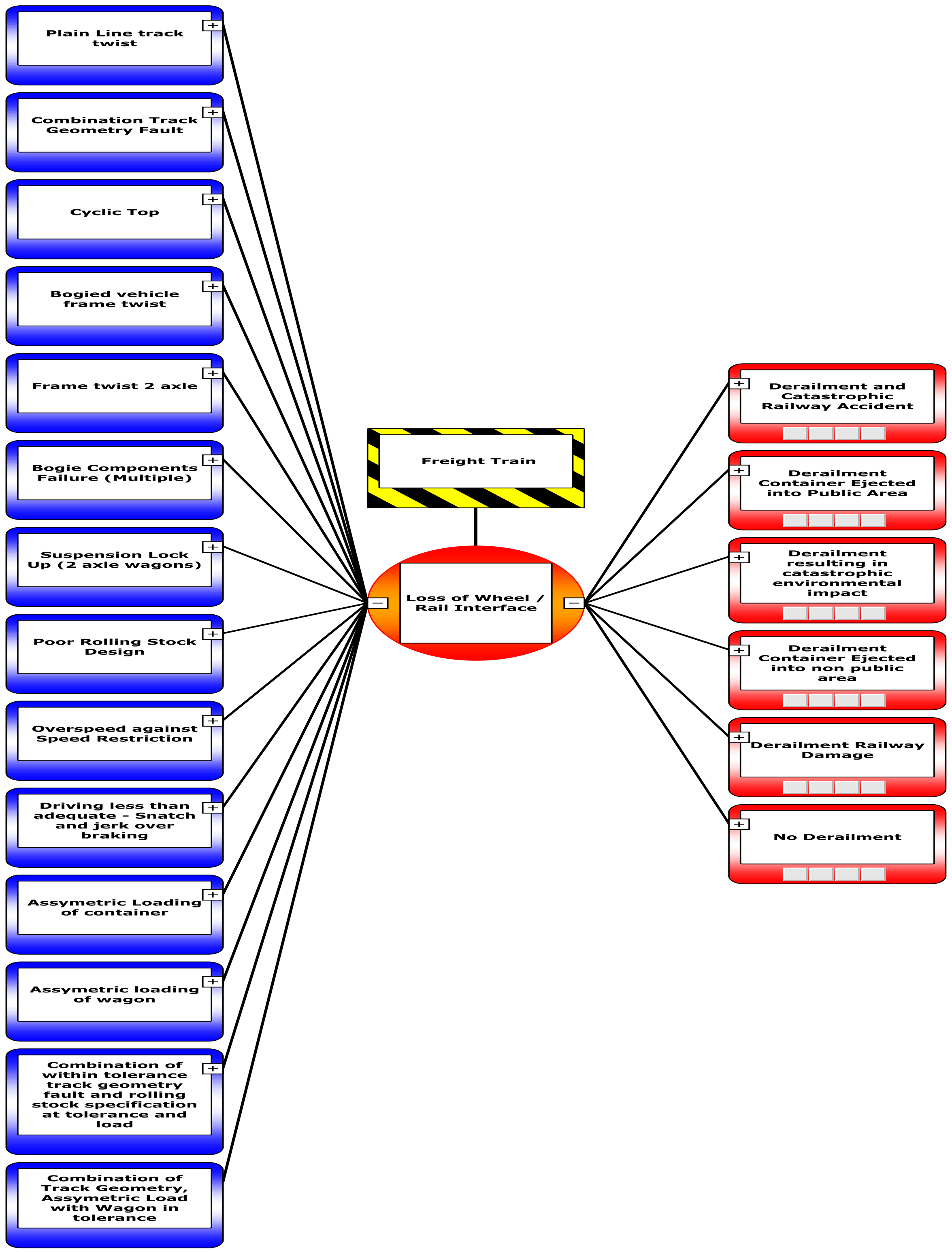
**Incident causal factor analysis from RAIB reports**

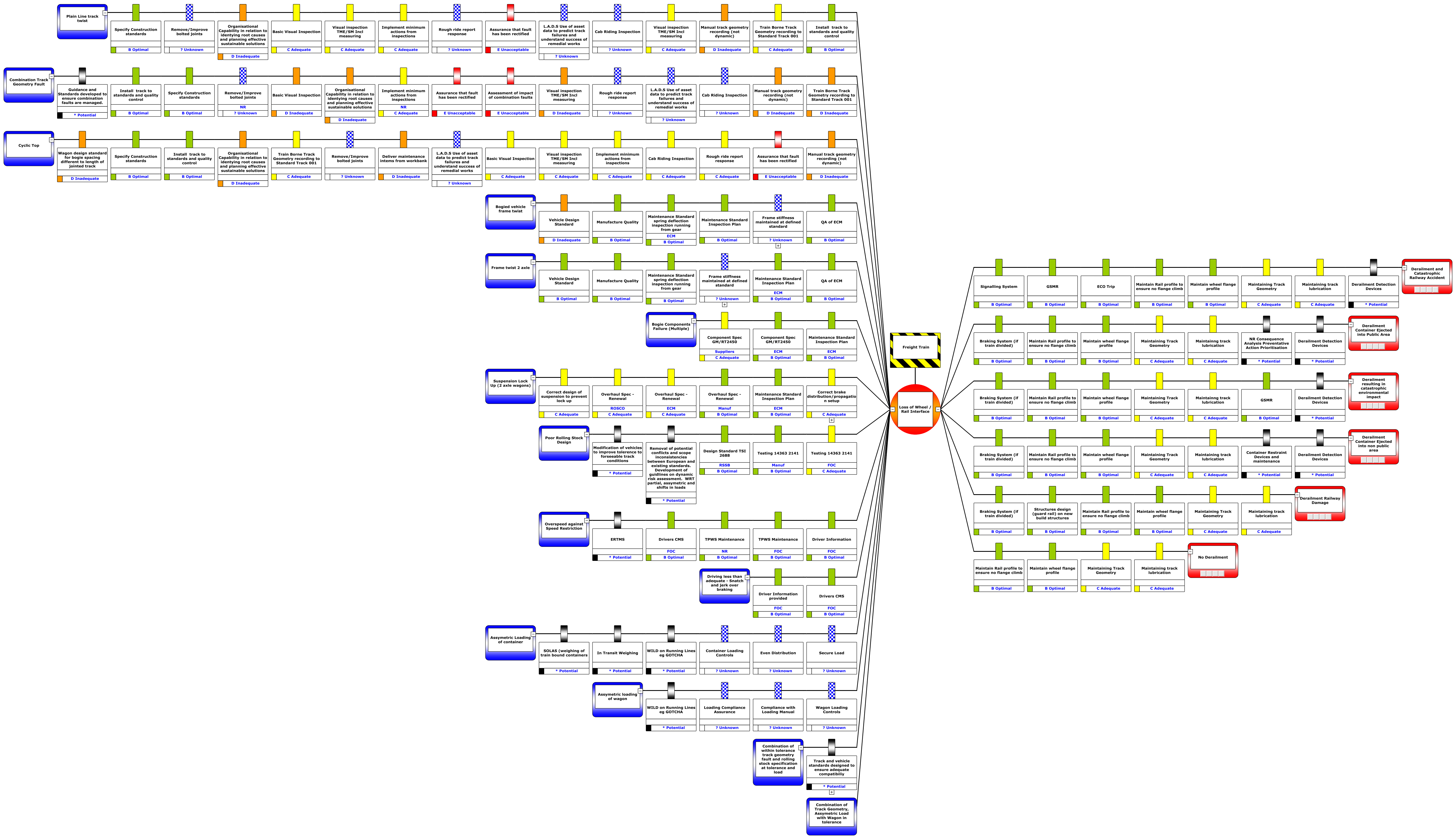
| | |
|---|---|
| (yellow) | = Track element |
| (blue) | = Vehicle element |
| (olive) | = Load element |
| (grey) | = Container wagon incident |

| | | | | | | | | | | | | From draft RAIB reports | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Washwood Heath** | **King Edward Bridge** | **Ely** | **Duddeston Junction** | **Santon** | **Moor street** | **Marks Tey** | **Wigan NW** | **Bordesley** | **Reading West** | **Shrewsbury** | **Camden Lock** | **Gloucester** |
| **Date** | 08/09/2006 | 10/05/2007 | 22/06/2007 | 10/08/2007 | 25/01/2008 | 25/03/2008 | 12/08/2008 | 25/08/2009 | 26/08/2011 | 28/02/2012 | 07/07/2012 | | |
| **Vehicle** | FAA | HAA/HMA | PHA/KJA | FEA-B | HHA | SSA | FTA/FSA | FCA | PHA | FEA | HXA | FEA-B | SL45 |
| **Type** | Container Flat | Hopper | 2 Axle Hopper | Container Flat | Hopper | Box | Container Flat | Container Flat | 2 Axle Hopper | Container Flat | Hopper | Container Flat | Container Flat |
| **Suspension** | Y33 | 2 Axle leaf springs | Gloucester Mk4 | Y33 | TF25 | 2 Axle - Pedestal | Y33 | NACO Swing Motion | Gloucester Mk4 | Y33 | SCT BER25.4 | | |
| **Wagon No.** | 13th | 23rd | 15th | 7th/8th | 10th | 14th 15th | 10th | 12th | 26th | 24th | 16th | 5th | |
| **Imm Cause** | Flange Climb | Flange Climb | Suspension Lock Up - Flange Climb | Flange Climb | Flange Climb | Flange Climb | Flange Climb | Flange Climb | Suspension Lock Up - Flange Climb | Flange Climb | Unsafe Points | Flange Climb | Cyclic top caused wheel unloading |
| **1st Casual Factor** | Design and condition of side bearers | TRACK Twist (1:214 at Point of derailment(3 mtr) but 1:164 over wheelbase of vehicle (5.5m)) | Friction Liner Performance | TRACK Twist (1:103 combined with a 1:237) | TRACK Geometry - twist and lateral alignment | TRACK Twist (1 in 74) | Wheel unloading on wagon | TRACK Geometry Design - lack of a check rail | Friction Liner Performance | Wheel Unloading due to Lateral Payload offset | Maintenance regime did not control the degradation risk at the points | Multiple opposing twist faults over wagon wheelbase | Cyclic top track defect unmanaged |
| **2nd Casual Factor** | Wheel unloading | Frame Twist | Frame Twist | TRACK Inspection not identifying dynamic twist | Undetected Geometry | TRACK Geometry Design | Dip in TRACK vertical alignment | Frame Twist | Lack of detection and rectification of worn suspension components | Lack of process for packing containers | | No check rail fitted | IDA wagon susceptible to cyclic top |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **3rd Casual Factor** | | Suspension Fault | Differential Axle Loading | Asymmetric Loading | Wheel Unloading due to Lateral Payload offset | Capability of identifying dynamic twist fault | Cyclic top | | TRACK Twist (1:193) | Payload offset not detected | | Lateral track defects | |
| **4th Casual Factor** | | | | | Excessive cant and poor drainage | Voiding | Lack of post work inspection and follow up works | | repeat TRACK geometry faults not managed | TRACK Twist (1 in 188) | | Assymetric loaded wagon | |
| **1st Contrib Factor** | TRACK twist (1:108) | X over Design Fault | Inadequate Wheelchex Intervention | X over not examined under traffic | Inadequate Maintenance Intervention | Track construction (asymmetric fishplates) | wagon in the part-laden condition did not meet the vertical dynamic performance requirements of GM/RT 2141 | wrong handed transition rail | no organisational ownership of suspension lock up | Routine TRACK inspection process did not identify twist fault | | Loading control | Poor track drainage |
| **2nd Contrib Factor** | | X over Monitoring frequency not sufficient | Pedestal Suspension Contamination | X over no signs of voiding | Inadequate Supervision & Monitoring | contribution to derailment risk from the development of voids | lack of formal planning of the bearer replacement at the heel of points | | | | | | Lack of assurance in compliance with track standards |
| **3rd Contrib Factor** | | Undetected Frame Twist | Undetected Frame Twist | Payload offset not detected | Standards & Guidance relating to Cant | | lack of knowledge by TRACK engineering staff | | | | | | Testing procedure during wagon approval |
| **4th Contrib Factor** | | | | Pre departure checks | | | | | | | | | |
| | | | | | | | | | | | | | |
| **Underlying Cause** | dynamic performance of the wagon when exposed to TRACK twist | dynamic performance of the wagon when exposed to TRACK twist | dynamic performance of the wagon when exposed to suspension lock up | dynamic performance of the wagon when exposed to TRACK twist | dynamic performance of the wagon when exposed to TRACK twist | dynamic performance of the wagon when exposed to TRACK twist | dynamic performance of the wagon when exposed to cyclic top | dynamic performance of the wagon when exposed to poor TRACK geometry design | dynamic performance of the wagon when exposed to suspension lock up | dynamic performance of the wagon when exposed to TRACK twist | | | |

**Annex 2**


Plain Line track twist
Combination Track Geometry Fault
Cyclic Top
Bogied vehicle frame twist
Frame twist 2 axle
Bogie Components Failure (Multiple)
Suspension Lock Up (2 axle wagons)
Poor Rolling Stock Design
Overspeed against Speed Restriction
Driving less than adequate - Snatch and jerk over braking
Assymetric Loading of container
Assymetric loading of wagon
Combination of within tolerance track geometry fault and rolling stock specification at tolerance and load
Combination of Track Geometry, Assymetric Load with Wagon in tolerance
Freight Train
Loss of Wheel / Rail Interface
Derailment and Catastrophic Railway Accident
Derailment Container Ejected into Public Area
Derailment resulting in catastrophic environmental impact
Derailment Container Ejected into non public area
Derailment Railway Damage
No Derailment


Plain Line track twist
Combination Track Geometry Fault
Cyclic Top
Bogied vehicle frame twist
Frame twist 2 axle
Bogie Components Failure (Multiple)
Suspension Lock Up (2 axle wagons)
Poor Rolling Stock Design
Overspeed against Speed Restriction
Driving less than adequate - Snatch and jerk over braking
Assymetric Loading of container
Assymetric loading of wagon
Freight Train
Loss of Wheel / Rail Interface
Derailment and Catastrophic Railway Accident
Derailment Container Ejected into Public Area
Derailment resulting in catastrophic environmental impact
Derailment Container Ejected into non public area
Derailment Railway Damage
No Derailment

**Annex 3**

Track Twist

1. Track twist is defined as the variation in cross level over a given distance along the track. Twist is reported as a gradient e.g. 1 in 200.

2. In the UK main line infrastructure, track twist is primarily measured over a set length of 3 metres, this dimension relates to the 10-foot wheelbase of older four wheel single axle wagons with rigid suspensions. This type of wagon was the most susceptible to derailing on twist faults however wagons with 3 metre wheelbase have nearly all been replaced with modern wagons. Modern bogie container wagons have bogie centres of 1.8 and 2.0 metres and fixed axle wagons have wheelbases typically over 4mtrs.

3. **Railway Group standard GC/RT5021** 2.11.2.1 states that 'Twist faults (measured over 3 m) worse than 1 in 200 shall not be permitted to remain in the track. When twist faults are discovered they shall be repaired within a timescale commensurate with the risk of derailment, which in any case shall not be less stringent than the timescales set out below.' The standard requires closure of the line when a fault of 1 in 90 or worse is discovered. The corrective action is mandated to be carried out within timescales which are based on expected further deterioration and which will prevent an unsafe condition occurring.

| **Twist fault** | **Action** |
|---|---|
| 1 in 90 or worse | Stop all traffic immediately and correct fault |
| Between 1 in 91 and 1 in 125 | Correct fault within 36 hours of discovery |
| Between 1 in 126 and 1 in 199 | Radius < 400 m: Correct fault within one week of discovery<br>Radius ≥ 400 m: Correct fault within two weeks of discovery |

4. **Network Rail standard NR/L/TRK/001/mod11** aligns with the RGS with the exception of imposing a more stringent timescale for taking action on twist faults on lines with speeds over 75mph. It also requires faults between 1:200-1:250 to be repaired during planned maintenance.

| **Minimum action to be taken following detection of Immediate Action Limit (IAL) track geometry faults** | | | | |
|---|---|---|---|---|
| **Fault** | **Speed range** | **Limiting Value (or Range)** | **Immediate Action** | **Remedial Action 1** |
| Twist (3m) | All speeds | greater than 33mm<br>(worse than 1 in 90) | **BLOCK THE LINE** | Correct before opening to traffic |
| Twist (3m) | Up to 75mph<br>80 to 125mph | 33mm to 24mm<br>(1 in 91 to 1 in 125)<br>33mm to 21mm<br>(1 in 91 to 1 in 143) | Correct within 36 hours | |

| | | | |
|---|---|---|---|
| | | | |
| **Minimum action to be taken following detection of Intervention Limit (IL) twist faults** | | | |
| **Fault** | **Speed range** | **Limiting Value (or Range)** | **Action 1, 2** |
| Twist (3m)<br>curve radius is less than 400m | Up to 65mph (max) | Less than 24mm to greater than 15mm<br>(1 in 126 to 1 in 199) | Correct within 7 days |
| Twist (3m)<br>curve radius is 400m or greater | Up to 75mph<br>80 to 125mph | Less than 24mm to greater than 15mm<br>(1 in 126 to 1 in 199)<br>Less than 21mm to greater than 15mm<br>(1 in 144 to 1 in 199) | Correct within 14 days |
| | | | |
| **Limiting values for Alert Limit (AL) Track Geometry Faults** | | | |
| **Fault** | **Speed range** | **Limiting value** (or Range) | Action |
| Twist (3m) | All speeds | 12mm to 15mm (1 in 250 to 1 in 200) | Alert Limit (AL) geometry faults do not have prescribed repair timescales. Correction should be undertaken during planned maintenance. |

5. **En 13818** ‘Railway Applications’ lays down ‘Immediate Action’ limits for twists more severe than 1:144 measures over a 3 mtr base-length. No guidance is given on what ‘Immediate Action’ means although through discussion it is considered that the 7/14 day repair timescale complies. The EN does however give a graph showing a range of immediate action limits for track twist over a range of base-length measures up to 20mtrs.

**Annex 4**

Areas to consider

1. The infrastructure manager and freight operating companies working together should define the current track, vehicle and load system; how the three elements interact; describe the current risk controls in place; detail the gaps in those risk control systems; and specify the action required in the short medium and long term to reduce those risk gaps so far as is reasonably practicable. RSSB or other suitable research and testing organisation (e.g. TCCI) may be useful in facilitating this work.

2. This work should include consideration of:

a) The current 3 metre track twist measure (and associated action levels) and its compatibility with the bogie centres and wheelbases of current modern vehicles.

b) The management of combination track faults

c) The track parameters set in the vehicle standards for current wagons and infrastructure in particular consideration of:

   (i) Long wavelength track twist angle between running rails

   (ii) Short wavelength track twist angle between running rails

   (iii) The need to include a parameter relating to combination track faults.

d) The development of clear robust guidelines on when a dynamic vehicle assessment is required and what they should cover with particular reference to:

   (i) partial loads

   (ii) asymmetric loads.(covering longitudinal, lateral and combination loading)

   (iii) marginal shifts of load that could be encountered in service.

e) Potential vehicle modifications to improve tolerance to foreseeable track conditions

f) The development of methods to identify asymmetrically loaded containers that present a risk to the railway and prevent them from entering traffic and removing them from traffic if loads shift in transit.

**Annex 5**

**Extract from Railway Group Standard GC/RT5021**

# Appendix C Explanatory Note: Requirements for Twist Faults

The content of this appendix is not mandatory and is provided for guidance only

## C.1 Twist faults and vehicle resistance to derailment

C.1.1 A perceived 'incompatibility' between track twist limits and vehicle resistance to derailment requirements is an issue that arises from time to time. It is the result of a misunderstanding.

C.1.2 GC/RT5021 requires that *'Twist faults (measured over 3 m) worse than 1 in 200 shall not be permitted to remain in the track. When twist faults are discovered they shall be repaired within a timescale commensurate with the risk of derailment, which in any case shall not be less stringent than the timescales set out in Table 2*'. Table 2 requires closure of the line when a fault of 1 in 90 or worse is discovered.

C.1.3 GM/RT2141 requires vehicles to be tested for resistance to derailment on a twist fault. *'The test shall be such that it permits the measurement of the wheel load changes which are induced by the passage of the vehicle at very low speed over the track irregularity defined in Figure A.1. A test which simulates the behaviour by raising or lowering of the wheels of a stationary vehicle shall be acceptable*. *The off-loading of any wheel shall be such that, for any axle, the difference between the nominal wheel load (on level track) and the wheel load measured in the test does not exceed 60% of the nominal wheel load*.' The test is based on a long wavelength twist on which is superimposed a short wavelength track twist, giving a local twist of 1 in 150.

C.1.4 A direct comparison is sometimes made between the 1 in 90 in GC/RT5021 and the 1 in 150 in GM/RT2141. Such a comparison does not take into account that the 1 in 150 vehicle test is for wheel unloading of 60% (a larger unloading would be required for a derailment) and that the 1 in 90 track twist is an extreme fault, and a twist of worse than 1 in 200 is not permitted to remain in the track. In essence, the vehicle is tested for wheel unloading against a benchmark fault representing 'bad track', and not the most extreme fault it may encounter. There is no evidence that the two standards are incompatible.

C.1.5 RSSB Research Project T357 'Cost-effective reduction of derailment risk' analysed the derailments where measures on both sides of the vehicle / track interface were relevant. This included slow speed derailments on twisted track which is the risk managed by the measures referred to above, and commented that additional contributory factors were required and '*control of these derailments would be improved by earlier twist identification and better management of known derailment risks*'. The recommendation stated (for all the identified risks): '*Our analysis does not suggest that a change to mandatory standards would be effective in managing the residual derailment risk and therefore no action to amend RGS is proposed*'. No evidence of incompatibility of standards was identified.