The background of the slide is a faded photograph of a freight train. A worker in a high-visibility yellow jacket and white hard hat is visible on the right side, standing near the front of a train car. The train is moving through a landscape with bare trees in the background.

# The interaction of track, freight vehicles and their loads

*The RAIB perspective*

# Outline

- Controlling the risk of derailment
  - Analysis of RAIB investigation findings
  - Areas of recommendation
  - Key issues arising
- *Case studies*

# Controlling the risk of derailment

## 1 Track

- Geometric limits, and specific construction requirements defined in:
  - TSI Infrastructure; and/or
  - Railway Group Standard GC/RT5021
- Network Rail construction and maintenance standards

# Controlling the risk of derailment

## 2 Rolling stock

- Requirements for resistance to derailment defined in:
  - TSI Wagons (EN 14363, 'Testing for the acceptance of running characteristics of railway vehicles')
  - Railway Group Standard GM/RT2141
- Rolling stock maintenance standards (usually company specific)

# Controlling the risk of derailment

## 3 Loads conveyed by wagons

- Laws and standards governing the loading of wagons and containers
  - Standards, guidance, good practice and contractual requirements governing the even distribution of loads within containers/wagons, and the protection against loads shifting
  - Legislation for loading and packing of containers; eg Merchant Shipping (Carriage of Cargoes) Regulations 1999 (no equivalent for rail)
  - Standards governing the distribution of weight on loaded trains
    - Longitudinal distribution (front to back)
    - Lateral distribution (side to side)

# Controlling the risk of derailment - container loading standards

- *IMO/ILO/UNECE guidelines for packing of cargo transport units*
- *ISO 3874, 'Series 1 freight containers – Handling and securing'*
- *BS 5073, 'British Standard guide to stowage of goods in freight containers'*
- *'European best practice guidelines on cargo securing for road transport'*
- *'Code of practice – safety of loads on vehicles'*
- *'Safe transport of containers by sea – industry guidance for shippers and container stuffers'*
- *'Working with containers – an Freight Transport Association best practice guide'*

## Derailment mitigation measures that are not formally managed

- Rail lubrication: reduces flange climb risk, but fitted to reduce rail side wear
- Wheel flange lubrication: reduces flange climb risk, but not generally specified
- Naturally occurring moisture and rail head contaminants

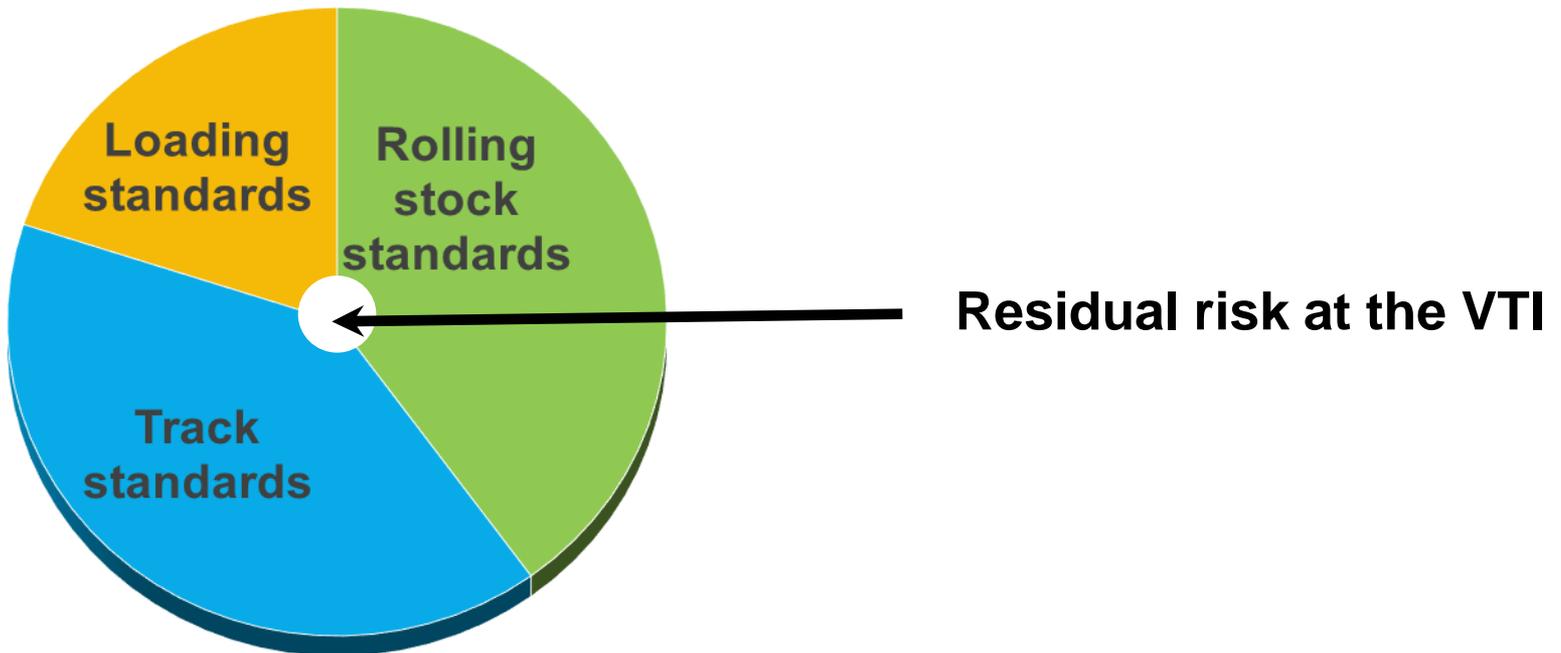
# The residual risk at the Vehicle/Track (V/T) system interface

This is the V/T system interface risk that remains even when track, train and loading are compliant with mandated requirements:

- Research work in the 1970s by the ORE B55 committee, which underpins some of the current derailment standards, acknowledged that ensuring (absolute) derailment safety would mean ‘unjustifiably high costs of (vehicle) construction’. It therefore proposed reducing the ‘stringency of conditions’ for vehicles by finding a ‘compromise solution’
- It is often argued that the risk of derailment remains acceptable while allowing for the residual V/T system interface risk – the RAIB understands that this is an argument based on the belief that risk has already been reduced SFAIRP

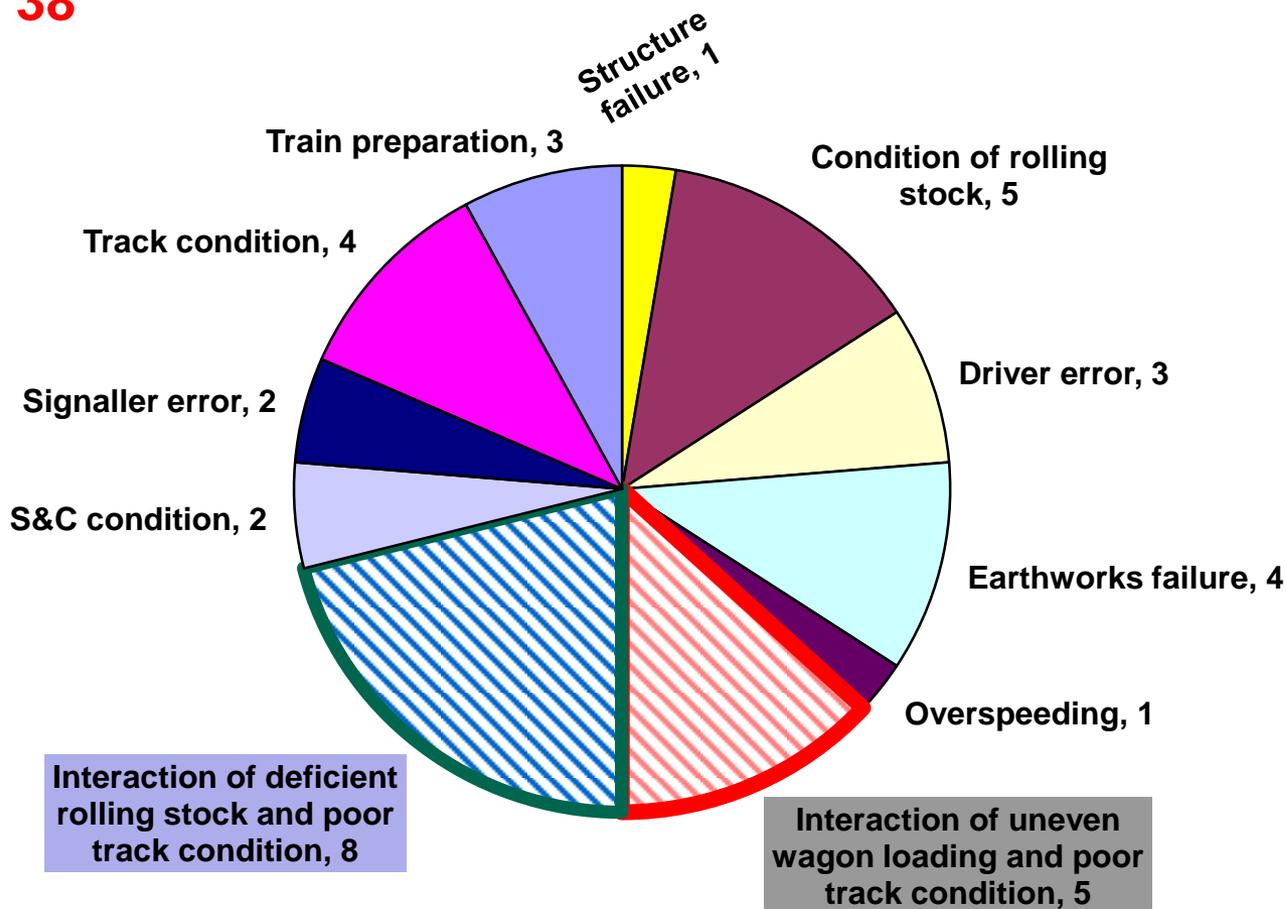
# Do current track and rolling stock standards cover all derailment risk at their interfaces?

How the vehicle/track system interface risk is managed



# Principal causes of freight train derailments identified in RAIB investigations 2005 to present

**Total = 38**

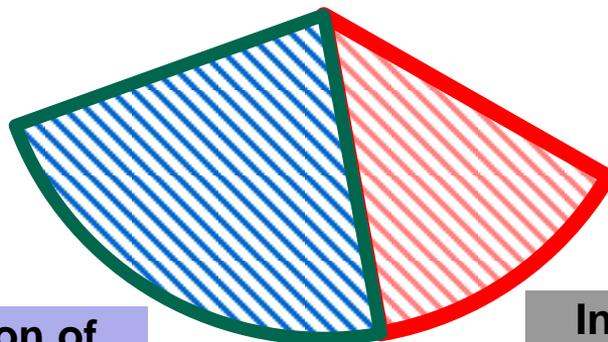


# Factors linked to V/T system interface

**Total = 13**

Of these, in 11 cases the track condition was permitted, albeit for a limited period of time (as shown below)

Undefined	= 2
30 days	= 1 case
7 days	= 2 cases
14 days	= 4 cases
36 hours	= 2 cases



Interaction of deficient rolling stock and poor track condition, 8

Interaction of uneven wagon loading and poor track condition, 5

# Factors linked to V/T system interface

**In cases where both track and train/load have featured as factors, the following issues were found:**

- Undetected or uncorrected twist (8)
- Cyclic top (2)
- Absence of check rail (2)
- Stiff bogie rotation (1)
- Frame/bogie twist (3)
- Defective suspension components (3)
- Poor ride performance when partially loaded (2)
- Weight distribution of the wagon's load - lateral asymmetry exacerbated by the longitudinal asymmetry (5)

# Factors linked to V/T system interface

**Of these, three are of particular interest to the RAIB:**

- Undetected or uncorrected track twist
- *Cyclic top*
- *Absence of check rail*
- *Stiff bogie rotation*
- **Frame/bogie twist**
- Defective suspension components
- Poor ride performance when partially loaded
- **Weight distribution of the wagon's load - lateral asymmetry exacerbated by the longitudinal asymmetry**

# Some key issues

## Undetected or uncorrected track twist

- How to better manage twist faults on the network, particularly those at high risk locations?
- Can we be smarter in the way we measure and evaluate the likely impact of track twist; is the 3m base sufficient?
- Monitoring of track twist at locations where track measurement trains do not run

# Some key issues

## Frame/bogie twist

- How prevalent is frame twist in existing fleets of wagons and do we understand the associated risk posed by twisted wagon frames?
- How do wagons with high torsional stiffness respond to 'long-wave' twist?
- How prevalent is uneven loading across bogies (and/or incorrect packing) and is this allowed for in our current understanding of derailment risk?

## Use of track side equipment (eg GOTCHA)

- Can we use such equipment to identify individual wagons with uneven wheel loads due to defects such as:
  - abnormal levels of frame twist?
  - excessive bogie twist or suspension defects?

# Some key issues

## Weight distribution of the wagon's load - lateral asymmetry exacerbated by the longitudinal asymmetry

- Do we understand the risk?
- Are there reasonable practicable measures that can be taken:
  - to prevent uneven (and insecure) loading at source eg with shippers?
  - to detect dangerous levels of load asymmetry and prevent it entering the railway network?
- Can we reduce the potential impact of lateral asymmetry by controlling the extent of longitudinal asymmetry?

# Factors affecting wheel unloading

- Recommendation 2 of report into the derailment at Camden Road encourages industry to see this as a system issue.
- Recommendation (summarised) is:

*Freightliner and Network Rail should jointly:*

*research the factors that may increase the probability of derailment when container wagons are asymmetrically loaded, including:*

- *sensitivity to combinations of longitudinal and lateral offsets in loads that can reasonably be encountered in service;*
- *the effect of multiple track twist faults over various distances*

*and work with other industry stakeholders to identify, evaluate and promote adoption of any additional reasonably practicable mitigations capable of reducing the risk from asymmetric loading of wagons.*

# Effect of offset payload on derailment risk

**Increased longitudinal payload offset increases the derailment risk due lateral wheel load imbalance**



\*at-risk wheel

$$DQ/Q = (Q_{ave} - Q1) / Q_{ave}$$

where:  $Q_{ave} = (Q1 + Q2) / 2$

Typical effect

	Level track				Twisted track			
	Q1 (kN)	Q2 (kN)	Qave (kN)	DQ/Q	Q1 (kN)	Q2 (kN)	Qave (kN)	DQ/Q
No load offset	50	50	50	0%	35	65	50	30%
Longitudinal offset load	35	35	35	0%	20	50	35	43%
Lateral offset load	35	65	50	30%	20	80	50	60%
Lateral + Longitudinal load offset	20	50	35	43%	5	65	35	86%

# Why re-examine this issue now?

- The work of the RAIB shows that uneven loading of wagons continues to be a major factor in the cause of derailments
- It is possible likely that the 'historic norm' will be influenced by a number of changes significant changes; eg
  - Growth in the numbers of 40' containers
  - Increase in max. weight of 20' containers since 1994
  - Introduction of higher containers
  - Changes to the ways that containers are allocated to wagons
  - Torsionally stiffer underframes may be making modern container wagons more prone to long-base track twists

# Extent of the issue

- The uneven and insecure loading of containers is an issue that is bigger than the rail freight sector. Is there any scope for pan-freight learning and problem solving?



# Other areas of recommendation relating to the V/T system interface

- ***More effective detection and management of track geometry (various) ONGOING***
- ***Extended use of WHEELCHEX/GOTCHA to detect uneven wheel loads due to wagon condition (KEB and Ely) ONGOING***
- ***Assessing the risk associated with uneven loading of bulk materials (Santon) NOT FULLY ADDRESSED***
- ***Assessment of how changes to infrastructure or maintenance arrangements can impact on the risk of derailment on tight radius curves (Ordsall) ONGOING***
- ***Standard for assessing a wagon's response to cyclic top (Gloucester) ONGOING***
- ***Actions to address pedestal suspension lock-up (Ely and Bordesley) ONGOING***