Specification for research project

T1143: Devices to guide derailed trains

# Background

RAIB have noted a sequence of derailment incidents over many years where the lateral excursion of the lead vehicle has been limited by engagement between vehicle and track features that were not intended for that purpose.

The most recent of these was in September 2016 at Watford Junction[[1]](#footnote-1) where the right-hand rail engaged between the traction motor and gearbox housings of the derailed vehicle and limited the deviation from the track and as a consequence reduced the severity of the impact with an oncoming vehicle.

RAIB have made recommendations to consider the use of mechanical devices or structures to guide derailed trains with the latest recommendation in recommendation 3 of the Watford report:

1. *“3. The intent of this recommendation is to identify and assess the effectiveness of design features that provide guidance to trains when derailed, so limiting the deviation of trains from the track and reducing the risk of collision with trains approaching on other lines. This could be achieved by the retention or strengthening of features already forming part of the bogie structure, or infrastructure measures such as guard rails. It is also intended that the learning from research in this area is used to derive meaningful design requirements.*

*The Rail Delivery Group (RDG), in conjunction with RSSB, should:*

*a. commission research into the ways in which guidance can be provided to derailed trains. This should include consideration of:*

1. *how the design of bogies and bogie mounted equipment can assist in limiting the lateral deviation of passenger trains during a derailment;*
2. *practice in other countries (eg Japan);*
3. *how specially installed infrastructure features can achieve the same effect at high risk locations;*
4. *potential design requirements for the retention or enhancement of such features on new trains or infrastructure; and*
5. *the potential benefits and drawbacks of such measures.*

*If such features, whether existing or additional, are shown to have a net beneficial effect in reducing risk by limiting lateral deviation, RDG/RSSB should:*

*b. share this information with the relevant Standards Committees; and*

*c. record and disseminate the design requirements with a view to their incorporation into future standards.”*

Previous similar recommendations made have been reviewed by industry through the Rolling Stock Standards Committee and concluded that such devices were unlikely to be practical or effective. The purpose of this study is to provide a broader, more comprehensive study with objective outputs to provide a definitive position on derailment mitigation.

# Objectives

It is proposed that the project is split into three work distinct packages; the first addresses the feasibility of using rolling stock mounted solutions, the second investigates the feasibility of infrastructure mounted solutions, and the third brings the findings of work packages 1 and 2 to recommend an approach based on evidence for guiding trains post derailment.

* 1. Work Package 1: Assessing the potential for Rolling Stock Mounted Equipment to reduce lateral deviation post derailment
     1. Assessment of existing rolling stock mounted equipment

Identify, categorise and assess different rolling stock mounted systems for limiting lateral deviation in the event of a derailment. This should include an assessment of both established solutions, and those under development, including academic research, and solutions used in GB and worldwide.

For each device, the study shall include a clear description of design, define the mechanism of restraint and assess the potential effectiveness and limitations of each system for use in GB railways. The assessment should include consideration of compatibility with Lower Sector Vehicle Gauge, and any other restraints particular to GB.

2.1.2 The behaviour of a derailed vehicle during and immediately after leaving the rails

To use suitable dynamic modelling for a range of derailment scenarios to understand the geometry and forces relating to secondary engagement of bogie mounted structures on the rail following derailment. The modelling should indicate the direction and magnitude of potential restraining forces to be imposed by track features, and the resultant lateral deviation from normal running position. Modelling should be carried out for plain line track only, but parameters that are likely to need to include (but are not limited to) vehicle type, speed (variation from speeds up to 125mph should be considered), and track curvature. The tenderer is asked to clearly define how these, and other parameters will be included the range of derailment scenarios, which should include both leading locomotives and leading passenger vehicles.

Additionally, this task will need to qualitatively consider the impacts of Switches and Crossings (S&C) on lateral deviation following derailment on both ‘standard’ vehicles and those with additional mounted devices. Given the range of factors and variables around S&C, it is not necessary to carry out dynamic modelling, but expert opinion may be used to take a qualitative approach.

2.1.3 Potential for bogie or axle mounted equipment in GB railways

Evaluate the options available to provide rolling stock mounted devices for limiting lateral deviation following derailment on GB. This should include:

* Any promising solutions identified in the assessment of existing rolling stock mounted equipment (2.1.1)
* Consideration of the devices that acted unintentionally to reduce lateral deviation in previous GB derailments (see Appendix A).
* Consideration of new or hybrid devices based on both the above and the behaviour of a derailed vehicle during, and immediately after, leaving the rails (2.1.2)

The evaluation should consider constraints of GB Lower Sector Vehicle Gauge (LSVG) and interactions with switches and crossing. Summarise the viable options, including commentary on effectiveness, likely costs and any other relevant observations. For the options that are ruled out due to their impracticality or costs, clearly justify and document the reasons for this decision.

*Note: There might be some circumstances where there is a good case for devices that exceed of LSVG, and where this is necessary the considerations should be presented.*

## Work package 2: Assessing the potential for Infrastructure mounted equipment to reduce lateral deviation post derailment

2.2.1 Understanding of Current Worldwide Solutions and approaches

The current use of guard rail systems in GB is associated with the prevention of catastrophic events following a derailment. These are generally associated with structures over water, and high-level structures in urban areas. The logic behind the location of the sites that use guard rails systems is perhaps not consistently applied or well understood, and it is unlikely, in the event of a track renewal, that an alternative solution would be implemented and therefore a like for like replacement would be implemented.

As a starting point, this study should seek to understand current best practise in GB rail authorities, and other comparable rail authorities across the world. This study should include an examination of the rationale, assumptions and any calculations used, and highlight the use of any tools used and approaches defined.

The study should also address any research that has been carried out previously to understand the mechanism of the interaction of derailed trains with infrastructure and any associated factors. For example, it is understood that some European rail authorities have found that any form of guard rail or derailment guidance is not effective above a certain speed and could then in fact increase the risk of harm.

This above work should be brought together in a cohesive manner to summarise the variability of each approach, highlight best practise and comment on any potential improvements of current approaches.

2.2.2 Understanding of the magnitude of risk and development of a risk-based approach

The wholesale installation of guard rails, or alternative infrastructure system has a high installation cost and ongoing operational cost of the rail system. This work should develop a risk-based approach which gives the infrastructure manager the ability to target or justify investment according to areas of highest risk. The defined approach should be systematic and should be embedded in a tool or other suitable format for processing.

When developing the tool, or other suitable format for processing, considerations should be given to both the likelihood of an event and impact, and will likely include, but not necessarily limited to, an assessment of the following parameters:

* Properties of the track including curvature, ballast depth, presence of parallel line and distance of the six-foot interval
* Line speed
* Type, frequency and crashworthiness of traffic
* Presence of local structures, and height and condition of the structures
* Presence of cuttings and embankments, their geometry and risk of landslides
* Consequential risk in immediate area
* Dead load on the structure
* Clearances to structural members
* The existence of derailment-containment kerbs

Assumptions of impact of relevant parameters in the approach should be justified and backed by suitable evidence where appropriate. The approach should be developed with industry consultation and tested on representative cases to ensure results have a good degree of confidence.

Once the approach has been agreed as suitable for the study (in consultation with the project steering group), it should be applied to a suitable mix of base cases and compared with industry practise as a baseline and consideration given to the following questions:

1. Does installing infrastructure mounted solutions generally represent value for money in reduction of lateral deviation post derailment?
2. Under what circumstances does these solutions represent best value for money?
3. Is there general agreement between current practises and the results provided by the developed approach, i.e. do we see these infrastructure solutions where we expect them?

It is recognised that this work aims to inform a general approach and is not responsible for recommending a particular spending/policy approach.

## Work package 3: Review use of devices to guide derailed train

The challenges for risk mitigation post derailment are different for rolling stock and infrastructure solutions. Rolling stock solutions are likely to be relatively low cost but are unproven and untested in GB. Work package 1 has therefore investigated the technical feasibility of these solutions. However, infrastructure solutions are an accepted method for limiting lateral deviation after derailment but are likelier a costlier solution to implement. Work package 2 has therefore focussed on the approach taken to assessing investment decisions for infrastructure solutions.

Work package 3 attempts to bring the findings from both previous work packages together and take a whole railway approach, whether a rolling stock solution, infrastructure solution or a combination of the two. The tenderer is asked to consider the following factors in coming up with a recommendation to industry on how to most appropriately reduce overall risk post derailment in the most cost-effective manner. The tender should consider:

1. A comparison of the merits of Rolling Stock or Infrastructure solutions – taking into account retrofit and new build cases for rolling stock solutions, and existing and renewed track for infrastructure solutions.
2. Potential effects on other systems, inspection and maintenance regimes – to include potential disbenefits and compromised access for rolling stock and track engineering activities.
3. Difference in risk profile between plain line and switches and crossings – dynamic modelling could show benefits in terms of controlled deviation on plan line but for derailments on the approach to S&C the situation could be different.
4. The contribution of non-controllable factors that affect the outcome of derailed train trajectory – this could include objects on the line and damaged equipment affecting the derailed train trajectory.
5. Identify situations where derailment guidance is not likely to be justified – this consideration could be in terms of generic route or service characteristics, for example a simple single track route or where the train service is very infrequent.
6. Range of costs and feasibility of different implementation approaches – to include a comparison of fitment and maintenance costs contrasted with effectiveness in different scenarios.

# Budget, timescales and dependencies

The budget for this work is up to £140,000*.* Any bid above this value will need to provide detailed explanation on why the supplier doesn’t feel that the budget is adequate and in such case, we strongly encourage suppliers to provide costed options for RSSB to consider.

The work is expected to start in January 2019 with the ambition to have the work complete by September 2019. These are indicative dates and RSSB is prepared to consider bids that vary from these expectations if they have a robust and realistic project plan, and an explanation of the proposed changes to the dates.

1. Derailment due to a landslip, and subsequent collision, Watford (RAIB, 16 September 2016) [↑](#footnote-ref-1)