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Evaluating Platform Gap Fillers to Reduce Risk at the Platform/Train Interface

Executive summary

The aim of research project T1054 ‘Evaluating platform gap fillers to reduce risk at the platform/train interface’ is to provide an understanding of the current status of existing platform gap filler solutions and evaluate their potential application across the GB rail network. To achieve these objectives, a data gathering and literature review exercise examining platform gap filler devices and solutions was undertaken which was further supplemented by an industry workshop.

A range of fixed and active platform gap filler solutions have been identified, which can be applied to either the infrastructure or rolling stock. However, the effectiveness of a particular device, or combination of solutions, will vary on a location by location basis. The benefits and disadvantages of particular solutions based on known operational factors and site conditions are discussed within the summary report.

A lack of peer reviewed research on the long term reliability of platform gap fillers has been highlighted. Analysis of recent accident statistics indicates that the severity of injuries associated with boarding and alighting could potentially be reduced by using a platform gap filler located solely at doorway stopping positions of the rolling stock, or mounted to the rolling stock itself. Reducing the size of the bodyside to platform edge gap may reduce the severity of accidents at times other than boarding and alighting. However, no publicly available studies are available that investigated the pre- and post-intervention effects at any locations where platform gap fillers have been introduced. Furthermore, safety considerations in the event of product failure or inappropriate passenger behaviour are not well documented.

A number of recommendations have been made as a result of research undertaken for T1054 which are:

- The role of platform gap fillers needs to be considered as part of a ‘whole system solution’ alongside other actions to positively influence passenger behaviour at the platform train interface (PTI) and to manage the journey through the station environment.
- There is a lack of peer reviewed research relating to the successful application of platform gap filler devices and track solutions.
- In the event of an operator wishing to pursue a platform gap filler solution for trial, in depth analysis of projected costs and installation considerations should be undertaken involving the manufacturers and the industry stakeholders affected by any amendments required to infrastructure or rolling stock.
Introduction

The aim of research project T1054 ‘Evaluating platform gap fillers to reduce risk at the platform/train interface’ is to provide an understanding of the current status of existing platform gap filler solutions and evaluate their potential application across the GB rail network. To achieve these objectives a data gathering and literature review exercise examining platform gap filler devices and solutions has been undertaken. A summary of this work is presented within this report, with a separate document giving more detail on specific solutions provided in Appendix A.

The data gathering exercise was supplemented by an industry workshop, which is also summarised within this report with a full narrative included in Appendix B. A review of recent GB accident statistics published by the Rail Safety and Standards Board (RSSB) and recent investigations by the Rail Accident Investigation Branch (RAIB) provided an opportunity to review the potential effectiveness of the platform gap filler solutions identified, and this is described in Appendix C.

This report concludes with a summary of the work undertaken, the main findings of the research and recommendations for future work. The report intends to provide a usable reference for railway undertakings (RU) and infrastructure managers (IM) considering implementing a platform gap filler solution.

Background

The mainline railway network includes approximately 6,000 platforms at over 2,500 stations. With an estimated 1.6 billion passenger journeys each year this equates to more than 3 billion crossings of the platform train interface (PTI) as passengers board and alight. The number of injuries sustained per PTI interaction is low, but 21% of the overall passenger fatality and weighted injury (FWI) risk and 48% of the passenger fatality risk occurs at the PTI (RSSB 2015d). The management and operation of the PTI presents a number of hazards for station users that can often be exacerbated by an individual’s
actions or behaviour. Following the accident at James Street, Liverpool in October 2011 where a passenger died after falling into the gap between the train and platform as the train departed the station, there has been considerable focus on improving the operation and management of the PTI. The RAIB made several recommendations following the accident, including the evaluation of equipment and methods that could reduce the chances of a person falling into the platform edge gap (RAIB 2012b).

In view of the range of PTI related issues, and the need to co-ordinate actions across the industry, the RSSB in January 2015 published the ‘Platform Train Interface Strategy’ (RSSB 2015a, 2015b), a joint collaboration between RSSB, Network Rail, the Association of Train Operating Companies (ATOC), Department for Transport (DFT), Office of Rail and Road (ORR), Rolling Stock Operating Companies (ROSCOs) and the train operating companies (TOCs). The strategy identified a ‘work stream’ for the optimisation of the step and gap. The aim of this work stream is to improve understanding and reduce the risk from slips, trips, and falls between the train and the platform while boarding and alighting. In addition to safety improvements, other benefits of this work could include a reduction in dwell times and optimisation of capacity.

The PTI Strategy identifies platform gap fillers as a potential solution for reducing the horizontal gap between the platform edge and the train. Platform gap fillers can be fitted to the infrastructure or to the rolling stock with multiple different products in use worldwide. However, further knowledge gathering was required in order to understand the range of products available that can fill the gap between the vehicle and platform edge, their effectiveness and their applicability to the UK rail network.

The stated objectives of T1054 (RSSB 2015c, BBR 2015) were:

- Gather information on existing products that are in use on other networks, both domestically and internationally.
- Identify the purpose of the platform gap filler, for example as a stepping aid at the doorway or a physical barrier to prevent passengers from falling between the platform edge and the train bodyside.
- Where possible, obtain information on installation costs and how the platform gap filler is installed and maintained.
- Recognise potential limitations of the platform gap filler due to infrastructure, rolling stock, and operational restrictions.
• Consider safety and performance factors both in normal working condition and failure modes.
• Gather information on product reliability.
• Document any other potential solutions that have not been used yet, but have potential for future development.

Method

A literature review and data gathering exercise on platform gap filler devices currently in use on domestic and international rail networks was undertaken. This review covered both train borne and platform mounted solutions, with the aim of documenting as many existing products as practicable. Where possible, high level information on the product cost; impact on train performance; effect on passenger behaviours and safety implications were documented (see Appendix C).

The information sources used were:

• Keyword search of national and international publications and research including relevant conference proceedings, using Google and Google Scholar
• Review of recent RAIB and CIRAS publications
• Keyword search of SPARK library
• Interviews with industry stakeholders to attain knowledge of operational platform gap fillers

Contact with industry stakeholders was obtained via existing contacts on the PTI Strategy Implementation Group and information gathered during the data review. The data review process took place over the course of six weeks in the autumn of 2015 and is presented in Appendix A. The information in Appendix A should not be viewed as exhaustive; neither is it the intent for the information presented to be viewed as a recommendation of any particular product or platform gap filler solution.
An industry workshop was held at the RSSB offices in London in December 2015. Invited delegates included representatives from TOCs, railway engineers, human factors specialists and members of the RSSB PTI strategy group. The aim of the workshop was to present the findings of the data gathering exercise and literature review to delegates, and gather further information on the potential impact of installing such devices at locations on the GB network. The themes that were covered in the workshop include:

- What risks are associated with the PTI?
- How could risk be minimised?
- What would drive a decision to install a gap filler solution?
- What factors could inhibit the uptake of a gap filler solution?

Information gathered at the industry workshop is presented in this Technical Summary Report, and was integral in the development of the recommendations.
Findings from the literature review and data gathering exercise

A range of solutions to reduce the gap between the train bodyside and the platform edge were identified during the literature review and data gathering exercise. The solutions could be broadly categorised as ‘infrastructure’ or ‘rolling stock’ solutions. Infrastructure solutions include solutions that require alteration to the existing platform or modifications to the track running through the station. Rolling stock solutions incorporate any device that is applied directly to a vehicle or even the design of the rolling stock itself. Note that infrastructure and rolling stock combinations are not mutually exclusive, and in some cases a combination of methods, such as raising the platform and utilising an extendable footstep from the train, may be deemed suitable for further investigation.

A further differentiation is the use of ‘fixed’ (non-moving) or ‘active’ to describe a solution. Fixed platform gap fillers do not move once installed, for example physical alterations to the platform edge. Active solutions will move, such as deployable footsteps or platform edge solutions that will actively extend once a train is in position. The products identified during the data review and literature search are presented in Appendix A.

Where possible, solutions were reviewed using four broad criteria:

- Infrastructure – are there limitations to where this can be implemented based on platform construction or the geometry of the track?
- Installation and maintenance – What impact does installation have on normal performance, and are there implications associated with the time to install and planned maintenance schedules?
- Cost – what are the costs associated with installing such a device? As well as the purchase price of a product, bespoke or novel solutions may require additional finance for research and development; viability studies; lifetime maintenance and other factors
- Performance – what evidence based or anecdotal evidence is available relating to the performance of the product, with respect to reliability, impacts on dwell time and passenger behaviour? Is there any evidence of positive or negative impact on passenger safety?
Infrastructure solutions

Examples of modifications to platform infrastructure were found that included platform length applications and those concentrated solely at doorway stopping positions. When considering platform alterations a number of factors need to be given attention, in particular the effect on existing calling services; limitations imposed by the gauging requirements of any non-stopping services; knock-on effects on the rest of the station architecture and the impact on public and passenger behaviour.

Fixed platform mounted devices and alterations

A number of examples of fixed platform mounted devices were covered by the data review. These ranged from the simple attachment of boards to the platform edge to reduce the gap, through to more sophisticated ‘rubber finger’\(^1\) devices. In the UK, at the time of the T1054 data review, the only example of a platform mounted platform gap filler was at the Heathrow Express airport terminals. Here, platform gap fillers have been applied at the doorway stopping positions for the Class 332 rolling stock (Figure 1). These were installed in 2014 to combat the number of accidents reported at the PTI for passengers boarding and alighting, the device uses deformable rubber edging material to reduce the horizontal gap between the high level platform and the floor of the vestibule. Heathrow Express claim a reduction in passenger accidents from approximately 15 per year to zero since installation, although the long-term effect is yet to be verified (Hex 2016).

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\(^1\) Rubber fingers protrude normal to the platform edge, effectively closing the horizontal gap between the platform edge and the train bodyside. These are designed to provide enough stiffness for a passenger to stand on them, but offer a degree of flexibility in the event of a rolling stock body coming into contact with the fingers.
There are further fixed solutions available from Pipex px (currently planned for installation at locations in the Thameslink core stations), STRAIL and CDM. All of these devices, in common with the Delkor Rail product, claim resilience when contacted by rolling stock in normal practice.

Fixed platform edge devices provide an absolute reduction in horizontal offset, and if used in conjunction with a raised platform can contribute to an overall reduction in gap between the bodyside and platform edge. The extent of gap closure will be limited by the passing clearance required at a station to route cleared rolling stock, including ‘on track’ machinery. Platform curvature will affect the application; as radius becomes tighter, the horizontal offset between running rail and platform edge is required to increase to accommodate vehicle overthrow. A high level of installed cant (a feature on some curving platforms with high speed through traffic) also impacts the vertical gap.

Raising the infrastructure by means of a high level platform or platform hump achieves smaller vertical stepping distances for boarding and alighting, and
can also reduce the horizontal gap to trains with a ‘cut-away’\(^2\) solebar region (Figure 2). In the UK, modular platform humps have been designed and installed by Pipex px and Hammonds (ECS). Whole length raised platforms have been used at some specific locations such as the Heathrow Express terminals. Wherever such applications are made, a standards deviation is required as the platform geometry will not conform to the nominal platform profile defined in the RGS (RSSB 2014a, RSSB 2014b).

Raising the platform edge will have an impact on the vertical clearance to route cleared rolling stock in much the same way that horizontal platform gap fillers do to lateral clearances. Furthermore, consideration will need to be made in the presence of overhead lines to ensure that passengers and staff are not brought too close to the electricity supply infrastructure. Altering the platform surface may also increase the risk of slips, trips and falls at the PTI.

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\(^2\) Beneath the solebar, the bodyside of the train curves inwards, creating a larger gap between the train bodyside and any infrastructure in the lower sector such as a platform edge. This gap is necessary to provide gauging clearance to tight structures on the network, and is discussed further in the section on ‘Gauging solutions’.
Active platform mounted devices

Deployable platform edges, typically used at doorway stopping locations, have been used internationally but at present no installations have been completed in the UK. Generally the devices are installed in conjunction with platform edge doors or screen gates that prevent passenger access to the platform edge until the train has pulled in and the devices have deployed. However, Bigorre Inginierie have installed devices on the Orleans tramway in France where open access to the platform edge is available at all times. Kyosan and Hyundai also manufacture deployable systems for the Tokyo and Seoul metro systems. Figure 3: shows one of the active platform gap fillers in deployed state at the Place d’Italie station in Paris.
The advantages of deployable devices are that the existing gauging clearance is maintained as the devices are retracted at all times when the train is not in the station. The application has always been limited to the stopping doorway position of the trains in order to alleviate horizontal gaps in stepping. For station platforms that are served by multiple rolling stock types, the complexities of fitting these devices would be increased due to variation in door stopping positions and the size of the gap.

**Further infrastructure solutions**

A novel solution for stations with high speed through trains and freight requirements is the use of multiple (‘gauntlet’) tracks to bring the stopping service closer to the platform edge (Figure 4). The gauging requirements for the non-stopping traffic are therefore maintained, although the overthrow on tight curvature would again reduce the benefits of such a solution at curved platforms. There are no examples of this being used in the UK; however a case study in Oregon, US, is presented in Appendix A. At the industry workshop, concerns were raised over the additional complexity of signalling requirements. Increased maintenance and cost of installing such a system were also viewed as significant drawbacks to such a system being implemented.
Increasing the fixity of track at stations by using concrete slab track or solutions such as polyurethane ballast reinforcement to fix the ballast would reduce impact of infrastructure positional tolerances when providing structure clearance analysis. This offers the potential for track to be moved closer to the platform edge without worsening the calculated clearances to through traffic.

**Rolling stock solutions**

Rolling stock solutions were generally found to be focussed on improving accessibility to the vehicle. The solutions covered in Appendix A concentrated in the footstep region to facilitate boarding and alighting, and also in the inter-car area to enclose the gap between carriages.

**Fixed rolling stock mounted devices**

Fixed solutions on rolling stock range from extending the width of the existing footstep plate (gauge clearance allowing) through to fitting body length
‘running boards’ that reduce the gap along the full length of the vehicle. There are further examples of international metro stock fitting gap reducers to the sills of doorways to reduce the horizontal stepping gap but these have been on trains not fitted with external footstepping.

**Active rolling stock mounted devices**

Deployable footsteps have been used widely internationally (Figure 5 shows an example from Austria). However, the only current examples in the UK are the Virgin Pendolino trains which use a horizontal deployable footstep and the Class 373 Eurostar trains which feature a two-step design. One manufacturer of deployable steps claimed that large improvements in reliability have been made in recent years (Stadler 2015), with a key factor being the integration of the footstep deployment with the door unlocking mechanism. Footsteps that will extend to cover the horizontal platform gap are in use on a number of international services, but again statistics for reliability could not be sourced during the data review.

*Figure 5 - Stadler deployable footstep*

Automatic ramp options provide coverage of the gap with the added accessibility benefits for wheelchair users, but consideration needs to be made of the ramp gradient at low level platforms and the danger of falls to the side of the ramp at locations with large horizontal offsets. A recent innovation in the US has been the ‘Brightline’ retractable platform gap fillers developed by Bode in collaboration with Brightline and Siemens for the Florida metro
(Figure 6). This platform gap filler will extend up to 300 mm prior to the opening of the doors and will pivot to meet the station platform. Note that the Florida metro features platforms that are generally designed to be ‘level’ with the passenger door entrance, so the angular rotation of the pivot is not required to be large.

Figure 6 - Bode deployable ramp

Inter-car solutions
A common feature on metro stock is the use of ‘gangway bellows’ to join the ends of adjacent cars. An example of this is found on the London Underground S stock (Figure 7). The S stock is designed to allow passengers to pass between cars without hindrance; the inter-car areas are not separated by doors and passengers can stand over the articulation point. On mainline rolling stock the movement between cars is generally through doorways, and the gangway bellows are sited well within the width of the car body profile. Filling the inter-car gap with a body-width gangway bellows potentially reduces the chances of a passenger falling into this area. However, a number of factors may limit the functionality of such a device. Passenger rolling stock on the mainline operates at higher speeds than metro stock, and thus is generally subject to more dynamic movement (sway, drop, lift and roll). The effects of this movement at the extreme ends of two adjacent cars would need to be accommodated by the gangway bellows construction. In addition, the gangway bellows contour with the vehicle bodyside profile and cut in at the solebar level. Therefore platforms located on the inside of a curve will not see an improvement in the size of the horizontal gap at platform level. The effect
of body width gangway bellows on structure and passing clearances would also need to be assessed if retro-fitting to existing rolling stock.

Figure 7 - S stock gangway bellows

Gangway bellows for fitting on multiple unit stock are available (Hübner 2014), including innovative designs for high speed trains. Inclusion in new rolling stock design could be considered for future rolling stock orders, but the impact on improving safety is not documented.

Further rolling stock solutions

Previous research (Atkins 2004) and further feedback from stakeholders captured during the data review identified the possibility of using the train’s active suspension to allow ‘kneeling’ towards the platform, although there is no evidence of this practise being used on the railways. Airbags to be deployed at stations when stationary, or permanently mounted bodyside panels along the length of a carriage were further novel ideas captured during the data review process.
Gauging solutions

A further solution investigated during the data review was the concept of designing rolling stock to a ‘route specific’ gauge. Vehicle manufacturers develop generic train models to access as much of the network as possible, and this ‘go anywhere’ approach can lead to the maximum build gauge being limited by structures that may not be applicable on certain routes. By designing bespoke gauges for specific routes, a tailored gauge could be developed which, if vehicles were built to fill the available space, could significantly reduce the gap between the train bodyside and the platform edge.

A case study involving the Merseyrail vehicle gauge (MVG) developed by Balfour Beatty Rail (BBR) is presented in Appendix A (BBR 2014a, BBR 2014b). Following a fatal accident at James Street station in 2011, the Rail Accident and Investigation Branch (RAIB, 2012b) recommended that:

Merseyrail, in conjunction with Merseytravel, Network Rail and other relevant industry bodies, should evaluate equipment and methods that reduce the likelihood of a person falling through the platform edge gap. Platform edge gap fillers and vehicle body side panels should be included in the evaluation, the outcome of which should be a plan to implement measures when appropriate to do so, for example when trains or the infrastructure are changed, improved or replaced.

With Merseytravel due to replace the existing rolling stock on the Merseyrail routes, the MVG was developed to be used as a vehicle build gauge by vehicle manufacturers invited to tender for the rolling stock replacement contract. The MVG was optimised in the solebar region on the basis that all platform infrastructure on the Merseyrail routes was bought into conformance with the lower sector structure gauge (LSSG) defined in RGS GC/RT5212 ‘Requirements for Defining and Maintaining Clearances’. The MVG minimises the horizontal and vertical gaps to the nominal platform edge geometry and these values could potentially be reduced further in practice by defining the gauge line using more precise vehicle dynamic behaviour and increase track fixity to reduce lateral movement.

The potential for vehicle manufacturers to add body panelling to existing rolling stock to achieve optimum filling of a route specific gauge is apparent.
However, the impact on the dynamic characteristics of the vehicle would have to be incorporated into any subsequent gauging analysis.

Summary

A range of solutions to reduce the gap between the train bodyside and the platform edge were identified during the literature review and data gathering exercise. Infrastructure solutions were identified that would require alteration to the existing platform or modifications to the track running through the station. Rolling stock solutions included any devices applied directly to a vehicle or even the design of the rolling stock itself. It was found that in some cases a combination of methods, such as raising the platform and utilising an extendable footstep from the train, have been proposed as solutions to reduce the platform edge gap. The products identified during the data review and literature search are presented in Appendix A.

The data gathering exercise revealed a significant lack of peer reviewed research relating to the successful application of platform gap filler devices and track solutions. Evidence based studies linking pre- and post- installation accident statistics and passenger flow are difficult to source. Information on the reliability of deployable devices particularly is also not readily available.

In the event of an IM or RU wishing to pursue a platform gap filler solution for trial, in depth analysis of projected costs and installation considerations should be undertaken involving the manufacturers and the industry stakeholders affected by any amendments required to infrastructure or rolling stock. For large scale trials of platform gap filler devices, careful consideration should be given to the collection of data relating to reliability and performance to enable effective comparison of the methods.
Workshop – Industry views on platform gap fillers

An industry workshop was held at the RSSB headquarters in London on 14 December 2015. The purpose of this workshop was to present the findings of the data gathering and literature review to industry stakeholders and to capture additional information that was not covered by the initial work. The invitee list was agreed with the project steering group, with delegates including safety representatives from seven UK TOCs. Specifically, manufacturers of platform gap filler devices were not invited to attend the workshop to prevent skewing of data when discussing the solutions available. Prior to the meeting the Literature Review and Data Gathering Exercise document (Appendix A) was distributed to all attendees.

The aims of the workshop were:

- To discuss the perceived dangers of the platform/train gap
- Assess the factors that may promote or inhibit using a bespoke device to fill the gap
- Evaluate what considerations would need to be made before implementing a gap filling solution for a specific location
- A narrative of the workshop is included in Appendix B.

Summary

These key messages were gathered from the workshop:

- Platform gap fillers need to be considered as part of a ‘whole system solution’ with other improvements, not a standalone resolution.
- The effectiveness of a given solution would vary on a location by location basis, with other factors to consider including the capacity and rolling stock requirements at individual stations.
- IM and RU need to understand the implications of requiring a minimum distance between the bodyside of the train to the platform edge.
- Evidence of the safety improvements achieved by a given solution would be key in securing support for its implementation.

The findings from the industry workshop have been integrated into the summary and recommendations of this report.
Potential impact of gap fillers on safety

A key part of understanding the potential benefits of a platform gap filler solution is knowledge of the impact of PTI incidents, and how the installation of a platform gap filler may have mitigated the consequences of such incidents. Reported PTI incidents include events such as passengers falling from the platform where no train is present; accidents as the train is entering or leaving the station, and accidents during the process of boarding and alighting. Appendix C reviews the RSSB Annual Safety performance Report to provide an overview of the risk posed by the PTI. Information from the RAIB reports into PTI incidents is also presented to gain a broad knowledge of events that can occur at the PTI.

For the majority of serious PTI accidents investigated by the RAIB, the injured party has fallen between the train and platform. These accidents have in most cases been at locations other than the step or doorway area, whilst the train has been arriving at or leaving the station. As described in the RSSB Annual Safety Performance Report only two of the 18 fatalities in the last five years at the PTI not associated with boarding and alighting have been caused by the passenger falling between the train and platform, together with nine out of 63 major injuries reported. If the gap between the bodyside and the platform edge was smaller, the severity of the accidents could potentially have been reduced. However, this would need to be a solution that remained in place whilst the vehicle was moving, rather than a deployable solution that is only active when the train is stationary.

In cases where the injured party has fallen into the gap between train carriages, solutions will be harder to achieve as the gaps between train carriages are necessary to allow for the dynamic movement of the train in normal operation. Covering the junctions between carriages with gangway bellows may go some way to alleviating the issue.

For trap and drag incidents, a platform gap filler may give the injured party more time to free themselves before falling through the gap between platform edge and train. However a number of preventative measures including safe train dispatch methods and the door locking mechanisms play a key role in reducing the frequency of such events. If the passenger is still
trapped once the train reaches the end of the platform then an outcome of serious injury or fatality is likely.

The combination of platform edge doors and deployable steps mounted within the infrastructure to fill the platform/train gap appears to have been successful in reducing major injuries and fatalities. However numerous issues with multiple rolling stocks calling at stations and the platform construction may make this solution unviable for large portions of the UK network, in conjunction with prohibitive cost.

Taking the above into account, it may be considered that the application of platform gap filler devices will have limited impact on the injury statistics in the absence of other mitigations to reduce passenger egress on to the track at times other than boarding or alighting. Ultimately, if a gap filling solution were to be used then devices or methods that remain in place during train movement would be key to mitigating such accidents:

- Fixed platform edge fillers (deformable or rigid) mounted along the whole length of the platform
- Infrastructure works to optimise the gap between platform edge and rolling stock
- Making rolling stock ‘route specific’ using a gauging solution to optimise the gap between platform edge and the rolling stock

Looking at boarding and alighting incidents, deployable solutions to ease access may have benefits for reducing major injuries (50 out of 200 incidents in the past 5 years) and the more numerous minor injuries due to trips and falls at the PTI. However, a lack of evidence base means that this is still a matter of conjecture. As discussed at the industry workshop, conformance to RVAR 2010 for accessibility requirements is desirable for operators, but evidence of increased trips and falls where vertical steps have been reduced suggest that there is no ‘one size fits all’ solution for mitigating gap incidents.

Where possible, operator’s intending to install platform gap filler devices should be encouraged to undertake a comprehensive data collection exercise both before and after installation using pre-defined criteria. Given the relatively small number of accidents that occur at the PTI in relation to overall PTI crossings, accident data for specific installations will most likely not prove to be a useful outcome measure. However, taken over a wider number of
installations as part of a cohesive trial this could potentially provide a good long term indicator of an intervention’s success.

Potential for application across the GB rail network

When considering the potential use of different platform gap filler solutions it is important to understand the nature of the platform and station structures located on the GB network.

In the RSSB T866 work package (RSSB 2011, BBR 2011), ‘Investigation of platform edge positions on the GB network’, a platform edge and track geometry investigation was undertaken to identify the extent of ‘non-standard’ platforms across the GB rail network. The term non-standard here refers to platforms that do not conform to the lower sector structure gauge (LSSG) illustrated in Figure 8.3.

3 In December 2015, GC/RT5212 was superseded by GJ/RT7073. This now includes reference to the ‘lower sector infrastructure gauge’ (LSIG) – whilst details relating to areas in proximity of the rail have been amended the application of X and Y geometry remains unchanged in the new RGS.
The horizontal offset (X) and height (Y) values are dependent on the point radius (R) and cant values for each platform survey profile. GI/RT7016 provides tolerances within which new platforms should be constructed:

- $X = 730 \text{ mm} \ [+15 \text{ mm} / -0 \text{ mm}]$ for $R \geq 360 \text{ m}$
- $X = 658 \text{ mm} + 26000 / R \ [+15 \text{ mm} / -0 \text{ mm}]$ for $R < 360 \text{ m}$
- $Y = 915 \text{ mm} \ [+0 \text{ mm} / -25 \text{ mm}]$ for cant $\leq 130 \text{ mm}$
- $Y = 905 \text{ mm} \ [+0 \text{ mm} / -15 \text{ mm}]$ for cant $>130 \text{ mm}$

All platform X and Y are recorded and reported in plane of rail.

T866 used platform geometry data from the January 2011 National Gauging Database (NGD) snapshot to investigate:

- Minimum, maximum and average values for X and Y per platform
- Distribution of station platforms on curved track (radius $< 10000 \text{ m}$)
- Identification of station platforms with tight radius less than 1000 m and platforms with significantly tight radius less than 160 m
- Relationship between installed cant and radius
- Range of installed cant within each platform
- The relationship between installed cant, track radius and operational linespeed on through platforms to determine vehicle operational cant deficiency

- Locations where a combination of high levels of installed cant and low operational cant deficiency may restrict footstep design through meeting gauging requirements

The information from T866 can be used as an indicator for locations that would be suitable for trials of platform gap fillers where geometry or cant may be a factor in the effectiveness of a device; in addition, worst case platforms can be identified that may be suitable for targeting in any future trials to assess the impact and operability of a platform gap filler.

As a consequence of curve overthrow there is potential for large gaps at the centre and extreme ends of individual rolling stock cars, with stepping distances also affected for door placements located at areas away from the location of the bogie pivots.

Of additional note is that track position can vary throughout the routine maintenance cycle both laterally and vertically. As the vast majority of platform data on the NGD represents a measured track position it is possible that a structure may have reported non-standard platform geometry due to normal variations in track position during a defined maintenance cycle.

All survey data is submitted to the NGD via approved sources at the instruction of Network Rail. Data validation by Balfour Beatty Rail was not included in the scope of T866 or T1054 work package and it is likely that a small quantity of unrealistic data was reported due to the presence of old or incorrect survey data on the NGD. Given the GB wide application of the analysis the weight of any inaccurate survey data included is not be expected to be of statistical significance.
T866 Findings

Key conclusions from T866 were:

- 60% of platforms had a mean X offset (i.e. the average offset value across the entire surveyed length) that was larger than that specified in the RGS
- 28% of platforms had a mean Y offset (i.e. the average height across the entire surveyed length) that was lower than that specified in the RGS
  - When combined, 17% of the platforms had platform geometry that demonstrated increased horizontal offset and reduced vertical offset relative to the running rail edge
- 39% of platforms had localised radius < 1000 m at some point along their surveyed length, with 1.8% including a minimum radius < 160 m

Update on T866 findings

For T1054 the platform geometry analysis from T866 has been updated using the October 2015 NGD snapshot.

The October 2015 NGD included a total of 5798 platforms. Examining the mean average of X and Y offsets for each platform on the GB network, 3364 of platforms (58%) report an X offset greater than the limit defined in RGS GI/RT7016; 948 of these (16%) also feature a Y offset less than the RGS. In other words they are low platforms with a potentially large horizontal gap between the train body and platform edge.

As demonstrated in T866, the NGD can provide a useful benchmark to highlight stations and platforms that may be suitable for deployment of platform gap filler devices for testing. As an example of the data that can be extracted from the NGD, 13 platforms are detailed in Figure 9, where the issue of large horizontal X offsets could be considered in any future platform gap filler trial. Additional analysis as undertaken in T866 could be re-run or developed further with the specific aim of identifying testing sites.
Also of note is the recent work undertaken for RSSB research project T1037 ‘Investigation of passenger vehicle footstep positions to reduce stepping distances and gauging constraints’. This analysis has made use of conventional stepping distance analysis, together with a novel technique for calculating the ‘actual’ stepping distance when factors such as suspension settlement and installed cant are considered. The stepping distances measured to both route cleared and booked rolling stock at platforms across the GB network have been covered by the report. These, may be of assistance to stakeholders when considering platform gap fillers to facilitate boarding and alighting at specific platforms.

Determining the suitability of platform gap filler solutions

For straight and level track, platform length edge fillers or bodyside panels attached to the vehicles themselves offer a fixed solution that would require only minor maintenance if installed correctly. Shifting the track laterally (gauntlet track) would also reduce horizontal offset, and when applied in conjunction with further infrastructure measures such as adjusting the platform offset to conform with the RGS, and increasing the track fixity the overall reduction could be considerable. However, all these solutions become less effective as the track curvature at a station increases, due to the effects of overthrow. The presence of high installed cant is also an issue where the train may lean away from the platform when stationary.

When considering vertical offset management, the application of a platform hump will raise the platform to the required level, as would physically altering the platform to conform with the RGS. Note, however, that conformance with
the RGS may not necessarily imply the optimum closure of vertical gap. For vehicles with ‘cut away’ solebar regions increasing the height of the platform also has the potential to reduce horizontal gap between the train and platform edge.

The case for route specific gauging could be made for certain franchises and locations, as a specifically designed rolling stock at platforms with controlled geometry could provide minimal clearances between rolling stock and the infrastructure.

**Impact on existing infrastructure**

Extensive installation time may be required for some solutions, dependent on platform construction and additional works required to the infrastructure which may be a limiting factor at some locations. The assumption has been made that any works to the platform infrastructure may adversely affect installation time; active platform edge fillers may also need to be linked in with signalling. Two platform hump solutions are identified in Appendix A that use a modular system of panelling. Both manufacturers claim that the platform can be kept in service during installation so this solution may be most useful when extensive work is not required at the station.

It is assumed that any work involving the track would require possessions, with signalling and switch requirements needing to be taken into account for the gauntlet track option.

**Impact on operations**

The effect a solution would have on traffic operating through the station and potential implications for services are an obvious consideration. For platforms with requirements for high speed through stock and service vehicle structure clearance, attachment of fixed devices to the edge of the platform may be inhibited. A deployable step from the platform edge could be considered, but this solution may be ineffective if stopping traffic is comprised of multiple types of rolling stock.

If viable, route specific gauging ensures that rolling stock and platforms are designed and maintained to ensure the smallest bodyside to platform edge gaps, whilst maintaining structure clearance. However, the application of this approach may be viewed as limited to new rolling stock contracts unless ROSCOs would consider retrofitting stock with bodyside panels.
Increasing track fixity would reduce the track tolerances associated with structure clearance assessments for through stock, however the time associated with track works and associated cost may be prohibitive as a large scale solution. Gauntlet track would effectively reduce the gap for stopping services, but with the same limitations regarding possession time and integration with often complex signalling requirements at major stations.

Dwell time, and the perceived increase and knock on effects with service, is hard to quantify but it can be safely assumed that fixed solutions or permanent changes to infrastructure would not increase the dwell time of a stopping service if applied correctly. The time to deploy moving devices, whether platform or rolling stock mounted, would need to be assessed by an operator prior to pursuing a given solution.

Consideration will be needed for any additional staff training, or increased numbers of staff at the PTI. Installation of gauntlet track will require additional training for signallers to increase awareness of a system that may not be in widespread use across the network. Active solutions mounted to rolling stock may require staff to activate the devices and also to prevent passengers accessing doors where the device may have failed. Platform edge devices that deploy automatically are rated lowest for this criteria, as staff will be required to know how the device is deactivated if the need arose.

A final issue is the impact a solution would have on operations in the event of failure. Fixed platform edge fillers may create an issue if they fail in a condition that reduces the passing clearance of rolling stock relative to the platform, but it could be assumed that the device could be removed if required. Active footsteps or ramps on the rolling stock may fail in deployed condition which could impact operations if a device could not be quickly removed or retracted manually. More seriously, bodyside panels becoming detached or misaligned would affect the clearance to the platform edge. In equal measure an active platform edge platform gap filler or failure to switch through traffic to the correct line on a gauntlet track application could result in costly damage to the platform edge and delays in service.
Summary: Using platform gap filler solutions to reduce risk at the PTI

T1054 aims to provide an understanding of the current status of existing platform gap filler solutions and evaluate their potential application across the GB rail network. To achieve these aims a data gathering and literature review exercise examining platform gap filler devices and solutions was undertaken, which was further supplemented by an industry workshop. The findings from these have been presented in this technical summary report, with a separate document giving more detail on specific solutions provided in Appendix A.

A range of fixed and active platform gap filler solutions has been identified, which can be applied to either infrastructure or rolling stock. These can be broadly classified as:

- Fixed platform edge platform gap fillers
- Active platform edge platform gap fillers
- Raised platforms
- Fixed steps mounted to rolling stock
- Active (deployable) step or ramp solutions mounted to rolling stock
- Adaptations to infrastructure or rolling stock to reduce the gap between bodyside and platform edge for stationary rolling stock, whilst maintaining structure clearance to through traffic

The effectiveness of a particular device, or combination of solutions, will vary on a location by location basis. Influences such as track curvature, presence of overhead line electrification and platform construction will need to be considered. In addition, the use of multiple rolling stock types at stations and the gauging clearance requirements of high speed through traffic and service vehicles will also impact the decision making process.
T1054 has highlighted a significant lack of peer reviewed research on the long term reliability of available platform gap filler solutions. The perception of active solutions such as moving platform edges and deployable steps being unreliable is widespread, and statistical evidence to either prove or disprove this perception is not readily available. However, some manufacturers have addressed this area and in the event of pursuing an active platform gap filler solution contact should be made directly with the product manufacturer. Data on the long term performance and maintenance of fixed platform gap fillers may also be available although statistics were not readily provided for the data gathering exercise and literature review (see Appendix A).

Safety considerations in the event of product failure or inappropriate passenger behaviour are not well documented. There are numerous reported incidents of passengers caught between the platform and train, a number of which result in fatalities or major injury if the train departs whilst the passenger is still in the gap. A review of accident statistics in the UK itself revealed that in the last five years there have been no fatalities associated with the act of boarding and alighting. However, 50 major injuries have been reported as a result of falling between the train and platform during this activity. The mean FWI over this period indicates many more minor injuries.

A platform gap filler located solely at doorway stopping positions of the rolling stock, or mounted to the rolling stock itself, could possibly mitigate against these accidents, or at least reduce the severity. Feedback from industry stakeholders indicates that enhancing accessibility is secondary to improving passenger safety in many instances; a device specifically targeted at the doorway location may, however, have the additional benefit of improved access for PRM when boarding and alighting.

In the past five years in the UK there have been 18 fatalities and 63 major injuries at the PTI at times not associated with boarding and alighting. These figures account for all incidents at the PTI, including those when a train is not present. The numbers reduce to two fatalities and nine major injuries respectively if just those incidents involving a fall between train and platform are considered. In a number of incidents investigated by the RAIB passengers have fallen between carriages having been leaning on the train body as it departed or been pulled under the train in a ‘trap and drag’ incident. The severity of such incidents could potentially be reduced by a gap filling solution that remains in place during train movement. Infrastructure modifications
such as fixed platform edge platform gap fillers could give passengers more time to release themselves or stay on the platform as the train comes to an emergency stop. Alternatively, designing a vehicle to fill the space between bodyside and platform infrastructure on a specific route or optimising platform geometry to the requirements of the RGS would also reduce the space available for passengers to fall through.

**Recommendations**

The following recommendations are made as a result of research undertaken for T1054:

- The role of platform gap fillers need to be considered as part of a ‘whole system solution’ alongside other actions to positively influence passenger behaviour at the PTI and manage the journey through the station environment.
- IM and RU need to understand the implications of requiring a minimum distance between the bodyside of the train to the platform edge.
- In the event of an operator wishing to pursue a platform gap filler solution for trial, in depth analysis of projected costs and installation considerations should be undertaken involving the manufacturers and the industry stakeholders affected by any amendments required to infrastructure or rolling stock.
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