Research Programme

Engineering

Guidance on protecting people from the aerodynamic effects of passing trains

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Aerodynamic effects of passing trains in stations

1 Introduction

1.1 Background

RSSB's R&D project T425 'Effective management of risk from slipstream effects at trackside and platforms', [Ref 1], published in 2007, drew conclusions on slipstream velocities, factors affecting the number and severity of reported incidents, and the particular risks to pushchairs, and recommended further work in these areas. Project T749 has involved the subsequent proposals to 'derive a guidance document for slipstream effects on stations under current operating conditions' and 'investigate the potential for increasing freight train speeds'.

The project strategy agreed by industry stakeholders, via the Aerodynamics GB Working Group (as principal client group), was to enhance the advice for station managers in Railway Group Standard GI/RT7016 on 'Interface between Station Platforms, Track and Trains' [Ref 2] in two stages:

1. To supplement the current guidance by adopting the accumulated slipstream research findings to date.
2. To refine this guidance by undertaking further research.

Consequently, several packages of work were endorsed including:

T749-07:*Production of guidance on protecting people from the aerodynamic effects of passing trains*, for the initial phase.

The deliverables for work package T749-07 consisted of a report [Ref 3] on the review of previous relevant British Rail Research (BRR) findings and a report summarising the findings of a workshop discussion convened with Network Rail and Train Operator representatives. The supplier's report 'Guidance on protecting people from the aerodynamic effects of passing trains - Phase I Review' was accepted by the Aerodynamics GB Working Group at its meeting in May 2009. The work package recommended a number of enhancements to the guidance in GI/RT7016, and also recommended a pilot study of a risk assessment for platforms that had previously been drafted but not trialled. This particular document relates to the results of the work package dealing with the risk assessment pilot study.

Railway Group Standard GI/RT7016 'Interface between Station Platforms, Track and Trains' (Issue 2, December 2007) contains

certain mandatory measures to protect people from the aerodynamic effects of passing trains and includes a degree of guidance in Appendix D. The intention is to enhance this advice for station managers to enable them to carry out suitable and consistent risk assessments.

1.2 Work package scope

The research outlined in this report is based on the British Rail Research (BRR) work, developed for Railtrack in 1996. Specifically, this project has consisted of a pilot study reviewing and trialling the risk assessment methodology for the aerodynamic effects of passing trains at platforms that had previously been drafted but not trialled or implemented. The methodology developed by BRR for Railtrack in 1996 has been reviewed for suitability and a number of theoretical desktop assessments have been carried out to test the methodology.

1.3 Work package objectives

The primary objective for this work package was to prove the suitability of the proposed risk assessment model for station platforms to provide a satisfactory quantitative method for undertaking the risk assessment referred to in GI/RT7016 Appendix D, but for which no method is currently specified or recommended.

The other main objective was to attain proof of suitability by achieving stakeholders' endorsement of the model and their support for its being proposed as a standards change project.

2 Work package method

A preliminary appraisal was carried out on the assessment methodology originally developed in 1996 by BRR for Railtrack. The method was reviewed for completeness and suitability. Following the review, a trial version of the method was developed in an Excel spreadsheet suitable for use in the desktop trials that formed a key part of this work package. The desktop trial assessment tool is shown in Appendix A and the quantified methodology is outlined in Appendix B.

A selection of ‘trial’ stations was chosen to represent various station and traffic characteristics. The selection also included stations where aerodynamic effects of passing trains have historically been noted (ie in a number of safety related incidents).

For each platform in each of the trial stations an aerodynamic effects risk assessment was carried out using the trial assessment tool to give comparative risk assessment scores. A total of 39 platform assessments were undertaken, across 11 stations.

In order to investigate the sensitivity of the assessment method and to improve the accuracy and validity of the trial assessments, a number of station visits were carried out during which staff with local knowledge were interviewed. It was consequently possible to improve and refine risk assessment assumptions and to analyse the effects of these assumptions on the risk assessment results.

A workshop was organised to allow key stakeholders to experience the method in detail and to gain an appreciation of its strengths and weaknesses. Practical feedback on the use of the methodology was captured in the workshop, some of which may be considered in future developments. Following the workshop, a further exercise was carried out to extend part of the methodology which was found to be limited - consideration of mitigation factors.

The detailed results from each of the above tasks are given in the following section.

3 Work package results

The original BRR assessment methodology was reviewed to identify what data is required to be collected to complete an assessment (eg platform type, traffic type, train type, train speed, geographical location, platform layout and wind exposure, number of trains passing the platform, mitigating factors). The completeness and suitability of the method was then considered.

3.1 Review of existing methodology

The risk assessment method that has been reviewed and trialled can be considered a relatively simple methodology. It consists of two parts:

- Part 1 is a simple semi-quantified risk assessment which results in a ‘risk score’ associated with the level of risk due to aerodynamic effects of passing trains at a specific station platform.

- Part 2 concerns qualitative information regarding relevant conditions associated with the platform, including measures already in place to mitigate the aerodynamic effects of passing trains. This part does not form part of the original BRR assessment method but was considered to be a useful addition which enhances the completeness of the assessment and could be developed further in future work. Although it does not fall within the scope of this work package, information has been recorded which may be used in future work.

3.1.1 Part 1 quantitative assessment

The semi-quantified assessment is based on the following parameters which are estimated for each station platform:

- Geographical location, (which indicates general cross wind exposure conditions)
- General platform layout, (whether open or enclosed/with a canopy, for example)
- Number of passenger trains stopping at the platform, (which indicates general levels of waiting passengers on the platform)
- Number, and highest passing speed, of non-stopping trains of each of the following types:
  - Road vehicle-carrying train, (Ford transit van carrier, cartic, carflat etc) with the load exposed
  - Freightliner / Flat-bedded wagons with vertical ends
  - Freight train other than those above, (tankers, hopper wagons etc)
  - Multiple unit / loco-hauled passenger train
  - High speed passenger train, (HST, IC225, Eurostar etc)

The original method was based on only the two worst consequence trains which the assessor had to select. For the new trial version this has been extended so that the assessor is asked to consider all five train types to collect the complete risk associated with all passing trains.

The number of passing trains can generally be estimated reliably from the local timetables, although where there is more than one option for platform selection this can be slightly more complicated. The number of non-stopping passenger and freight trains can be more difficult to estimate for each platform. However, it is considered realistic that staff with a reasonable amount of local

knowledge will be able to make suitable judgements for their station and freight traffic levels can be obtained from Network Rail [Ref 4].

Additionally, selecting an appropriate passing speed can be difficult at some locations where the maximum linespeed might be relatively high but where, in practice, trains pass much more slowly due to local features such as junctions and gradients, or even local operating characteristics and signalling arrangements. Again, it is considered realistic that staff with a reasonable amount of local knowledge will be able to make suitable judgements on these aspects.

The output of the assessment method is a numerical comparative indication of risk in the form of a risk score (generally between 0 and 400, although higher values could, in theory, be possible). The score represents the level of risk for each assessed platform associated with the aerodynamic effects of passing trains according to the parameters listed above.

3.1.2 Part 2 qualitative assessment

The BRR risk assessment methodology which has been the subject of the desktop trials did not originally take into account details of mitigation measures. As part of the review of the method, however, it was considered useful to begin to capture, at least qualitatively, risk shaping factors and risk mitigation measures that are relevant to understanding the risk associated with passing trains, but which have not been directly included in the scope of this work. These include:

- Specific platform infrastructure details
- Staffing arrangements
- Passenger behaviour and management
- Available mitigation measures

A full list of the identified platform risk shaping factors and mitigation measures is shown in Appendix C.

Although it was not within the scope of this work package to quantify the effects of the risk shaping factors and mitigation measures, this could be considered for future work.

3.1.3 BRR assessment method conclusion

The results of the review are that the method can be considered useful and generally suitable for purpose, but with limitations.

The method can be considered to be a useful tool within the wider context of a full risk management process which should take into account issues such as those captured in the risk shaping factors and mitigation measures (as listed in Appendix C). These lists could be considered for further development and/or risk quantification.

The assessment method results are limited in that the output risk score cannot be considered as an indication of absolute risk as it does not relate directly to a fully quantified measure of risk, such as Fatalities and Weighted Injuries per year (FWI/year). The use of the risk score is limited to providing a relative comparison of risk between two platforms. This makes it difficult to use in a detailed Cost Benefit Analysis but would allow an assessor to filter and prioritise efforts on higher risk platforms.

3.2 Trial assessments

3.2.1 Selection of stations

The assessment methodology was used on a number of trial stations. These stations were chosen on the basis of their representing as wide a range of conditions as practicable. They included those stations at which high levels of freight traffic are experienced and therefore where there is an increased slipstream risk. They also included a number of stations where aerodynamic risk incidents have occurred.

Table 1 - Stations selected for trial assessments

Station	Description
Apsley	West coast south, four platforms, high levels of freight traffic (London/North), record of aerodynamic risk incident
Berkhamsted	West coast south, four platforms, high levels of freight traffic (London/North), high levels of stopping trains, record of aerodynamic risk incident

Table 1 - Stations selected for trial assessments

Station	Description
Bletchley	West coast south, six platforms, high levels of freight traffic (London/North), high levels of stopping trains, records of two aerodynamic risk incidents
Long Buckby	West coast, two platforms (stopping and passing trains using the same platforms, no segregation), high levels of freight traffic (London/North), record of aerodynamic risk incident
Oxenholme	West coast north, three platforms, medium levels of freight traffic, record of aerodynamic risk incident
Newark North Gate	East coast, three platforms, medium levels of freight traffic, record of aerodynamic risk incident
Barnetby	Doncaster-Grimsby, four platforms, very high levels of freight traffic
Goring & Streatley	Reading-Oxford, four platforms, medium levels of freight traffic (Southampton/North)
Winchester	Southampton-Basingstoke, two platforms (stopping and passing trains using the same platforms, no segregation), high levels of freight traffic (Southampton/London & North), record of aerodynamic risk incident
Bellingham	Inner London station, two platforms (stopping and passing trains using the same platforms, no segregation), medium levels of freight traffic, high levels of stopping trains, record of aerodynamic risk incident
Shenfield	Outer London station, five platforms, high levels of freight traffic, very high levels of stopping trains

3.2.2 Desktop assessment results

In total, desktop trial assessments were carried out for 39 platforms at the 11 different stations chosen to represent a spread of conditions and traffic patterns. The results, in the form of comparative risk scores, are shown in Appendix D. The results have been ordered by risk assessment score, and results have been presented in risk bands: high, medium, low risk. These should be taken as an indication of comparative risk levels rather than absolute risk values. As such the risk scores and bands give an indication of the level of underlying risk at each platform due to the aerodynamic effects of passing trains. It should be noted that these values represent the unmitigated risk, ie. they do not take into account risk reduction measures such as the presence of yellow lines and automatic warning systems. These features should also be included when considering the full risk context.

3.2.3 Site visits and sensitivity analysis

Following the initial set of trial assessments the following stations were selected for site visits to validate the desktop assessment approach: Apsley, Berkhamsted, Bletchley and Shenfield. The 19 platforms at these stations were considered to represent a spread of station and traffic characteristics. In conjunction with interviews with local staff, the site visits enabled first hand observation of aerodynamic effects and review of the assumptions made in the theoretically based desktop trials.

Subsequent to the visits all the desktop assessment results were revisited and assumptions refined to produce a more accurate and valid set of results based on local knowledge. In addition, it was also possible during the visits to capture feedback from station staff on the practicality and usability of the assessment method. The results shown in Appendix D are the final assessment results revised following the station visits.

3.3 Workshop

3.3.1 Initial workshop approach and conclusions

A workshop was organised to review, refine and validate the findings of the desktop trial risk assessments and to confirm the validity of the methodology and its future use. The intention was also to allow key stakeholders to gain an appreciation of the nature of the assessment methodology, including its strengths and weaknesses, in order to form an opinion on its usefulness and suitability for implementation.

The workshop focused on the following areas:

- Testing and validating the desktop studies, considering assumptions and usability, for example.
- Interpreting the results of the methodology, eg in terms of levels of risk.
- Considering qualitative aspects of the risk assessment process, eg available mitigation measures.

The objective of the workshop was to obtain an opinion of:

- The validity of the methodology and its future use.
- The assessment method results and how they could/should be used.
- How the method might be enhanced or further developed in future.

Exercises were carried out to allow workshop members to experience the assessment methodology from first principles, and to allow them to understand its shortfalls and difficulties in application.

The assessment exercises also generated wider discussion on the safety management of risk due to the aerodynamic effects of passing trains. There was general agreement on the need for a common risk assessment methodology.

3.3.2 Post-workshop supplementary work

Following the workshop, stakeholders were invited to further test the method by themselves using additional trial material and to give feedback. In addition, a further exercise was carried out to extend part of the methodology which was found to be limited - the consideration of mitigation factors. An extended list of mitigation measures available to mitigate against the aerodynamic effects of passing trains was developed (both during the workshop and using post-workshop feedback). This was analysed to estimate the effectiveness of each mitigation measure in reducing the risk, the cost and effort to implement each mitigation measure, and recommendations on when the mitigation measures should be considered for implementation depending on the output of the risk assessment methodology for each platform. In this way, this provides the elements of a rudimentary cost-benefit analysis, which provides a practical context to the theoretical assessment results.

The results of the mitigation measures analysis can be found in Appendix E.

3.3.3 Workshop conclusions

Comments that were captured during the workshop and the post-workshop exercise have been combined in Appendix F. Six comments relate to suggestions on possible future changes to the assessment methodology. Fifteen comments relate to issues which should be taken into account when writing the guidance on how to apply the assessment method. Fourteen comments relate to general comments on management of relevant mitigation measures within the wider station safety management system.

Generally the current assessment method was considered by stakeholders to be a workable method. It was noted that there is scope for confusion in its application and that this should be mitigated by the development of suitable guidance to aid interpretation and to ensure consistency in assessment. The guidance should also give advice on how to interpret and use the results of the assessment methodology.

4 Conclusion

4.1 Overall work package conclusion

This work package has successfully proven the suitability of the original BRR risk assessment model for station platforms to provide a satisfactory semi-quantitative method for undertaking the aerodynamic platform risk assessment referred to in GI/RT7016. It has been presented to key stakeholders who have supported the development of the assessment methodology for inclusion in GI/RT7016 as a standards change project. The work package has also highlighted the limitations within the assessment methodology as it stands which should be considered when developing the final version for publication, and specifically in developing guidance on the assessment method, to ensure consistent and meaningful results. The work package also identified a number of assessment method issues which could be considered in future to refine and enhance the method.

In parallel with this work on the assessment of aerodynamic risk, recent work has also been carried out on RIS-3703 [Ref 5], concerning the assessment of platform-train interface (PTI) risk due to other causes (crowding for example). There are a number of features and mitigation measures that are shared between these two areas of risk which ideally should be considered in an integrated manner. Therefore, it would be beneficial to aim to

develop a common risk assessment methodology for platform risk as a future improvement stage.

4.2 Future work

As a result of the findings of this work package the following recommendations are made for further work; they can be considered as two stages:

4.2.1 Update Group Standard GI/RT7016

Group Standard GI/RT7016 should be updated to include the new reviewed and revised risk assessment method, with associated guidance and a downloadable assessment tool for use by assessors. Appendix F contains a record of comments and issues that have been raised during this work, especially from the stakeholder workshop. Comments indicated as guidance related may be useful when developing the guidance material.

4.2.2 Enhance method and combine with PTI risk assessment

Once implemented and embedded within the industry, the need for review and improvement of the method should be considered, taking into account the comments concerning options for enhancement recorded as part of this work package (see Appendix F). Additionally, consideration should be made to investigate the optimum way of integrating aerodynamic and platform-train interface risk into a combined station platform risk assessment methodology.

5 References

Ref 1 T425 'Effective management of risk from slipstream effects at trackside and platforms', published in 2007, http://www.rssb.co.uk/RESEARCH/Lists/DispForm_Custom.aspx?ID=531

Ref 2 Railway Group Standard GI/RT7016 on 'Interface between Station Platforms, Track and Trains', Issue 4, September 2010, http://www.rgsonline.co.uk/Railway_Group_Standards/Infrastructure/Railway%20Group%20Standards/GIRT7016%20Iss%204.pdf

Ref 3 Guidance on Protecting Perople from the Aerodynamic Effects of Passing Trains - Phase I Review, Roger Gawthorpe, 14 May 2009

Ref4 For national freight overview and freight specialist advice contact the Freight Development Manager, Network Rail, freight contacts, http://www.networkrail.co.uk/aspx/10451.aspx

Ref 5 RIS-3703-TOM, Rail Industry Standard for Passenger Train Dispatch and Platform Safety Measures, Issue 1, June 2011, http://www.rgsonline.co.uk/Railway_Group_Standards/Traffic%20Operation%20and%20Management/Rail%20Industry%20Standards/RIS-3703-TOM%20Iss%201.pdf

Appendix A: Example risk assessment tool sheet

The following assessment sheet contains a sample of the information that is required to use the assessment method to produce a 'Total Platform Unmitigated Risk Score' for each platform.

Assessment details	
Station name	Berkhamsted
Platform	Platform 3
Assessment completed by	Assessor's Name
Assessment date	14 July 2011

Station Characteristics	Answer	Weighting	Notes	
Is the platform a bay platform?	No		Yes or no?	Indicates if assessment is required
Does non-stopping traffic pass adjacent to the platform?	Yes		Yes or no?	
What is the geographical location factor for the station (see guidance map)?	Low	4	Low, Medium, High? (see map for location factor)	
What are the platform layout and wind exposure characteristics?	Open	1	Open, Intermediate, Enclosed? (see table)	

Stopping trains	Number of passenger trains stopping at the platform on a typically busy day	Weighting	Notes
Number of stopping passenger trains during a typical busy day	87	87	Estimated based on information given (weighting is actual estimated number of trains per day)

Passing trains (complete for each train type)	Number of trains passing without stopping on a typically busy day	Weighting	Highest typical train passing speed for each type (see table for speed bands)	Weighting
Road vehicle-carrying train (Ford transit van carrier, cartic, carflat etc) with the load exposed	3	0.59	Greater than 65 mph but less than or equal to 75 mph	32
Freightliner / Flat-bedded wagons with vertical ends	32	0.36	Greater than 65 mph but less than or equal to 75 mph	32
Freight train other than those above (tankers, hopper wagons etc)	10	0.28	Greater than 65 mph but less than or equal to 75 mph	32
Multiple unit / loco-hauled passenger train	0	-	-	-
High speed passenger train (HST, IC225, Eurostar etc)	0	-	-	-

Assessment Results	Train Type Risk Scores
Road vehicle-carrying train (Ford transit van carrier, cartic, carflat etc) with the load exposed	94.09
Freightliner / Flat-bedded wagons with vertical ends	125.72
Freight train other than those above (tankers, hopper wagons etc)	36.04
Multiple unit / loco-hauled passenger train	0
High speed passenger train (HST, IC225, Eurostar etc)	0
Total Platform Unmitigated Risk Score	**326**

Assessment assumptions / queries / unknowns
Canopy covers only part of the platform, mostly open railings. Platform 3 not considered to be an island platform (with Platform 2) as there is significant barrier separation between the two sides of the platform.

Appendix B: Risk assessment quantified methodology

This appendix contains the calculation tables which form the assessment methodology.

Weighting factors

The following weighting factors are used in the assessment formulae. They were developed by BRR for the original assessment methodology. The reference letters in parentheses are used in the formula.

Geographical location lookup table		(E)
Region		**Weighting**
Low (L)	See geographical location map	4
Medium (M)		4.4
High (H)		4.8

Platform layout lookup table		(F)
Summary	**Description**	**Weighting**
Open	Open platforms, possibly with low rear wall/fence and simple shelters	1
Intermediate	Any other platform layout (eg platform with high rear wall/ fence but no canopy OR platform with canopy but no rear wall)	0.5
Enclosed	Platform with rear wall/ buildings and canopy	0.8

Number of stopping passenger trains	(G)
Description	Weighting
Actual number of stopping trains	No. of trains per day

Train type lookup table		(A)
Train Type		**Weighting**
Road vehicle-carrying train (Ford transit van carrier, cartic, carflat etc) with the load exposed	Autos	0.59
Freightliner / Flat-bedded wagons with vertical ends	Containers	0.36
Freight train other than those above (tankers, hopper wagons etc)	Others	0.28
Multiple unit / loco-hauled passenger train	Regional, etc.	0.19
High speed passenger train (HST, IC225, Eurostar etc)	Intercity, etc.	0.17

Train speed lookup table	(C)
Train Passing Speed	**Weighting**
Less than or equal to 45 mph	17
Greater than 45 mph but less than or equal to 55 mph	22
Greater than 55 mph but less than or equal to 65 mph	27
Greater than 65 mph but less than or equal to 75 mph	32
Above 75 mph	36

Geographical location map

The initial geographical location weighting is taken from the approximate location of the station on the map in Figure 1.

Figure 1 - Map of stations used for location weighting

Assessment calculation sheet

The following table is used in conjunction with the weightings table to calculate the individual risk scores for each passing traffic type. The trial Excel assessment tool performs these calculations automatically.

	(A)	(C)	1. = (AxC)	2. = (0.03xCxExF)	3. = (1.+2.)	Number of non-stop/ passing trains per day factor (I)			4. = (3.x3.xGxI)	5. = (4. / 200)
Passing Train Type	**Weighting**	**Passing Train Speed weighting for platform**				**1-5 trains per day**	**6-20 trains per day**	**More than 20 trains per day**		**Individual train type risk score**
Road vehicle-carrying train (Ford transit van carrier, cartic, carflat etc) with the load exposed	0 .59					0.5	1.2	2		
Freightliner / Flat-bedded wagons with vertical ends	0.36					0.4	0.9	1.6		
Freight train other than those above (tankers, hopper wagons etc)	0.28					0.3	0.7	1.2		
Multiple unit / loco-hauled passenger train	0.19					0.2	0.5	0.8		
High speed passenger train (HST, IC225, Eurostar etc)	0.17					0.1	0.3	0.5		

Total Platform Risk Score (sum of individual risk scores)	

Appendix C: Platform risk shaping factors

A number of platform characteristics are not currently included in the quantified part of the original BRR assessment method. However, it is considered beneficial to record relevant information from the following lists in order to understand the fuller risk context. Some of these factors are already the subject of platform standards; some could be further developed and/or clarified in future work.

C1. Platform risk shaping factors

Infrastructure:

- Platform length (m)
- Platform width (m)
- Platform area unusable by passengers?
- Platform area usable by passengers?
- Is the platform an island platform?
- Is the platform straight, convex, concave?
- Is the line bidirectional?
- Is the view of approaching trains obscured (eg due to line curvature, foliage or infrastructure?)
- Is the platform flat or sloped towards or away from the platform edge?

Staff:

- Is the platform staffed at all times?
- Is the platform staffed at peak times only?
- Is the platform always unstaffed?
- Number of staff on platform at any one time (during typical busy period)?

Crowds:

- Is platform crowding ever a significant issue?
- Have there been any previous near-miss incidents at the platform?
- Are there ever any local special events, eg football matches, concert venues?
- Is there a high number of holiday makers with luggage?
- Is there a high number of children/elderly?
- Is there a high number of trolleys/buggies/etc?
- Are there any especially narrow or constricted parts of platform?
- Is there ever an uneven spread of waiting passengers due to platform layout, covered areas, location of information panels, etc?

C2. Platform risk mitigation measures

In order to form a complete understanding of the risk at a platform the existing mitigation measures should be recorded where in place. It should be noted, however, that the current risk assessment methodology does not take these into account and only gives an underlying unmitigated total risk score. Some or all of the following may be relevant to a platform assessment and highlight measures which may already be in place or may be considered for future implementation. Some measures will be more practical to implement than others, eg use of the train horn on approach to every station is

probably impractical to implement due to noise issues. However the following can be considered a full list of all theoretically available mitigation measures for aerodynamic risk in stations.

Improving passenger perception of risk:

- Platform edge white line
- Tactile paving
- Platform yellow line (presence and position)

Educating passengers on aerodynamic risk:

- Aerodynamic risk warning signage
- Temporary education campaigns (eg posters)
- Targeting of pushchair users with 'best practice' information

Warning passengers:

- PA system
- Automated warning announcements
- Train horn on approach

Physical separation:

- Platform separation (eg barriers, fencing, etc.)
- Waiting rooms/shelters
- Complete platform edge barrier (eg LUL Jubilee line)

Monitoring and intervention:

- Platform staff presence at all times
- Platform staff presence at peak times only
- CCTV monitoring
- Crowd management plan, number of waiting passengers on platform controlled, etc.

Managing crowd positions:

- Extend platform canopy (to encourage use of whole platform)
- Yellow hatching on platform (to discourage bunching of waiting passengers)
- Optimise location of CIS system (to encourage use of whole platform)
- Optimise stopping train position

Managing train traffic:

- Reduction in speed of passing passenger trains
- Reduction in speed of passing freight trains
- Send freight through at off peak
- Divert passing traffic on to non platform line (if available)

Rolling stock:

- Retrospective aerodynamic improvement of existing trains
- Improved aerodynamic design of new trains

Appendix D: Trial assessment results

The following is a summary of the 39 desktop trial risk assessments that were carried out for the 11 selected stations. They have been allocated to High, Medium and Low indicative risk bands to aid comparison. NB. The thresholds for the High/Medium/Low Risk bands shown below should only be considered as a preliminary evaluation and as such should be reviewed and confirmed before being included in guidance material.

Station	Platform	Risk Score	Risk	Risk range
Bletchley	1	0	LOW	<50
Bletchley	6	0		
Goring & Streatley	1	0		
Apsley	1	1		
Berkhamsted	1	3		
Berkhamsted	2	3		
Shenfield	5	14		
Barnetby	1	38		
Barnetby	2	38		
Barnetby	3	38		
Barnetby	4	38		
Bellingham	1	72	MEDIUM	50-200
Bellingham	2	72		
Goring & Streatley	4	74		
Goring & Streatley	2	91		
Goring & Streatley	3	91		
Newark North Gate	1	97		
Oxenholme	1	118		
Newark North Gate	2	144		
Newark North Gate	3	144		

Station	Platform	Risk Score	Risk	Risk range
Apsley	4	150	MEDIUM	50-200
Long Buckby	1	150		
Long Buckby	2	150		
Apsley	3	157		
Apsley	2	176		
Oxenholme	2	190		
Oxenholme	3	190		
Shenfield	1	244	HIGH	200+
Shenfield	2	244		
Berkhamsted	4	256		
Shenfield	3	283		
Shenfield	4	283		
Winchester	1	318		
Winchester	2	318		
Berkhamsted	3	326		
Bletchley	5	341		
Bletchley	2	362		
Bletchley	3	362		
Bletchley	4	364		

Appendix E: Mitigation measures analysis

The following table indicates a list of identified measures which may possibly mitigate against the risk of the aerodynamic effects of passing trains. Each measure has been given an estimated effectiveness rating, as well as ratings indicating how costly and difficult each one would be to implement. In addition there is an indication of whether the measure should be considered for a platform that has been assessed to be high, medium or low risk for the aerodynamic effects of passing trains. It should be noted that these evaluations relate only to the control of risk associated with the aerodynamic effects of passing trains. Some measures will be also relevant to controlling other sources of platform risk and, as such, implementation of mitigation measures should be considered in the context of the whole platform risk.

NOTES: These values should only be considered as preliminary evaluations and should be reviewed and confirmed before being included in guidance material. Some measures are only fully effective when used in combination with other measures. Some measures will be more practical to implement than others, eg use of the train horn on approach to every station is probably impractical to implement due to noise issues. When considering implementing a measure to control aerodynamic risk, care should be taken not to introduce possible new hazards, for instance due to increased signaller workload, or increased crowding effects.

ID	Mitigation Measures	Risk Reduction Effectiveness	Implementation		Guidance on which measures should be implemented (to mitigate aerodynamic risk):			NOTES
			Cost	Difficulty				
		High/Medium / Low	High/ Medium / Low	High/ Medium / Low	High risk platform	Medium risk platform	Low risk platform	
A	**Improving passenger perception of risk**							
1	Platform edge white line	Low	Low	Low	Recommended	Recommended	Recommended	Importance to enhance awareness of platform edge. (Currently mandated in GI/RT7016.)

ID	Mitigation Measures	Risk Reduction Effectiveness	Implementation		Guidance on which measures should be implemented (to mitigate aerodynamic risk):			NOTES
		High/Medium / Low	Cost High/ Medium / Low	Difficulty High/ Medium / Low	High risk platform	Medium risk platform	Low risk platform	
2	Tactile paving	Medium	Medium	Medium	Recommended	Recommended	Recommended	NB. In fact this measure is a requirement to mitigate other, non-aerodynamic, platform risk. (Currently mandated in GI/RT7016.)
3	Platform yellow line	Medium	Low	Low	Recommended	Recommended	Recommended	Good practice to instil importance of keeping well back from platform edge. (Currently mandated in GI/RT7016.)
B	**Educating passengers on aerodynamic risk**							
4	Aerodynamic risk warning signage	Medium	Low	Low	Recommended	Recommended	Recommended	Good practice to instil importance of keeping well back from platform edge. (Currently mandated in GI/RT7016.)
5	Temporary education campaigns (eg posters)	Medium	Low	Low	Recommended	Recommended	Recommended	Good practice to instil importance of keeping well back from platform edge.

ID	Mitigation Measures	Risk Reduction Effectiveness	Implementation		Guidance on which measures should be implemented (to mitigate aerodynamic risk):			NOTES
			Cost	Difficulty				
		High/Medium / Low	High/ Medium / Low	High/ Medium / Low	High risk platform	Medium risk platform	Low risk platform	
6	Targeting of pushchair users with 'best practice' information	High	Low	Low	Recommended	Recommended	Optional	Safety leaflets given out when buying tickets
C	Warning passengers							
7	PA system	High	Low	Low	Recommended	Recommended	Optional	Good general measure to improve public awareness and reduce risk
8	Automated warning announcements	High	Low	Low	Recommended	Recommended	Optional	Good general measure to improve public awareness and reduce risk
9	Train horn on approach	High	Low	Medium	Optional	Optional	Not required (for aerodynamic risk)	Probably impractical to implement in most circumstances due to noise issues

ID	Mitigation Measures	Risk Reduction Effectiveness	Implementation		Guidance on which measures should be implemented (to mitigate aerodynamic risk):			NOTES
			Cost	Difficulty				
		High/Medium / Low	High/ Medium / Low	High/ Medium / Low	High risk platform	Medium risk platform	Low risk platform	
D	**Physical separation**							
10	Platform separation (eg barriers, fencing, etc.)	High	High	High	Optional	Not required (for aerodynamic risk)	Not required (for aerodynamic risk)	Reconsider for new high speed lines/upgrades
11	Waiting rooms/ shelters	Medium	Medium	Medium	Optional	Optional	Not required (for aerodynamic risk)	Reconsider for new high speed lines/upgrades
12	Complete platform edge barrier (eg LUL Jubilee line)	High	High	High	Optional	Not required (for aerodynamic risk)	Not required (for aerodynamic risk)	Reconsider for new high speed lines/upgrades
E	**Monitoring and intervention**							
13	Platform staff presence at all times	High	High	High	Optional	Not required (for aerodynamic risk)	Not required (for aerodynamic risk)	
14	Platform staff presence at peak times only	Medium	Medium	Medium	Optional	Optional	Not required (for aerodynamic risk)	

ID	Mitigation Measures	Risk Reduction Effectiveness	Implementation		Guidance on which measures should be implemented (to mitigate aerodynamic risk):			NOTES
			Cost	Difficulty				
		High/Medium / Low	High/ Medium / Low	High/ Medium / Low	High risk platform	Medium risk platform	Low risk platform	
15	CCTV monitoring	Medium	High	Medium	Recommended	Optional	Not required (for aerodynamic risk)	
16	Crowd management plan, number of waiting passengers on platform controlled, etc.	High	Medium	Medium	Recommended	Optional	Not required (for aerodynamic risk)	
F	**Managing crowd positions**							
17	Extend platform canopy (to encourage use of whole platform)	Medium	High	High	Optional	Not required (for aerodynamic risk)	Not required (for aerodynamic risk)	Effect of extending canopy unclear. Need to confirm physical benefit.
18	Yellow hatching on platform (to discourage bunching of waiting passengers)	Medium	Medium	Medium	Optional	Optional	Not required (for aerodynamic risk)	May be strong case for heavily used platform.

ID	Mitigation Measures	Risk Reduction Effectiveness	Implementation		Guidance on which measures should be implemented (to mitigate aerodynamic risk):			NOTES
			Cost	Difficulty				
		High/Medium / Low	High/ Medium / Low	High/ Medium / Low	High risk platform	Medium risk platform	Low risk platform	
19	Optimise location of CIS system (to encourage use of whole platform)	Medium	Medium	Medium	Optional	Optional	Not required (for aerodynamic risk)	
20	Optimise stopping train position	Medium	Medium	High	Optional	Optional	Not required (for aerodynamic risk)	May be some benefit if stopping can be arranged in more sheltered part of platform area.
G	**Managing train traffic**							
21	Reduction in speed of passing passenger trains	High	High	Medium	Optional	Optional	Not required (for aerodynamic risk)	Probably commercially and operationally undesirable, but significant effect on reducing risk.
22	Reduction in speed of passing freight trains	High	High	Medium	Recommended	Optional	Not required (for aerodynamic risk)	Probably commercially and operationally undesirable, but significant effect on reducing risk.

ID	Mitigation Measures	Risk Reduction Effectiveness	Implementation		Guidance on which measures should be implemented (to mitigate aerodynamic risk):			NOTES
		High/Medium / Low	Cost High/ Medium / Low	Difficulty High/ Medium / Low	High risk platform	Medium risk platform	Low risk platform	
23	Send freight through at off peak	Medium	High	High	Optional	Optional	Not required (for aerodynamic risk)	
24	Divert passing traffic on to non platform line (if available)	High	Medium	High	Recommended	Optional	Not required (for aerodynamic risk)	
H	**Rolling stock**							
25	Retrospective aerodynamic improvement of existing trains	High	High	High	Optional	Not required (for aerodynamic risk)	Not required (for aerodynamic risk)	Not easy to undertake but may be possible for some types of train which pose the greatest risks (cover in trains that transport vans)
26	Improved aerodynamic design of new trains	High	Medium	Medium	Recommended	Optional	Not required (for aerodynamic risk)	Probably economic to do for new build. Important for high speed lines and upgrades for increased speed.

Appendix F: Workshop feedback

The following table contains comments and issues identified during the assessment workshop and in follow-up work. They generally relate to three aspects:

- The method
- The guidance to be developed for using the method
- General issues concerning possible mitigation measures

They may be considered useful in development of future versions of the method. The comments concerning guidance material should be considered when developing the material.

ID	Comment	Issue
1	Platform 'openness' can be difficult to assess on account of the variability of the structures present. Perhaps this issue could be looked at in more detail.	method/ guidance
2	General exposure of the station needs to be considered. Some station platforms are on embankments and the interactive effect of ambient winds with train slipstreams could be significant. Indeed in some cases, winds could be a greater hazard than the slipstreams of trains.	method/ guidance
3	The case for the more expensive mitigation measures (eg platform barriers) will become more compelling as speeds increase. Perhaps there could be some classification into three groups: • existing lines • upgrades for increased speeds • new high speed lines	mitigation
4	Consideration might be given to a broader scale of assessment, from 1 - 5, say, for effectiveness, cost, implementation.	mitigation
5	Any thoughts on confirming the validity of the slipstream velocity exposure limit?	method
6	For island platforms, for example for Platforms 1 & 2 at Shenfield, firm advice needs to be given as to whether the number of stopping trains per day for either platform should be the total for both platforms or not. For narrower and open island platforms which are busy, the answer should be 'yes' (due to waiting passengers migrating onto both platforms) whereas, for wider island platforms (particularly those having extensive buildings separating the 2 platforms), then the answer is likely to be 'no'.	guidance
7	On the 'Station Notes' sheet, the traffic info is defined as the numbers per day, in each direction. This is confusing as it suggests traffic is passing in both directions on each platform. If this is not the case, then I suggest you omit 'in each direction'.	method/ guidance

ID	Comment	Issue
8	As an overall comment, I think the general User will need more guidance as to how to assess certain platform situations which fall outside the 'typical' cases.	guidance
9	The platform loading / station use - you could crudely mathematically relate this to the ORR station usage stats with the overall station use risk value being multiplied by station users	method
10	The platform width for the majority of the platform length (2m or less, 2.5m , over 2.5m)	method
11	If the station is an interchange point - slight weighting upwards of risk for interchanges to reflect the fact passengers may linger on platforms	method
12	A weighting to reflect the amount of platform covered (guestimated percentage) to take account of the fact people crowd under shelter in rain, ultimately pushing some people towards the platform edge thus placing them at risk.	method
13	A view was expressed that the arguments for yellow lines on some sections of track where trains passed at up to 100mile/h were unclear and confusing	mitigation
14	There was much discussion about layout of stations/platforms with regard to 'crowding' and the inferred dangers from it. People accumulate at the top of stairways/lifts and gather under canopies if raining. A 'pass right down the bus' request could be a help in some circumstances. Also, crowding can be highly variable with time of day	mitigation
15	Since a cautionary message of 'turbulence from slipstreams' is now often shown on the platform-based CIS (Customer Information System), care in optimum positioning of the CIS screens is important	mitigation
16	With regard to Workshop Exercise 1: Choice of factor F difficult when you have a variation down the platform: part-length canopies, local shielding from buildings, walls, etc. Which value for F do you take - the worst case, the most prevalent situation along the platform, or the situation where most people will congregate?	guidance
17	Need more specific traffic info with respect to which types of train pass which platforms. View expressed that local knowledge will be most accurate but there are also good arguments for using a small team of assessors who will be expert at interpreting the questionnaire/rating method but not so knowledgeable of local information.	guidance

ID	Comment	Issue
18	The particular case was mentioned of *narrow* island platforms where people on both platforms are affected by traffic on each line. Shouldn't a question on this point be included in the 'Other relevant platform Information' part of the assessment? [This would need to include a qualifying threshold value of maximum island platform width]	guidance
19	Wind exposure factor needs careful assessment and would benefit from more guidance. A view that a category of 'close to open sea' is warranted as this situation produces consistently high winds from that direction. There may be other important situations involving local effects	guidance
20	The question was raised of using local staff knowledge to rate severe operating cases (with the result that the official rating procedure is ignored). Strongly suggested that this practice is to be discouraged as, without a recognised quantitative procedure, local worst cases cannot be compared on a network-wide basis.	guidance
21	Case was raised of what to do in a situation where a four-track operation through a station is cut down to two platforms due to possessions on the other two. Though a temporary situation, this could go on for some time (months?) and the increased traffic through two platforms may warrant their own mitigation assessment for that period	guidance
22	Consideration needs to be made of the effects of poor weather which causes people to gather under limited canopy space. This relates also to other aspects of platform layout such as stairs, lifts, entrances/exits, etc.	mitigation
23	The question was raised as to how ALARP worked under circumstances of mitigation choice. Similarly, if a CBA is undertaken in particular cases, what is the implication for ALARP?	mitigation
24	Question raised about how to choose the optimum mitigation in particular circumstances - advice will be needed	guidance
25	Suggestion that LUL-type platform barriers might be an option to be considered	mitigation
26	Regarding public-address announcements, it was said that these were becoming less effective due to being shrouded by other noise, people listening to mobiles/iPods, etc	mitigation
27	Claimed that there is still a lack of clarity about the use and justification of yellow lines on platforms having lower speed traffic. Where should people walk if crowded behind the yellow line, etc? Education needed.	mitigation

ID	Comment	Issue
28	Confusion due to the proliferation of lines: white lines, blue lines *and* yellow lines	mitigation
29	Now recognised by railway managers that there is a need for yellow lines on platforms having high speed freight	mitigation
30	There are still inconsistencies with the position of some yellow lines from the platform edge	mitigation
31	If yellow lines are removed in some circumstances, there may be litigation implications	mitigation
32	View expressed that some platforms may be assessed to have a low or medium risk overall but that, actually, one severe train passing once a day at a busy time could in itself constitute a serious risk. In that case, addressing and mitigating that particular daily event (eg by providing an increased station staff presence) could avoid or significantly reduce the mitigating action for that platform in general	guidance
33	However, employing too much subjectivity in the identification of a special case should be avoided. The method would itself need to cater for special cases in some way	guidance
34	It was proposed that the reporting form for these aerodynamic incidents should be reviewed to include all the relevant detail and to help the reporter on how to express it	guidance
35	Since the regular and exactly repeated messages over public address and CIS are in danger of sinking into the mind's subconscious of a waiting passenger, the sounding of the driver's horn when approaching a crowded platform becomes more valuable - and should be revisited as a worthwhile action.	mitigation
36	Regarding questions raised about how to choose the optimum mitigation in particular circumstances. Basically, this will be a matter of choosing a mitigation measure and then recalculating. But help will be needed in that initial, and subsequent, choice. This would be probably best done by a block diagram method starting off with the cheapest effective Measures (eg signage/yellow lines, public address announcements, poster campaign) and, if risk number still too high, move on to the others in some cost-effective order depending on the circumstances.	method

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