NETWORK RAIL

0-12MP RSR Exemption

Options Selection Report

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AMENDMENT HISTORY

Version	Sections	Amendment Details
0.0x	All	Draft. v0.01 issued to NR on 6/3/19 for information purposes.
1.0	All	First Issue
1.1	All	Second issue following review by Options Selection Meeting attendees, see change bars.
1.2	4, 5	Amendments following review by NR team

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1. INTRODUCTION AND PURPOSE

1.1 INTRODUCTION

This document summarises the outputs of an Option Selection meeting, held on the 21st February 2019 to consider options for the future operation of the GWML with delays to the anticipated ETCS L2 overlay. The delay to ETCS and the proposed rolling stock may result in the need to produce an exemption against the Railway Safety Regulations 1999 (ref. 1), in a similar manner to the exemption already in place in the same area (ref. 2).

The purpose of the meeting was to confirm the available options and to assess them against an agreed set of criteria. The meeting was supported by the issue of a Briefing Document (ref. 4).

It should be kept in mind that the scope of this document is Paddington buffers i.e. 0mp/ transition point from Crossrail CBTC system to the Area A L2 ETCS transition on approach to Heathrow tunnels (approx. 12mp) only.

1.2 PURPOSE

The purpose of this document is to report the outcome of the Options Selection Meeting. The meeting had the following agenda:

1) Introductions and establishment of quoracy i.e. if relevant expertise is present in the room to enable a comprehensive output
2) Agreement of the Options - are the Options complete and are any missing?
3) Acceptance/ Modification of Criteria
4) Acceptance/ Rejection of initial decision by VSE to eliminate Options
5) Assessment of Options against Criteria
6) Selection of final Option or Options
7) Identification of new hazards should the final Option or options be implemented

2. REFINEMENT OF OPTIONS AND ASSESSMENT CRITERIA

2.1 REFINEMENT OF OPTIONS

The attendees were asked to confirm if the list of options presented in the Briefing Document (ref. 4) were comprehensive. It was noted that:

1) Options that had been rejected as part of the 2015 exemption application were not included in the list. These options are already discounted due to their obvious impracticality e.g. build new lines to separate non-ATP traffic from ATP traffic, extend CBTC signalling for Crossrail traffic
2) Timetable changes i.e. reducing number of non-ATP trains could be used as an option. This approach can be used as a mitigation for all the carried forward options and is not considered as an Option in its own right. Taken to an extreme, this would result in either no service or service with only ATP-stock (equivalent to Option 3).

2.2 REFINEMENT OF ASSESSMENT CRITERIA

The criteria proposed in the Briefing document (ref. 4) were discussed and resulted in the following amended list of criteria being adopted.

1) RSR Exemption required and for what duration?
2) TT1 Quantified Overall Safety Risk (Sotera: FWI per year)
3) TT2 Quantified Overall Safety Risk (Sotera: FWI per year)
4) TT3 Quantified Overall Safety Risk (Sotera: FWI per year)
5) Feasible to deliver works required for an exemption prior to Dec 19?
6) Technically feasible, irrespective of time frame?
7) Safety benefits (not quantified in Sotera report)
8) Safety disbenefits (not quantified in Sotera report)
9) Non-safety benefits
10) Non-safety disbenefits
11) Further potential mitigations to reduce safety risks
12) Costs (capital, maintenance, operational)
13) Impact to other parties (e.g. ToCs, maintainer)
14) Critical assumptions
15) Degraded/emergency mode risks
16) Confirmed for elimination at Options Selection workshop?

2.3 ENDORSEMENT OF OPTIONS FOR REJECTION

The group considered the options proposed for rejection prior to the meeting by Vertex within the Briefing Document (ref. 4). The following Options were confirmed as rejected prior to more detailed analysis against the Criteria:

No.	Description	Reasons for Rejection
Option 2	Do Nothing to the existing infrastructure and fit ATP to Crossrail and HEX service trains (Class 345 and 387)	Fitment of ATP to existing stock has been considered by both Crossrail (for Class 345, ref. 5) and GWR (for Class 387, ref. 6). Both ToCs conclude that retrofitting ATP is highly undesirable, is likely to be unachievable prior to Dec 2019 and will carry substantial costs of several million pounds that alone are grossly disproportionate to the safety risk. This opinion was shared by the wider group. Retrofitting will also have ergonomic and driver training impacts that are undesirable to ToCs.
Option 2a	Do nothing to the existing infrastructure and fit ATP to Class 345 Crossrail service trains and Class 387s operated by GWR to Reading	As per Option 2
Option 2b	Do Nothing to the existing infrastructure and fit ATP to HEX service trains (Class 387 only).	As per Option 2
Option 4	Second Driver on the footplate of Class 345/387	This is a procedural control and is subject to human factors and common mode human failures. Safety benefit not quantifiable. ToCs would be unable to supply a sufficient number of trained 2nd drivers and the cost of doing so would be prohibitive in any case.
Option 5	Fitment of ETCS Level 1 (Area C), ETCS L2 (Area B)	ETCS L1 is not a mature system in the UK. There are no National Deployment Rules developed. Using L1 was predicted to be more difficult than, and would take as long as, deploying L2 and therefore is not a realistic option.

No.	Description	Reasons for Rejection
Option 6	Fitment of ETCS L2 (area B+C)	This is not feasible prior to Dec 2019 and is the reason why options are being sought

Table 1 Rejected Options

2.4 RECLASSIFICATION OF OPTION 1D

Option 1d (Install enhanced TPWS on approach to buffer stops and PSRs) was recognised as not being an option in its own right, but rather a mitigation to buffer stop/ overspeed risks that exist under multiple options. It has therefore been re-categorised from an Option to a potential mitigation. The costs/benefits of Option 1d are discussed further in Section 5 and Appendix C.

2.5 POTENTIAL MITIGATIONS

The following mitigations were identified as part of the review of Options. They are not options in their own right but could be applied to proposed Options in order to further reduce risks.

1) Non-ATP rolling stock could be fitted with Mk4 TPWS units (if not already fitted)
2) Where trains are fitted with Version 4 GSM-R radios, it is possible that a technological solution could be developed to utilise the GPS available on these sets to aid in identifying train physical location/ SPAD/ overspeed. No such solution exists at the current time.
3) Option 1d from the Sotera report (Ref. 3) has been reclassified as a potential mitigation for any option with non-ATP traffic
4) As described in Section 2.1, timetables could be amended to minimise or eliminate non-ATP traffic where possible.

3. ANALYSIS OF CARRIED FORWARD OPTIONS

3.1 SUMMARY OF CARRIED FORWARD OPTIONS

Option No.	Description	Safety Cost per Year for TT1 (ref. 3)
1	No Infrastructure modification - base case with new timetables Equivalent to the base case with the potential future timetables. Risk calculations are without ETCS and without replacement of track circuits with axle counters.	£22,230
1a	Defer trackside ETCS fitment in lieu of train detection upgrade. Area B+C ETCS operation - Dec 2023 Carries the same train protection preventable risk as option 1, for an extended period prior to the fitment of ETCS. Improved train detection reliability will bring reduced maintainer exposure to on-track hazards. Risk calculations are without ETCS, but with axle counters.	£22,230
1b	Fitment of trackside ETCS as early as possible, delaying axle counter programme. Area B+C ETCS Operation - Dec 2021 Carries the same risk prior to ETCS fitment as option 1, the period prior to the fitment of ETCS is minimised. Retention of track circuits impacts train detection reliability with performance and degraded mode safety impacts. Risk calculations are without ETCS and without replacement of track circuits with axle counters.	£22,230
1c	Fitment of Trackside ETCS (Area B only) as early as possible. Area B ETCS Operation - Dec 2020. Area C ETCS operation 2023. No train detection upgrade Area B has ETCS infrastructure fitment between Heathrow Airport Junction and Acton. Risk calculations are with ETCS for Area B only and without axle counters.	£21,850
3	Do nothing to the existing infrastructure and utilise existing ATP fitted stock for Crossrail and HEX (Class 360, 332, and 800)	£17,252

Option No.	Description	Safety Cost per Year for TT1 (ref. 3)
3a	Do Nothing to the existing infrastructure and utilise ATP on existing train fleets for Crossrail Services (Class 360, 332).	£18,886
3b	Do Nothing to the existing infrastructure and utilise ATP on existing train fleets for HEX services (Class 360, 332).	£20,710

Table 2 Summary of Carried Forward Options

3.2 RISK TOLERABILITY OF CARRIED FORWARD OPTIONS

It was noted that all the carried forward options, for all proposed timetables carry a relatively small amount of risk as calculated by Sotera. The annualised safety risk for the highest risk timetable (timetable 1) is in the order of 1.2×10^{-2} FWIs. This level of risk is low and was considered by the group to be inherently tolerable for all proposed options, with no option standing out as being vastly superior in terms of safety alone. It was noted that the level of safety cost (in the region of £20k-£30k per year) would give a low-cost ceiling on interventions if subjected to formal cost: benefit analysis.

The low levels of train protection related risk at Paddington are due to:

- Most of the traffic having ATP
- The provision of enhanced TPWS fitment as part of mitigation for the previous RSR exemption that protects both ATP and not-ATP stock
- Stock being relatively modern, with the majority having Mk 4 TPWS equipment which has superior protection against 'reset and continue' events

3.3 ELIMINATION OF OPTION 3, 3A AND 3B

Prior to analysis of Options against the Criteria, each remaining Option was discussed in turn in order to determine if it was considered viable/ practicable by the group. It was determined that all Options involving swapping the currently planned rolling stock (387s/345s) for other, ATP fitted, rolling stock were strongly opposed by the group (especially ToCs). The reasons for this were:

1) A relatively small decrease in safety risk by switching stock to ATP-fitted types
2) Contractual issues surrounding procuring such stock which are likely to be insurmountable in the time available prior to Dec 2019
3) Knock-on effects to other operators who may be relying on cascade of ATP-stock
4) Driver training issues, since drivers are likely to require retraining on Classes of stock that they are not currently familiar with
5) Knock-on effects to HS2 if Class 332 are retained, since this would prevent the closure of the Class 332 maintenance facility at Old Oak Common. The inability to close this facility would lead to delays in the HS2 programme

6) Extremely negative public/ industry / political reaction to rolling stock changes from the proposed newer stock to existing, older stock. For example, Crossrail not operating the stock which has been specifically provided for the ToC. No existing ATP stock has CBTC functionality, which would mean that TT3 becomes undeliverable.

7) The inability of existing ATP-fitted rolling stock to utilise the CBTC signalling system and other systems e.g. ATO enforced stopping positions for alignment to platform edge doors/DOO CCTV within the Crossrail core tunnel, therefore preventing through-running of Crossrail trains.

Given the minor safety risk improvements and large and costly contractual and operational issues caused by switching rolling stock types, it was decided to eliminate options 3,3a,3b,3c.

3.4 ANALYSIS OF CARRIED FORWARD OPTIONS

The following tables are extracted from the spreadsheet used during the Options selection meeting (ref. 7). This spreadsheet also contains analysis of the rejected options.

3.4.1 OPTION 1

Summary

Option 1 represents the infrastructure situation at present, but with the proposed new timetables. This Option has been analysed, but since NR are committed to both providing the ETCS L2 overlay and replacing track circuits with axle counters, Option 1 represents the situation before these enhancements are delivered.

The main relevant conclusions from Option 1 analysis are that it has a tolerable level of train protection risk under all proposed timetables and is operationally tolerable for the ToCs.

Assessment against Criteria

Criteria	Assessment
1. RSR Exemption required and for what duration?	Equivalent to the base case with the potential future timetables. Risk calculations are without ETCS and without replacement of track circuits with axle counters.
2. TT1 Quantified Overall Safety Risk (Sotera: FWI per year)	Yes. Until Dec 2021 or Dec 2023 (option 1a or 1b) or longer if neither 1a or 1b feasible.
3. TT2 Quantified Overall Safety Risk (Sotera: FWI per year)	1.17E-02
4. TT3 Quantified Overall Safety Risk (Sotera: FWI per year)	1.04E-02
5. Feasible to deliver works required for an exemption prior to Dec 19?	9.98E-03
6. Technically feasible, irrespective of time frame?	Yes- no infrastructure modifications needed.

Criteria	Assessment
7. Safety benefits (not quantified in Sotera report)	Yes- no infrastructure modifications needed.
8. Safety disbenefits (not quantified in Sotera report)	Less chance of degraded mode operations due to no ETCS overlay
9. Non-safety benefits	HEX Drivers unfamiliar with driving under AWS/TPWS and may assume that they have ATP protection - potential higher SPAD/overspeed rates than modelled. (Over reliance on ATP driver display) Small additional risk of degraded mode operations due to retained track circuits having higher failure rate than axle counters
10. Non-safety disbenefits	No ETCS overlay system - no additional equipment to fail and cause degraded mode operations. Delays caused by track circuit failures not addressed
11. Further potential mitigations to reduce safety risks	Yes- see options 1d, 5, and all 3 and 4 sub-options.
12. Costs (capital, maintenance, operational)	No capital costs. On-going safety/operational and maintenance costs of unreliable track circuit train detection.
13. Impact to other parties (e.g. ToCs, maintainer)	Signalling transition pattern not 'as planned' e.g. for Crossrail tunnel to Heathrow a CBTC to Level NTC, then Level NTC to L2 transition would exist. For HEX, a Level NTC to Level 2 transition would exist HEX Class 387 drivers will require AWS/TPWS training
14. Critical assumptions	None
15. Degraded/emergency mode risks	Track circuit failures not addressed by replacement with axle counters: risk when in degraded more (e.g. talking past signals) and to maintenance workers when working trackside
16. Confirmed for elimination at Options Selection workshop?	No. Not preferred since neither ETCS is delivered nor track circuits replaced.

Table 3 Option 1 Assessment Against Criteria

3.4.2 OPTION 1A

Summary

Option 1a defers introduction of the ETCS L2 overlay, instead prioritising replacing track circuits with axle counters. The benefits of ETCS for train protection are therefore offset against the benefits of

improving train detection reliability. There are no costs over those already planned for ETCS delivery and axle counter fitment.

The main relevant conclusion from Option 1a analysis is that it has a tolerable level of train protection risk under all timetables but is operationally intolerable for GWR. Delaying Area B/C ETCS to 2023 would delay the resolution of Area A residual issues, which would lead to GWR being unable to operate short-form Class 387s on HEX service.

There is an additional risk for Option 1a that ETCS delivery will become dependent upon the completion of the axle counter programme.

Assessment Against Criteria

Criteria	Assessment
1. RSR Exemption required and for what duration?	Yes. Until Dec 2023
2. TT1 Quantified Overall Safety Risk (Sotera: FWI per year)	1.17E-02
3. TT2 Quantified Overall Safety Risk (Sotera: FWI per year)	1.04E-02
4. TT3 Quantified Overall Safety Risk (Sotera: FWI per year)	9.94E-03
5. Feasible to deliver works required for an exemption prior to Dec 19?	Yes
6. Technically feasible, irrespective of time frame?	Yes- with proviso that axle counter programme does not overrun.
7. Safety benefits (not quantified in Sotera report)	Decrease in train detection failures leads to decrease in risk associated with degraded mode operations.
8. Safety disbenefits (not quantified in Sotera report)	"HEX Drivers unfamiliar with driving under AWS/TPWS and may assume that they have ATP protection - potential higher SPAD/overspeed rates than modelled. (Over reliance on ATP driver display). Deferring stage A residual issues (e.g. signaller ergonomic issues, inability to supervise TSRs in level 1 area) until 2023"
9. Non-safety benefits	Train detection reliability increase due to deployment of axle counters

Criteria	Assessment
10. Non-safety disbenefits	Deferring stage A residual issues (e.g. limitation of minimum train length) if trains run under L2 in Heathrow tunnels. This would prevent GWR from using short-form 387s during service disruptions as 4-car 387s do not meet this minimum length requirement. Inefficient delivery of ETCS (will require 2 interventions)
11. Further potential mitigations to reduce safety risks	Yes- see options 1d, 5, and all 3 and 4 sub-options.
12. Costs (capital, maintenance, operational)	Decreased maintenance and operational costs due to lower maintenance requirement/ increased reliability of axle counter train detection.
13. Impact to other parties (e.g. ToCs, maintainer)	Signalling transition pattern not 'as planned' e.g. for Crossrail tunnel to Heathrow a CBTC to Level NTC, then Level NTC to L2 transition would exist. For HEX, a Level NTC to Level 2 transition would exist. Potential for GWR to be prevented from running short form 387s on HEX until 2023. Improved train detection reliability should lead to decreased NR maintenance load. HEX Class 387 drivers will require AWS/TPWS training
14. Critical assumptions	Axle counter programme delivers on time.
15. Degraded/emergency mode risks	No short form HEX 387s possible in degraded mode until ETCS introduction due to minimum train length constraint
16. Confirmed for elimination at Options Selection workshop?	No. Not preferred due to impact on HEX and non-resolution of outstanding Area A issues.

Table 4 Option 1a Assessment Against Criteria

3.4.3 OPTION 1B

Summary

Option 1b represents the reverse situation to Option 1a. In Option 1b, ETCS delivery is prioritised over track circuit replacement. Therefore, the benefits of ETCS are expedited and the disbenefits of unreliable track circuits remain for longer. Track circuit unreliability manifests as both operational delays, as well as a safety benefit when operating in degraded mode e.g. signallers talking trains past red signals in failed train detection sections.

The main relevant conclusion from Option 1b analysis is that it has a tolerable level of train protection risk under all timetables. ETCS delivery is earlier than in Option 1a and therefore Area A residual issues

are resolved earlier than Option 1a. However, the inability of GWR to run short-form Class 387s until ETCS introduction in 2021 is a considerable disbenefit to GWR.

Option 1b has the additional advantage that Area B and C ETCS is commissioned together as one 'big bang' and therefore Option 1b avoids multiple, evolving, transitions between signalling systems.

Assessment Against Criteria

Criteria	Assessment
1. RSR Exemption required and for what duration?	Yes. Until Dec 2021
2. TT1 Quantified Overall Safety Risk (Sotera: FWI per year)	1.17E-02
3. TT2 Quantified Overall Safety Risk (Sotera: FWI per year)	1.04E-02
4. TT3 Quantified Overall Safety Risk (Sotera: FWI per year)	9.98E-03
5. Feasible to deliver works required for an exemption prior to Dec 19?	Yes- no infrastructure modifications needed.
6. Technically feasible, irrespective of time frame?	Yes – ETCS delivery by end of 2021 considered achievable
7. Safety benefits (not quantified in Sotera report)	Resolution of stage A residual issues earlier than for option 1a
8. Safety disbenefits (not quantified in Sotera report)	HEX Drivers unfamiliar with driving under AWS/TPWS and may assume that they have ATP protection – potential higher SPAD/overspeed rates than modelled. (Over reliance on ATP driver display) Benefits of reduced train detection failures not realised.
9. Non-safety benefits	Resolution of stage A residual issues by Dec 2021
10. Non-safety disbenefits	Delays caused by track circuit failures not addressed
11. Further potential mitigations to reduce safety risks	Yes- see options 1d, 5, and all 3 and 4 sub-options.
12. Costs (capital, maintenance, operational)	Ongoing higher rate of train detection failures (maintenance, operational and safety costs) if track circuits retained

Criteria	Assessment
13. Impact to other parties (e.g. ToCs, maintainer)	Transition pattern moves more quickly in line with anticipated CBTC to level 2 class 345 transition. Potential for GWR to be prevented from running short form 387s on HEX until Dec 2021. HEX Class 387 drivers will require AWS/TPWS training
14. Critical assumptions	None
15. Degraded/emergency mode risks	Track circuit failures not addressed by replacement with axle counters: risk when in degraded more (e.g. talking past signals) and to maintenance workers when working trackside. No short form HEX 387s possible in degraded mode until ETCS introduction due to minimum train length constraint
16. Confirmed for elimination at Options Selection workshop?	No. Preferred over 1a due to earlier resolution of Area A outstanding issues. More efficient than 1c in terms of ETCS delivery, however.

Table 5 Option 1b Assessment Against Criteria

3.4.4 OPTION 1C

Summary

In Option 1c, Area B ETCS L2 overlay is prioritised. ETCS is therefore delivered in two steps, Area B in 2020 and Area C in 2023. The advantage of prioritising Area B is that it results in the earlier resolution of Area A residual issues than if ETCS Areas B and C are delivered a single unit as per Option 1b. Additionally, the Area B ETCS can be implemented without delaying the axle counter programme, meaning that the benefits of improved train detection reliability occur sooner than with Option 1b.

The disadvantage of Option 1c is that it creates additional transitions to/from Level NTC due to the creation of a 'temporary' Area B only ETCS zone. Frequent changes to signalling layout/ system are considered to be potentially confusing to drivers and require driver briefing/training when the changes are made. Both GWR and Crossrail have stated that the 2-year period between Area B going live and subsequent ETCS fitment of Area C is more than sufficient to enable driver training and would not be so rapid as to cause confusion.

Option 1c was recognised as the optimum solution, since it has a tolerable level of train protection risk under all timetables and provides the lowest negative operational impact without additional infrastructure or rolling stock costs. ETCS delivery is earlier than in Option 1b and therefore Area A residual issues are resolved earlier than in other options. However, the inability of GWR to run short-form Class 387s until ETCS introduction in 2020 is still a disbenefit to GWR.

Assessment Against Criteria

Criteria	Assessment
1. RSR Exemption required and for what duration?	Yes. Until Dec 2023
2. TT1 Quantified Overall Safety Risk (Sotera: FWI per year)	1.15E-02
3. TT2 Quantified Overall Safety Risk (Sotera: FWI per year)	1.04E-02
4. TT3 Quantified Overall Safety Risk (Sotera: FWI per year)	9.60E-03
5. Feasible to deliver works required for an exemption prior to Dec 19?	As per Option 1
6. Technically feasible, irrespective of time frame?	Yes- area B by Dec 2020 and Area C by 2023 considered achievable
7. Safety benefits (not quantified in Sotera report)	Resolution of stage A residual issues earlier than options 1a or 1b
8. Safety disbenefits (not quantified in Sotera report)	HEX Drivers unfamiliar with driving under AWS/TPWS and may assume that they have ATP protection – potential higher SPAD/overspeed rates than modelled. (Over reliance on ATP driver display) Benefits of reduced train detection failures not realised.
9. Non-safety benefits	Resolution of stage A residual issues by Dec 2020
10. Non-safety disbenefits	Increase in transitions for Crossrail but different transitions for GWR. Delays caused by track circuit failures not addressed
11. Further potential mitigations to reduce safety risks	Yes- see options 1d, 5, and all 3 and 4 sub-options.
12. Costs (capital, maintenance, operational)	Ongoing higher rate of train detection failures (maintenance, operational and safety costs) if track circuits retained. Minor additional costs for temporary transition arrangements for Area B 'ETCS island'

Criteria	Assessment
13. Impact to other parties (e.g. ToCs, maintainer)	Additional ETCS transition(s) would be required since L2 would be deployed piecemeal – impact to driver training/ driveability due to changing 'layout' of route Potential for GWR to be prevented from running short form 387s on HEX until Dec 2020. HEX Class 387 drivers will require AWS/TPWS training
14. Critical assumptions	1c is acceptable to ToCs/drivers in terms of 'driveability'
15. Degraded/emergency mode risks	Track circuit failures not addressed by replacement with axle counters: risk when in degraded more (e.g. talking past signals) and to maintenance workers when working trackside. No short form HEX 387s possible in degraded mode until ETCS introduction due to minimum train length constraint
16. Confirmed for elimination at Options Selection workshop?	No. Preferred over option 1a, 1b due to earliest resolution of Area A residual issues- lowest impact to GWR.

Table 6 Option 1c Assessment Against Criteria

3.5 SELECTED OPTION

After running through the assessment criteria, the group selected Option 1c based on the following reasons/ rationale:

1) The safety risk is tolerable and is partially mitigated within 1 year
2) The resolution of 'Area A residual issues' occurs as quickly as practicable, and earliest of all options, by Dec 2020. The 'minimum train length' residual issue was highlighted as a major operational concern by GWR and option 1c gives the most flexibility to GWR in terms of their ability to run short-form Class 387s on HEX as soon as possible
3) Currently anticipated stock types can be run
4) Option 1c can be carried out without delaying the axle counter introduction programme and therefore enables the benefits of axle counters to be delivered as currently planned

The negatives associated with Option 1c are:

1) Resolution of 'Area A residual issues' does not occur until Dec 2020, which has operational impacts to GWR (no short form 387s can be run) for the period from Class 387 introduction (anticipated to be early December 2019) until Dec 2020
2) Piecemeal introduction of ETCS creates 'temporary' transitions, which will require drivers to be trained as the landscape evolves to the final layout. The 2-year period between Area B implementing ETCS and Area C implementing ETCS was considered by the ToCs to be more than adequate to avoid 'rapid-fire' changes that can lead to driver confusion and training backlogs

3.6 POSSIBLE ADDITIONAL MITIGATIONS

The potential for additional mitigations to decrease safety risk was considered by the group. Suggestions are:

1) Implementing the additional TPWS OSS protection at buffer stops, as proposed and quantified under Option 1d.

2) ToCs to prioritise, so far as possible, deployment of ATP stock in preference to non-ATP stock

The cost of fitting OSS loops has been estimated as in the region of £50k per unit. Given the short time frame before ETCS becomes available (19pprox.. 2023 in Area C) and relatively minor safety risk which can be mitigated by additional OSS on approach to buffer stops, it is unlikely that this intervention will provide a positive case on a cost: benefit analysis. A preliminary illustration of this is found in Appendix C.

4. PREFERRED OPTION HAZARDS

4.1 IDENTIFIED HAZARDS

During discussions and following review after the meeting, the group identified the following hazards for Option 1c, which should be carried forward.

Location	Discipline	Sub-discipline	Hazard Description	Hazard Consequence
transition points L2 to NTC and vice-versa	Signalling	driveability	If ETCS L2 deployed piecemeal, new transitions to/from the L2 'island' will be created. Risk of confusion to drivers due to frequently changing signalling landscape	risk of overspeed/SPAD if driver distracted by unexpected transition or mistakes which mode they are operating in
HEX routes	Driver	human factors	HEX drivers previously operating in ATP only. New stock will require them to use Level NTC or L2. Possible poor driver performance due to previous reliance on ATP – risk of SPAD and overspeed	Risk of SPAD/overspeed when in NTC if driver incorrectly assumes ATP/L2 protection is in force
HEX routes	Driver	human factors	HEX drivers previously operating in ATP only. New stock will require them to use Level NTC or L2. Possible poor driver performance due to previous reliance on ATP – risk of TPWS trip leading to emergency braking	Risk of TPWS trip/emergency braking in NTC if driver incorrectly assumes ATP/L2 protection is in force. Injuries to passengers due to sudden unexpected change in speed

Table 7 Hazards for Option 1c

5. CONCLUSION

The group considered the proposed Options that could be used as a basis for an exemption to the RSR 1999 due to non-provision of the planned ETCS Level 2 overlay system from Paddington to Stockley Junction (0-12MP).

The train protection risks associated with each option have been modelled by Sotera, and the risk for all options is considered tolerable and lower than at comparable major stations. This is partially due to the previous fitment of additional TPWS protection on the GWML as part of the 2015 RSR exemption programme.

The group agreed a set of criteria against which each Option could be assessed in order to determine which, if any, options to recommend.

Following elimination of obviously unviable options and subsequent analysis of the Options against the criteria, the workshop concluded that 'Group 1' Options were the most viable, and that Option 1c was the optimum. Option 1c is Area B ETCS Operation in Dec 2020 and Area C ETCS operation in 2023.

The reasons for selection of 1c are:

- The level of risk associated with the option is tolerable
- Currently planned stock can be utilised, which avoids the need for ToCs to implement expensive retro-fitment of ATP or obtaining additional ATP-fitted stock for a temporary period when ETCS is not fully available
- ETCS is introduced most rapidly outside of Area A, which leads to an earlier resolution of Area A residual issues
- Resolution of Area A issues gives the most operational flexibility to ToCs, especially GWR, due to removal of the minimum train length requirement
- The pace of change in terms of introducing signalling system changes is slow enough to allow drivers to be trained/briefed and is not rapid enough to be considered confusing
- Option 1c does not delay the axle counter introduction programme and therefore the delivery of axle counters and their associated benefits is not affected

There is a critical assumption with Option 1c that the proposed evolution of signalling arrangements is considered acceptable by ToCs/drivers. This assumption was assessed as sound by the ToC representatives in the group, but is subject to formal 'driveability' assessment processes.

There are additional mitigations that could be applied to Option 1c to further reduce risk, including fitment of OSS loops on approach to Paddington buffer-stops which would reduce collision risk. However, due to the relatively low level of safety risk it is unlikely that this intervention is cost effective.

APPENDICES

Appendix A REFERENCES AND ABBREVIATIONS

A.1 REFERENCES

1) The Railway Safety Regulations 1999, https://www.legislation.gov.uk/uksi/1999/2244/contents/made

2) Crossrail Train Protection (Plan B) -Railway Safety Regulations 1999 Exemption Application Report, PPA1A-ESG-REP-NCA-000001 Ver A03, 26th August 2015, Crossrail Limited, http://orr.gov.uk/__data/assets/pdf_file/0017/21293/crossrail-exemption-application-consultation-september-2015-exemption-certificate.pdf

3) Risk Assessment of the Paddington to Heathrow Airport Junction Train Protection Strategy – Options analysis, J2034/Doc002, Rev 02, 22nd January 2019, Sotera

4) Network Rail GWML 0-12 MP RSR Exemption Briefing Document, 007.450B, v1.0 14th February 2019, Vertex Systems Engineering

5) C160 Rolling Stock GW ATP Investigation, C160-MMD-R1-RGN-CR001-50115, Crossrail Limited

6) Class 387/1: ETCS ATP Case, Issue Draft v3, 16th January 2019, Great Western Railway (GWR)

7) 2019 RSR ETCS Exemption – Options Analysis (Excel Spreadsheet), 007.450A, 8th March 2019, Vertex Systems Engineering

A.2 ABBREVIATIONS

Term	Meaning
ATP	Automatic Train Protection
CBTC	Communications Based Train Control
CCTV	Closed Circuit Television
DOO	Driver Only Operation
ETCS	European Train Control System
FWI	Fatalities and Weighted Injuries
GWML	Great Western Main Line
GWR	Great Western Railway (TOC)
HEX	Heathrow Express

Term	Meaning
L1	Level 1 (ETCS)
L2	Level 2 (ETCS)
LNTC	Level National Train Control (ETCS)
MP	Mile Post
NTC	National Train Control (ETCS)
ORR	Office of Rail and Road
OSS	Overspeed Sensor (for TPWS)
RSR	Rail Safety Regulations, 1999
SPAD	Signal Passed At Danger
TOC	Train Operating Company
TPWS	Train Protection and Warning System
TT	Timetable
VSE	Vertex Systems Engineering

Table 8 Abbreviations

Appendix B MEETING ATTENDEES

Name	Company	Discipline
Aidan McGrady	Network Rail	ETCS Engineering
Alan Powell	Vertex	Option Selection Specialist
Andy Moore	GWR	GWR
Chris Knights	Heathrow Express	Heathrow Express
Christopher Rolfe	Network Rail	Programme
Dave Maxwell	Network Rail	Project Management
Ian Harrison	Network Rail	Sponsor
Ian Maxwell	ORR	ORR
Jonathan Osgood	Crossrail	Crossrail
Maramba Mojgan	Crossrail	Crossrail
Matthew Redstone	Network Rail	Route
Nick Wright	GWR	GWR
Peter Dray	Sotera	Risk Specialist
Peter Evans	Network Rail	Engineering
Ron Bailes	MTR Crossrail	MTR Crossrail
Steve Hebbes	Vertex	Option Selection Specialist
Ted Beausire	Network Rail	ETCS Project Operations Interfaces

Table 9 Options Selection Meeting Attendees

Appendix C OPTION 1D BUFFER STOP RISK ILLUSTRATION

Option 1d (later reclassified as a mitigation) proposes fitments of OSS loops at Paddington platforms, in order to reduce buffer stop collision risk from TPWS-only protected moves.

The Sotera report (ref. 3) estimates the buffer stop collision for the highest risk timetable (TT1) as shown in Table 10. This has been converted into a safety cost, based on a £1.9 million Cost of Avoiding A Fatality.

Risk type	Option 1d risk (FWI/year)	Option 1 risk (FWI/year)	delta	Safety Cost/ year
Buffer collision	3.48E-03	4.39E-03	9.10E-04	£1,729.00

Table 10 Buffer Stop Risk Costs

The costs of fitting a minimum 9 platforms with OSS loops has been estimated as in the region of £450k of capital expenditure, as well as minor additional maintenance costs per year.

Given the short-term (until Dec 2023) nature of the mitigation provided by the proposed OSS loops, the total safety cost to be mitigated is less than £10k over the projected lifetime of utility. A £450k expenditure therefore appears grossly disproportionate to this risk.