Chilternrailways
by arriva

Fleet Engineering

SELCAB ATP Short Term RSR 1999 Exemption Summary Report

Report No: R363

ISSUE	DATE	AUTHOR	DETAILS
1	June 20	S. Jarrett	First Issue

Prepared by: ____________________

Simon Jarrett,
Engineering Assurance & Development Manager

Reviewed by: ____________________

Simon Walker
Head of Fleet Engineering

Approved by: ____________________

Ian Hyde
Engineering & Safety Director

1 Purpose

1.1.1 This report summarises Chiltern Railways (CRCL) application under Regulation 6 of the Railway Safety Regulations 1999 (RSR1999) in association with Network Rail Infrastructure (NR), for exemption from the requirement under Regulation 3 that a train shall be fitted with a train protection system (as defined by Regulation 2).

1.1.2 This exemption application is required to support use of train protection arrangements for a limited period on services to be operated in the area between London Marylebone and Aynho Junction on the Chiltern Route, part of the London North Western Route. This proposal will need to be implemented when CRCL uses Class 165/0 Networker Turbo, Class 168/0/1/2 Clubman or Class 172/1 Turbostar trains without SELCAB ATP.

1.1.3 The exemption will be used by CRCL to permit the operation of existing ATP fitted trains without ATP due to irreparable equipment for all or part of the route between London Marylebone and Aynho Junction.

1.1.4 The exemption, if granted, will mitigate the impact of delays, shortforms or service cancelations due to the irreparable failure and obsolescence of ATP and thus improve the resilience of the Chiltern Route.

1.1.5 This Exemption is complimentary to a separate Exemption to RSR1999 being submitted by NR supported by CRCL to allow the removal of SELCAB ATP after 2023 by the roll out of Enhanced TPWS and an upgrade to the On-Train TPWS equipment.

1.2 Area of Scope

1.2.1 This Exemption is requested for CRCL operations over the following lines:

- Marylebone to Aynho Junction. (MCJ1 205m77ch to NAJ3 18m30ch Up Lines and 18m35ch Down Lines)
- Princes Risborough to Aylesbury (PRA 42m31ch to 49m 35ch Down & Up Aylesbury line)
- Neasden South Junction to LU/NR Boundary (MCJ1 197m 5ch to 200m 65ch Up & Down Harrow Lines)
- Aylesbury to LU/NR Boundary (MCJ2 38m 13ch to 25m 21ch Up & Down Mains)
- Aylesbury Vale Parkway to Aylesbury (MCJ2 40m 38ch to 38m 13ch Up & Down Aylesbury Line)

1.2.2 This Exemption is applicable to the following units fitted with SELCAB ATP:

- Class 165/0: 165001 to 165039
- Class 168/0: 168001 to 168005
- Class 168/1: 168106 to 168113
- Class 168/2: 168214 to 168219
- Class 172/1: 172101 to 172104

1.3 Timescale

1.3.1 This exemption is required to permit trains formerly fitted with SELCAB ATP to continue to operate while a scheme to allow the full removal of SELCAB ATP through Enhanced TPWS and Mk4 TPWS onboard fitment is implemented as detailed in Reference Document 1. Therefore, exemption is applied for the period from 1st July 2020 up to and including to 30th June 2024.

1.3.2 A separate exemption application is being made in parallel by NR supported by CRCL to permit the operation of Enhanced TPWS and Mk4 TPWS onboard as a replacement for SELCAB ATP from 1st January 2023 until 31st December 2027.

1.3.3 CRCL current franchise ends 31st December 2021, with an option to extend for up to 5 years. This exemption will be transferred to a new franchisee, who may operate the Chiltern franchise after 31st December 2021.

1.4 Applicant

1.4.1 The Applicant is The Chiltern Railway Company Limited ("Chiltern Railways"), company registration no 3007939.

Registered Address:
1 ADMIRAL WAY
DOXFORD INTERNATIONAL BUSINESS PARK
SUNDERLAND
SR3 3XP
ENGLAND

1.4.2 This exemption may be transferred to a new franchisee to operate the Chiltern franchise after 31st December 2021 or a later date as determined by the Secretary of State for Transport.

1.5 Abbreviations and Definitions

1.5.1 Abbreviations have been avoided as far as possible in this report, and where they are used they are defined within the text. The list below provides a summary of the abbreviations and definitions used:

ATP	Automatic Train Protection
AsBo	Assessment Body
Ch	Chain
CRCL	The Chiltern Railway Company Limited ("Chiltern Railways"),Company registration number: 3007939.
CSM	Common Safety Method
DMU	Diesel Multiple Unit
DfT	Department for Transport
Enhanced TPWS	TPWS system whose effectiveness is improved by additional trackside equipment
ETCS	European Train Control System
FWI	Fatality Weighted Injuries
LUL	London Underground Limited
LZB	Linenezugbeeinflussung (a train protection system used in Germany and parts of Austria and Switzerland)
MP	Mile Post
NR	Network Rail Infrastructure Limited (Company registration number: 02904587)
ORR	Office of Rail and Road
REA	Risk Assessment & Evaluation
RSR1999	Railway Safety Regulations 1999
RSSB	Rail Safety & Standards Board
SORAT	Signal Over Run Assessment Tool
SFAIRP	So far as is reasonably practicable
SPAD	Signal Passed at Danger
SRM	Safety Risk Model
TPWS	Train Protection & Warning System

2 Further Background and explanation of Train Protection Systems

2.1.1 Please refer to Reference Document 1 sections 3 and 4 for further background information and an explanation of train protection systems, CRCL operation and fleet.

3 Train Protection Exemption

3.1 Why is an exemption required?

3.1.1 In 2012, the SELCAB ATP system supplier notified both CRCL and NR that they would no longer be able to provide spares and new SELCAB ATP systems after 31st December 2012. At this point discussions were initiated between the CRCL, NR and the supplier to discuss how to best manage and support the SELCAB ATP system. This resulted in a "last time buy" of spares based on estimated requirements through to 2018.

3.1.2 Since 2013 NR and CRCL have regularly met to discuss the future of the SELCAB ATP system. In 2012 it had been identified through risk modelling that increasing TPWS provision ("Enhanced TPWS") combined with an On-train upgrade of the TPWS equipment presented an option to manage the risk into the future. It was recognised that an exemption to RSR1999 would be required to allow this to proceed.

3.1.3 Between 2013 and 2019 no funding was available to take this plan forward except for initial design development work within NR.

3.1.4 The ORR provided funding for NR to develop a project to eliminate the ATP obsolescence risk from the start of Control Period 6 in April 2019.

3.1.5 CRCL and NR have continued to work together since April 2019 to further develop the project and have submitted an RSR1999 Exemption Application (Reference Document 1) to allow Enhanced TPWS and Mk4 TPWS onboard as a replacement for SELCAB ATP from sometime in 2023. This is because it is estimated that it will take 2.5 – 3 years to implement this scheme.

3.1.6 CRCL is already at the point where on-train SELCAB ATP parts have failed and cannot be repaired or replaced, as no working spares exist. This situation will only worsen during the 2.5 – 3 year programme to provide the Enhanced TPWS scheme and On-train TPWS upgrade to Mk4 TPWS.

3.1.7 CRCL will have to withdraw from use ATP fitted trains with irreparable SELCAB ATP over the 2.5 – 3 year period without an RSR1999 exemption resulting in worsening overcrowding, cancellations and loss of passengers to less safe modes of transport without an exemption to RSR1999.

3.1.8 CRCL therefore seeks an RSR1999 Exemption to permit the use of trains with irreparable SELCAB ATP due to no suitable replacement parts available for an interim period whilst the scheme detailed in Reference Document 1 is implemented.

4 Risk Assessment

4.1.1 RSR1999 requires that trains fitted with ATP cannot have ATP removed or knowingly operate in a failed state without an exemption from the requirement under Regulation 3 that a train shall be fitted with a train protection system (as defined by Regulation 2).

4.1.2 As highlighted in Reference Document 1, there are no technical solutions to replace SELCAB ATP that can be implemented immediately and provide at least equivalent level of protection.

4.1.3 Compliance with RSR1999 would lead to a degradation of the fleet size over the 2.5 – 3 years as ATP components fail until the full Enhanced TPWS and On-train TPWS upgrade is completed. The rate of degradation is difficult to predict but a credible worst case is estimated at 20% of the ATP fitted fleet per year.

4.1.4 Any Exemption needs to demonstrate that risk is being controlled and reduced So-Far-As-Is-Reasonably-Practicable (SFAIRP).

4.1.5 This section explains how the risks have been assessed to determine a SFAIRP solution that justifies the Exemption.

4.2 Risk Evaluation Approach

4.2.1 The detailed risk assessment is contained within reference document 3. The risk assessment compares 2 different risk strategies to control the risk arising from ATP obsolescence in the period 2020 – 2023:

1. **Option A** - Trains with irreparable ATP are permitted to continue operating with an Exemption. Use of ATP is maintained working where practical on the rest of the fleet and infrastructure.
2. **Option B** - Trains with irreparable ATP are withdrawn from service – This approach does not require an Exemption since it complies with RSR1999.

4.2.2 The rate of equipment obsolescence is difficult to predict. Therefore, the modelling of both options has been based on a credible worst-case obsolescence rate of 20% of the ATP fitted fleet per year. This was estimated based on experience to date. The detailed risk assessment does also consider 5%, 10% and 30% per year obsolescence rates for comparison.

4.2.3 The basis of risk approach for Option A is that removing trains from service as a risk control measure is not in itself risk free and increases risks to both passengers and staff from hazards associated with overcrowding and its consequences such as slips, trips & falls and violence to staff & passengers.

The RSSB "Knock-on" risk tool has been used for most of this risk modelling work. This uses the Safety Risk Model (SRM) for the whole UK Railway network to evaluate the FWI risk impact of changes to operation. The RSSB explanation of the Knock-on risk model is provided below:

"The knock-on risk considers the impact on safety risk of train cancellations, delays and disruption. Previous work undertaken by RSSB, showed the linkage between delay minutes and the risk from specific hazardous events such as:

- *Boarding and alighting accidents*
- *Slips, trips and falls at stations*
- *Staff assaults both physical and verbal*
- *Crowding on trains/platforms/station concourses.*

Excluded from the RSSB assessment of knock-on risk is intermodal transfer, eg, passengers being forced to use alternative methods of transport such as the road network, which is inherently less safe than rail. It should be acknowledged that the whole area for linking delays minutes to hazardous events can only be considered an approximation.

*Based upon the analysis performed for RSSB project T758 **[1]** and the RSSB COMPASS project **[2]**, delays and cancellations are considered to cause about 3.8 FWI per year of risk on the whole national network. Most of the risk (60%) is associated with minor injuries arising from boarding and alighting accidents, and slips, trips and falls at stations. To obtain the annual knock-on risk contribution for a specific cause category, the 3.8 FWI per year risk is simply proportioned by the ratio of the equivalent delay minutes associated with a cause category and the annual average total delay minute burden on the network which corresponds to about 20 million equivalent delay minutes. This includes an amount of equivalent delay minutes for full and part cancellations occurring on the network, where full cancellations are defined as trains that did not run as planned or a train that ran but did not complete at least half of its scheduled journey. The formula (taken from Network Rail) used for determining the equivalent delay minute burden for full/part cancellations is as follows:*

*Equivalent delay minutes = [number of trains cancelled] * [Service interval] + 0.5 * [number of trains part cancelled] * [service interval]*

1 - T758 Recovery from Extensive Signalling Failures (ESF).

2 - Assessment of the risk from Temporary Block Working and signal-to-signal working: Information to assist with the setting of safety targets for the COMPASS Degraded Mode Working System project, RSSB, 2017."

4.2.4 The "knock-on" risk model predicts the FWI risk created by making short term operational changes arising from delay or cancellations. The "Knock-on" risk model is based upon RSSB's Safety Risk Model and train service delay and cancellation information. The model calculates network-wide risk values associated with each of the following events:

1. A train cancellation (A);
2. A train part-cancellation (B);
3. A train delay, measured using delay minutes (C).

Each of the events is effectively an initiator for knock-on risk events. The total FWI risk associated with a particular operational situation in a specific time period can then be calculated using the model, by determining the three above parameters for the operational situation and entering them into the model. The model essentially calculates the total risk as follows:

Total risk (FWI) = Cancellations x A + Part-cancellations x B + Delay minutes x C.

The network-wide figures are based upon data and risk modelling for the whole GB mainline railway.

4.2.5 It is likely that in the event of planned long-term cancellations and short-formed trains that may arise as a result of irreparable ATP that the FWI risk increase would be less than predicted by the model. This is because these longer-term changes do not result in some of the accident pre-cursors such as passengers running for trains and heightened stress levels that can occur following short term operational changes. However, some precursors such as increasing overcrowding remain valid. The "Knock on" risk model is still valid as the best available tool for assessing the risk impact of operational changes on the UK railway but the results in this case are likely to over-estimate risk. Its outputs should be seen as a guide to the order of magnitude of FWI risk for longer-term changes.

4.2.6 A further aspect of the risk assessment is the consideration of modal transfer. Travel by rail is very safe compared to all other forms of land transport. It is likely that passengers would seek alternative, less safe means of travel in the event of extreme overcrowding and persistent cancellations due to a lack of trains to operate CRCL services without an exemption being granted.

4.2.7 The modal shift assessment tries indicatively to assess the overall risk to passengers transferring to other forms of transport, if they were unable to travel on CRCL services.

4.2.8 The risk assessment concludes by considering operational changes and project priorities that CRCL and NR could reasonably make to mitigate the FWI risk increase that may arise from allowing units with irreparable ATP to operate. The aim being to achieve an overall solution that minimizes risk SFAIRP.

4.3 Risk Assessment Findings

FWI Risk Assessment

4.3.1 The CRCL timetable requires the trains for a weekday peak service shown in Table 1.

Train Type	Fleet size	Peak Service Requirement
2-car class 165	28	23
3-car class 165	11	10
2-car class 168	9	8
3-car class 168	9	8
4-car class 168	10	8
2-car class 172	4	4
Power Door Mk3 Trainset	4	4
Slam Door Mk3 Trainset	1	1

Table 1 Chiltern Railways Weekday Fleet Requirement

4.3.2 Trains that are not used for the peak service are either on maintenance or used as spares in case of train failures.

4.3.3 Reference Document 4 provides the findings of risk modelling for both Option A and Option B.

4.3.4 The number of units required for a full service, throughout the day, is shown in Figure 1 as a black line. As can be seen, the line has two peaks, representing the morning and evening peak; with a significant reduction in the number required late in the evening.

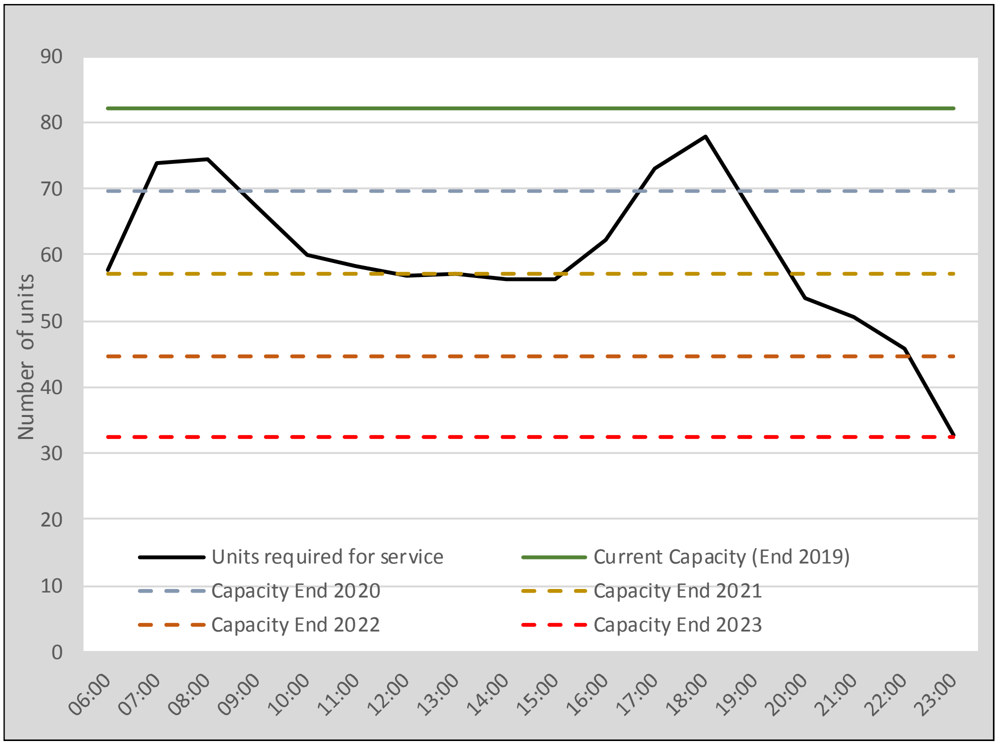

Figure 1:Units required and units available at 20% ATP degradation per year

4.3.5 Also presented on the chart are four dotted lines, indicating the number of units available at the end of each year up until the end of 2023. The assessment assumes there is a 20% reduction in availability of ATP stock available per year. 20% degradation of the current ATP fleet per year is considered to be the credible worst case and accounts for the current reliability, availability of spares and potential increase in rate of failure in the future, as the equipment ages.

4.3.6 As can be seen from Figure 1, after one year, the number of units available (assuming a 20% degradation rate) is insufficient to operate a full service at times during both the morning and evening peaks. By the end of 2021, there would be insufficient units to operate any of the peak only services, i.e. it would only be possible to operate a service equivalent to the current off-peak levels. By mid-2022 and through 2023, the train service would be drastically diminished throughout the day.

4.3.7 The degradation rate of 20% is uncertain; to investigate the effect of uncertainty on the assessment, three sensitivity cases have been run to investigate degradation rates at 5%, 10% and 30%. These are shown in Figure 2 to Figure 4.

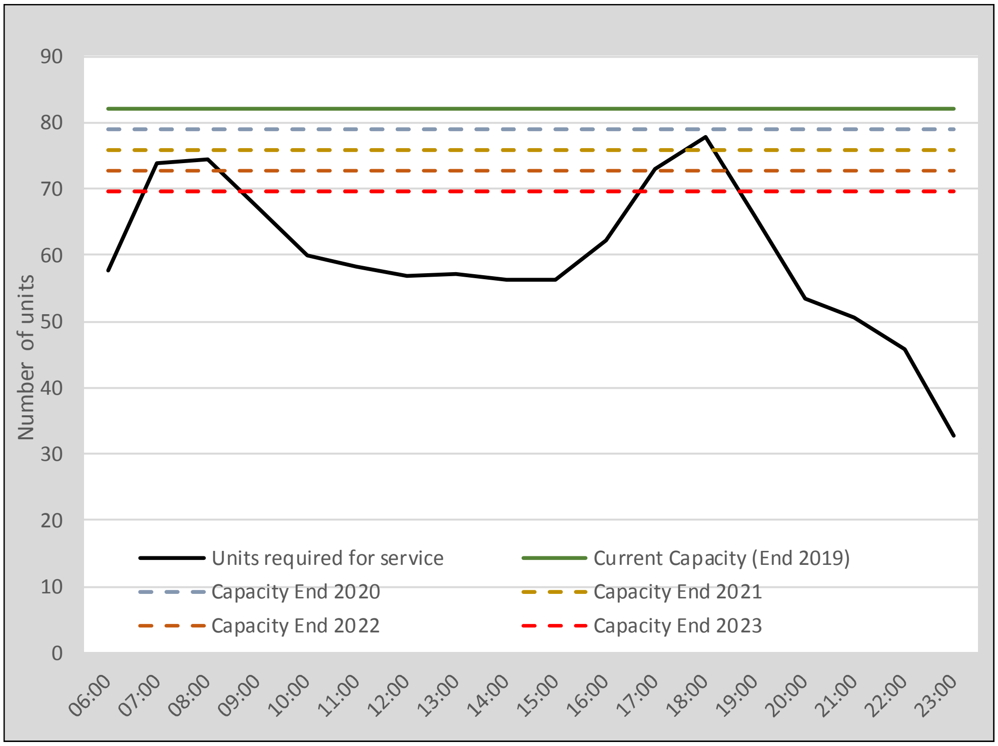

Figure 2: Units required and units available at 5% ATP degradation per year

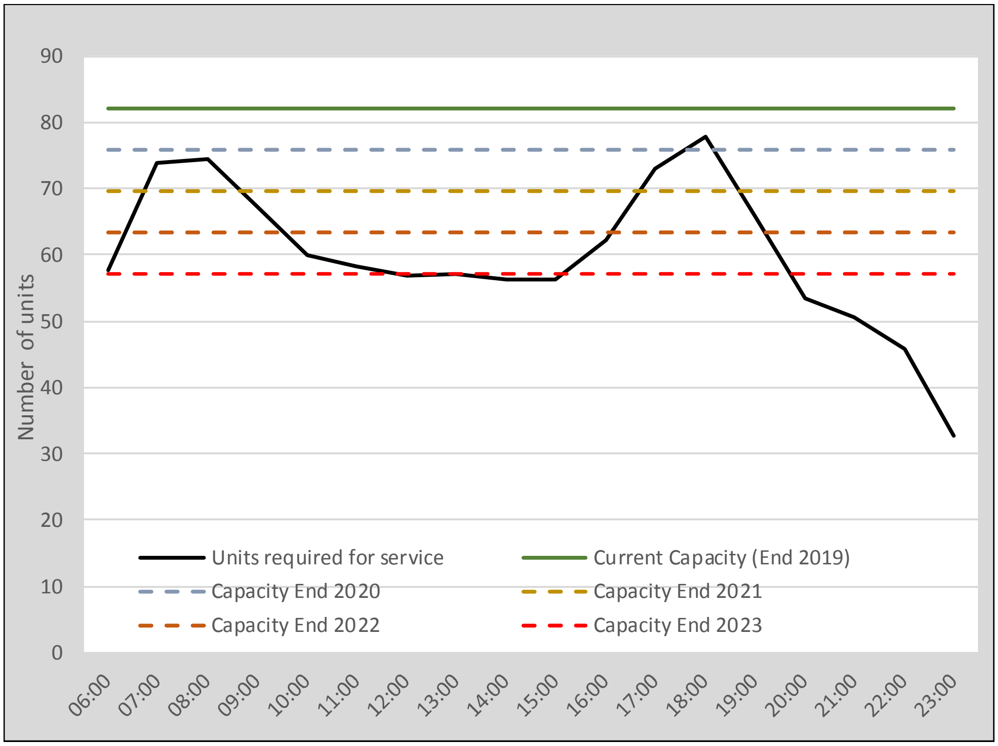

Figure 3: Units required and units available at 10% ATP degradation per year

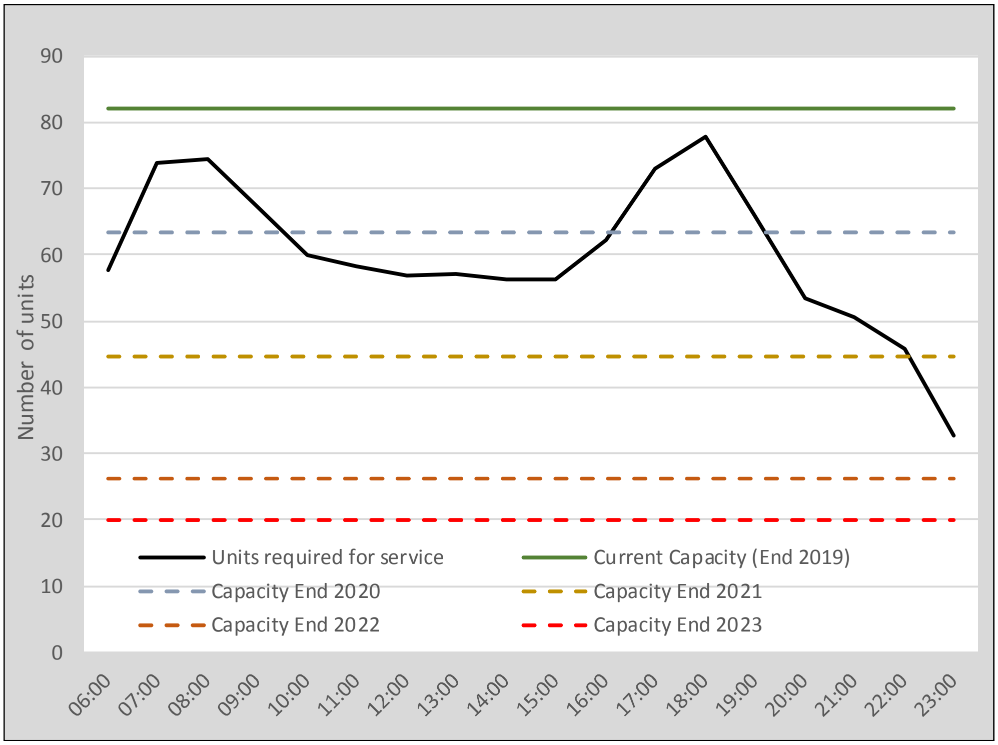

Figure 4: Units required and units available at 30% ATP degradation per year

4.3.8 The inferences that can be made from the analysis are:

- With the much more optimistic 5% degradation rate, there would be a significant reduction in peak service levels by the end of 2022. At this degradation rate, the off-peak service and some peak level services would be maintained until the end of 2023, when the planned TPWS upgrades are introduced.
- With a 10% degradation rate, there would be a significant erosion of peak level service by the end of 2021. It would be possible to operate at off-peak service levels until the end of 2023, when the planned TPWS upgrades are introduced.
- At a 30% degradation rate, provision of even an off-peak would not be deliverable at the end of 2021.

4.3.9 The resultant train cancellations in a particular year for each degradation rate has been estimated by reviewing the train diagrams for each fleet. The train diagrams show how many services a particular train is used upon. The gradual removal of unit diagrams starting with the least worst can be used to estimate the total number of train cancellations in a particular year arising from Option B. The knock on risk for Option B is then estimated by multiplying the total cancellations in a year by the FWI risk figure associated with a train cancellation.

4.3.10 The risk that would exist for Option A and Option B for each year up until the end of 2023 are compared in Figure 5. The train accident risk from collision, derailment and buffer collision as assessed in previous risk assessment underpinning the NR exemption are shown in blue, orange is used for the knock-on risk from the RSSB tool. As can be seen, at 20% degradation, by the end of 2020, the overall risk would be an order of magnitude of around 3 times higher gradually increasing to a factor of 140 higher by the end of 2023.

4.3.11 As mentioned earlier in this report, the “knock-on” risk model provides an order of magnitude estimate for the risk increase as a consequence of the cancellations and short formation of trains arising from the reduced capacity arising from the 20% degradation. It demonstrates the risk consequence of 20% degradation.

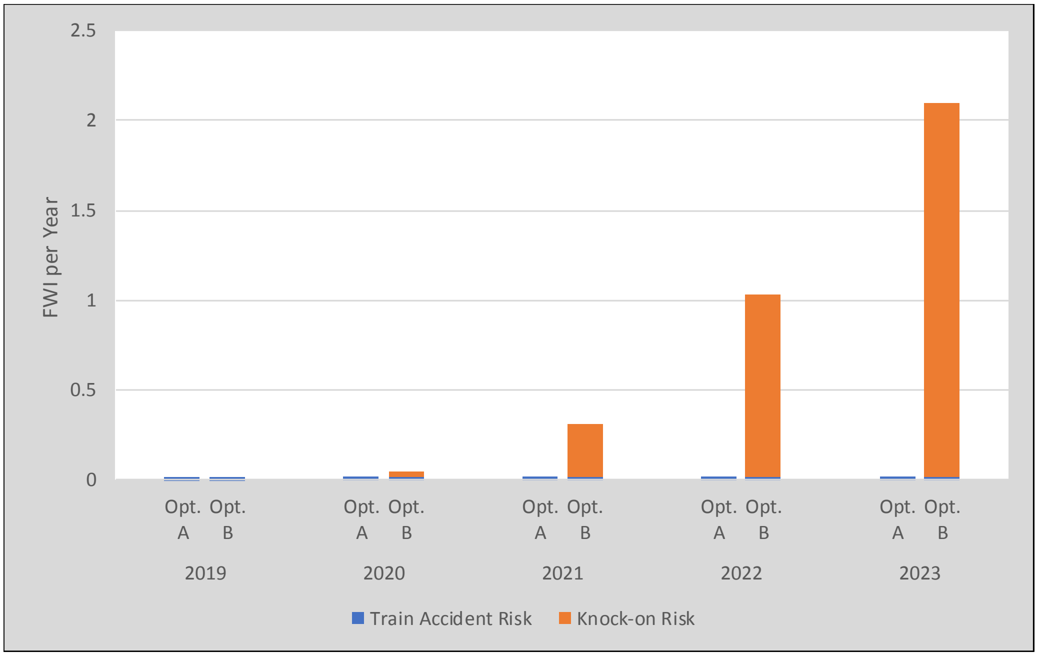

Figure 5: Comparison of the risk for Option A and Option B at 20% degradation

4.3.12 The inference from the assessment at 20% degradation per year is that it is significantly safer to permit trains with irreparable SELCAB ATP to operate using TPWS rather than withdrawing the units from service. This does not account for potential intermodal transfer, which would strengthen the case further to permit trains to run with TPWS and AWS.

4.3.13 From the sensitivity case of 5%, 10% and 30% degradation is it clear that even for the most optimistic case, with 5% degradation of ATP units per year, the knock-on risk that would result from withdrawing ATP units from service when they fail is much higher than the risk from permitting them to operated using TPWS and AWS.

Modal Shift Analysis

4.3.14 The effect of operating with Option B on fleet availability through to 2023 would clearly result in overcrowding in 2022 and 2023 particularly in the more severe rates of SELCAB ATP failure cases. In these circumstances, passengers are forced to consider other travel options. It is not possible to accurately model this modal transfer. Instead the risk associated with alternative transport modes have been reviewed.

4.3.15 The alternative means of transport include:

- Alternative train services offered by other operators (most which rely on conventional TPWS installation on trains and infrastructure).
- Bus replacement services, or alternative existing bus or coach travel
- Private transport by car or motorbike.

4.3.16 Figure 6 presents a comparison of risk per kilometre for alternative transport modes using data from RSSB. The values shown are referenced back to rail and therefore all other transport modes are a multiple of rail.

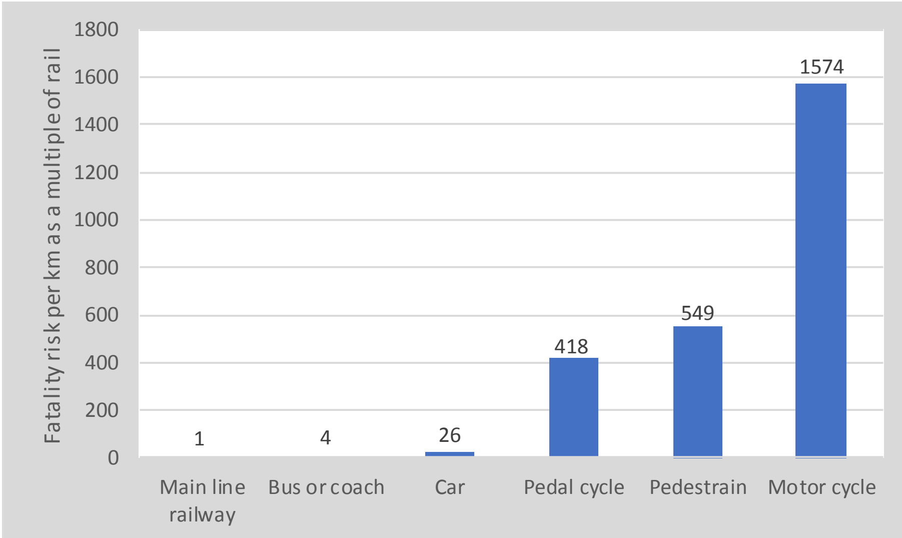

Figure 6: Comparison of the risk per transport mode on a km travelled basis

4.3.17 For passengers that cannot find an alternative, convenient rail service, the most likely alternative forms of transport are bus/coach and car; these are a factor of 4 and 26 higher than rail respectively. Hence, assuming a journey of equivalent distance is made by the alternative mode, the risk to an individual would be much higher for the journey.

4.3.18 In the best-case scenario, some passengers may find alternative methods of travelling to their destination by rail. This would be using services that are mainly protected by TPWS and therefore would carry substantially the same risk as CRCL services if they were permitted to operate with ATP isolated. In practice, the CRCL service would be a mix of ATP and TPWS protected journeys, hence travelling with an alternative operator is likely to introduce a slight risk increase.

4.4 Conclusion of Risk Assessment

4.4.1 There are two potential strategies to respond to irreparable SELCAB ATP on the CRCL fleet that cannot be repaired. These are termed Option A and Option B for the purposes of this report. Option A involves permitting the trains to operate using TPWS and AWS. Option B involves withdrawing the units from service until the planned TPWS upgrades have been implemented (due for completion by end 2023). The following conclusions are made:

- The credible worst case of the SELCAB ATP system failing irreparably on 20% of units per year, the safety risk from Option B vastly exceed the risk from Option A due to the knock-on risk that would result from train cancellations. By the end of 2020, the risk would be an order of magnitude of 3 times higher gradually increasing to a factor of 140 higher by the end of 2023. With this level of degradation, it would also not be possible to operate peak levels of service beyond 2021 (only off-peak levels of service would be deliverable).

- The risk assessment is highly sensitive to the assumption on the rate of ATP unit degradation and as mentioned earlier in this report, the 'knock-on' risk should be read as an estimated guide to order of magnitude of risk increase and not absolute. Hence a range of sensitivity cases has been analysed. Even with the most optimistic case assessed, at 5% degradation, the knock-on risk results in the risk from Option B being 20% higher than Option A by the end of 2021 and a factor of over 6 higher by the end of 2023. There would also be a moderate erosion in peak services from 2022 onwards.

- In addition to knock-on risk there is also the potential for passengers, when experiencing progressively lowering levels of overall railway capacity, to use other forms of transport (intermodal transfer). The most likely alternatives are other forms of road transport such as bike, car and bus/coach. Each of these modes carries a higher level of risk per km and per journey. The more likely alternative forms of bus/coach and car are a factor of 4 and 26 higher than rail respectively. Hence, the potential for intermodal transfer would also strongly indicate that the safer option is Option A.

4.4.2 In conclusion, the FWI Risk Assessment and Modal Shift Analysis both demonstrate that the lowest risk approach is Option A permitting trains with irreparable SELCAB ATP to operate with TPWS and AWS justifying this Exemption.

4.5 Operational Changes and Upgrade Prioritisation to Minimise Risk

4.5.1 During the Exemption period the FWI risk associated with train protection will change. The FWI risk will increase due to an increasing number of irreparable ATP units. However, the FWI risk will decrease as Enhanced TPWS is rolled out and the On-Train TPWS upgrade progresses.

4.5.2 This section considers how the FWI risk can be best managed during the Exemption period to maintain the FWI risk to SFIRP levels.

4.5.3 The only risk control measures that can be taken are to limit the risk through operational changes that maximise the availability of working SELCAB ATP and prioritise the Enhanced TPWS and cab TPWS upgrade schemes to maximise the early benefits of these upgrades.

4.5.4 The risk control measures may include:

1. Reformation of the fleet.
2. Operational controls to maximise the use of irreparable ATP units to infrastructure without ATP.
3. Prioritisation of the Enhanced TPWS infrastructure fitment.
4. Prioritisation of the on-train TPWS upgrade.

4.5.5 These options are considered in turn for reasonable practicability in the next sections.

4.6 Fleet Reformation

4.6.1 In early 2019, CRCL reviewed options to reform the fleet within the constraints of the existing timetable, franchise agreement and passenger requirements. This identified options to "box-in" 2 x 2-car Class 165 units to form a 4-car unit releasing 2 cab spares of SELCAB ATP equipment. This is now implemented in the CRCL base train plan.

4.6.2 The SELCAB ATP equipment on the Class 165, 168 and 172 units is slightly different due to their different maximum speeds and equipment differences across the trains.

4.6.3 The unit diagrams for the Class 168 fleet have been reviewed to see whether there are any opportunities to operate the fleet with some semi-permanently coupled units. This would allow cabs to be "boxed in" releasing SELCAB ATP spares to support the fleet. This review found that all Class 168 diagrams involved coupling and uncoupling daily and do not facilitate semi-permanent coupling.

4.6.4 In addition, the ATP fitted Class 168 units are all 3-car or 4-car units. Therefore "boxing-in" in 2 x 3-car units would lead to a 6-car unit. The CRCL train maintenance depot at Aylesbury is single ended and based on a longest unit length of a 4-car unit. Therefore a 6-car unit would not fit in the train maintenance depot at Aylesbury and would be impractical to operate.

4.6.5 The option of a large-scale reformation of the fleet to produce more 4-car Class 168 units by converting 3-car units to a combination of 2-car and 4-car units would likely require re-writing the timetable and deviations from the franchise agreement.

4.6.6 A review of the Class 172 fleet (4 x 2-car units) was undertaken but it was found that reforming them as 2 x 4-car units would lead to major problems in maintaining driver traction competence and the loss of a single vehicle due to a defect would result in the loss of 50% of the fleet. This would make this fleet even more difficult to operate and maintain than is currently the case given its small size.

4.6.7 A further complication in reformation of the fleet is that the Chiltern route has a large range of platform lengths compared to some other UK rail routes. This means that the timetable has to be carefully planned. A range of different unit lengths (2-car, 3 -car & 4-car) aids providing a range of train lengths to suit platform lengths. For example, the existing Class 168 fleet with nearly equal numbers of 2, 3 & 4-car units enable train lengths of 2, 3, 4, 5, 6, 7, 8 and 9 cars. The use of longer trains on CRCL services is unsafe, as there is no automatic selective door opening on the fleet to prevent doors from opening that are not on a platform. Fleet reformation would likely reduce this flexibility, which is a particular problem in times of service perturbation.

4.6.8 It is concluded that the option of reforming the fleet as a risk mitigation is therefore undesirable and would increase risk especially in times of service perturbation, as there would be less operational flexibility due to a proportionally smaller 3-car Class 168 fleet.

4.7 Limiting the use of irreparable ATP trains to non-ATP infrastructure

4.7.1 Figure 7 below shows the Chiltern network and Figure 8 the ATP infrastructure.

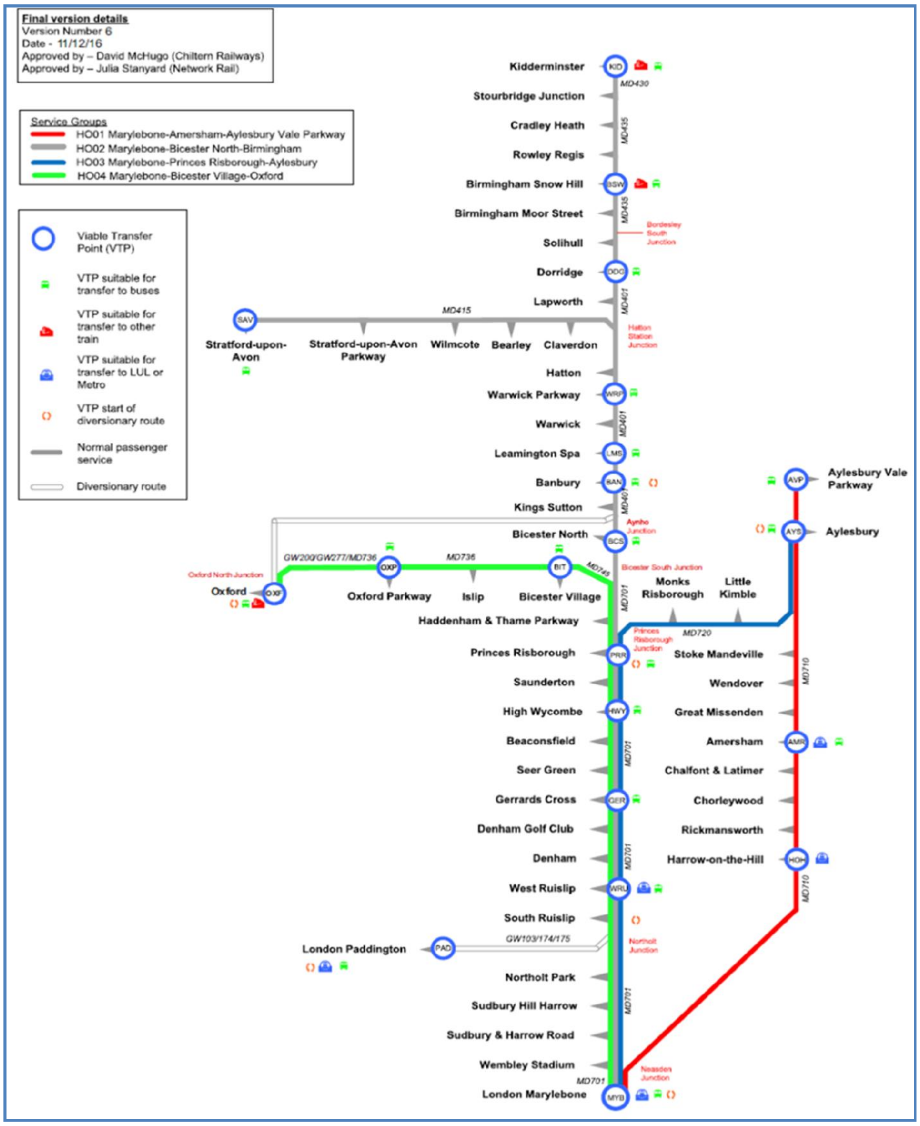

Figure 7: Chiltern Railways Map

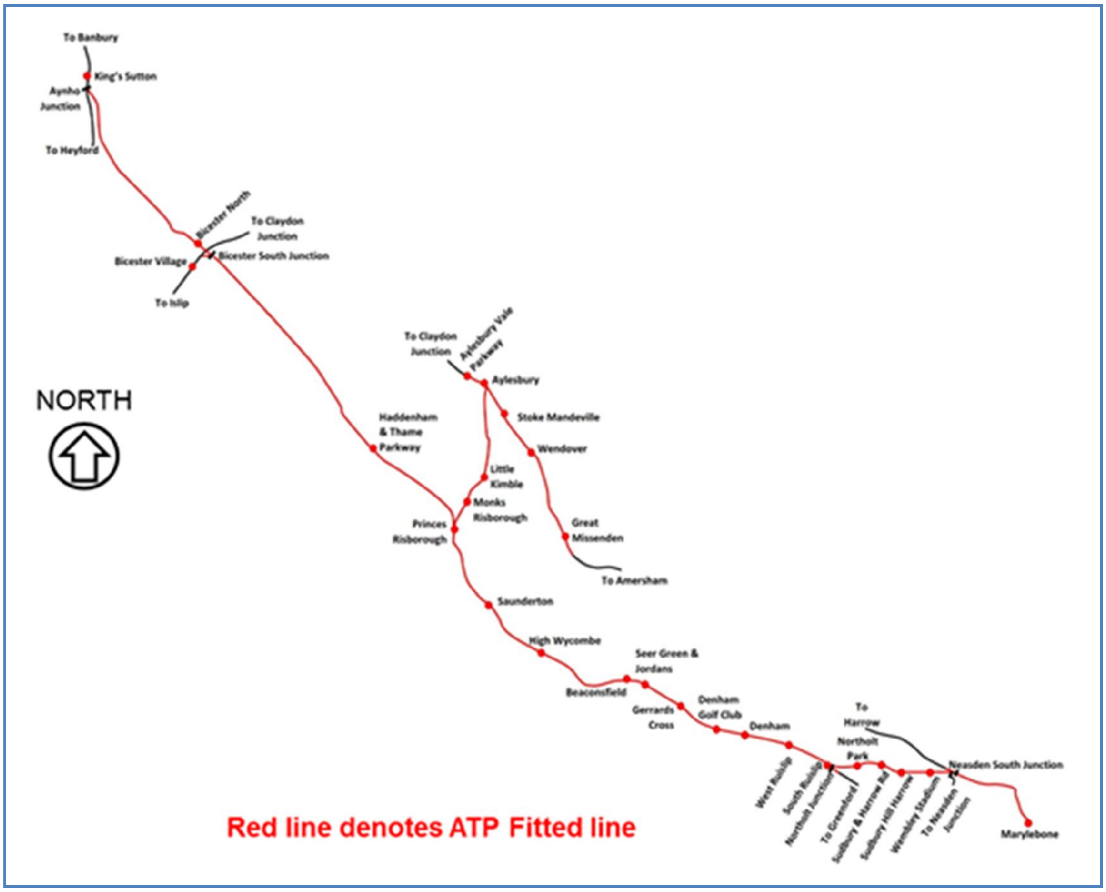

Figure 8: SELCAB ATP fitted infrastructure

4.7.2 It is clear from this that every train into London Marylebone uses ATP infrastructure and this is over 97% of CRCL services. The opportunity to limit irreparable ATP trains to non-ATP infrastructure is limited to just a single unit that operates the Birmingham Moor Street to Leamington Spa shuttle service. This unit is used to operate trains into London Marylebone in the case of service perturbation.

4.7.3 Reference Document 1 demonstrates that CRCL operates many services already with non-ATP fitted trains. This is essentially those cascaded into the company's fleet since 2011. Therefore, it is impractical and illogical to restrict trains with irreparable ATP to non-ATP infrastructure, when there are many trains (approximately 20% of the fleet) already operating in the ATP area without ATP protection.

4.7.4 It is therefore concluded that operational control to restrict trains with failed ATP equipment to non-ATP areas could only be of use on one train, is not logical and impractical as an operational risk control measure.

4.8 Prioritisation of Infrastructure for Enhanced TPWS Upgrade

4.8.1 The Enhanced TPWS infrastructure upgrade can prioritise higher risk infrastructure first to maximise the risk reduction. High risk infrastructure includes locations where there is a high intensity of trains, high passenger loadings and geographical features (such as tunnels & viaducts).

4.8.2 The most intense train service with ATP protection is from Neasden South Junction to Marylebone (see figure 2). Therefore, it would be reasonable to start at Marylebone and work towards Aynho Junction to maximise the benefits of Enhanced TPWS protection early.

4.8.3 This is a practical risk control that will be applied in the role out of Enhanced TPWS. Certain Enhanced TPWS installations may be constrained by access and technical restriction but the delivery strategy is to start at Marylebone and work north.

4.9 Prioritisation of Cab Upgrade to Mk4 TPWS

4.9.1 The benefit of the TPWS cab upgrade varies with sub-fleets of the CRCL fleet. This is because of the following factors:

- **Differences in utilisation** – The Class 165 units typically cover 105,000 miles per year. The Class 168 units have a typical annual mileage of 200,000 miles. The locomotive hauled trains and Class 172 fleet have a typical annual mileage of 140,000 – 150,000 miles. Earlier implementation of the cab upgrade on higher mileage trains will result in an early and larger risk reduction than on the lower mileage trains.

- **Differences in maximum speed** – The Class 165 units have a maximum speed of 75mph contrasting with a maximum speed of 100mph on the locomotive hauled Mk3 services and the Class 168 and 172 fleets. In general terms the severity of a major incident increases significantly as speed increases. Therefore, there is a greater risk reduction from the cab upgrade on the higher speed trains.

- **Differences in Use** – The Class 165 fleet tends to be used more on services between London Marylebone and Aylesbury via Amersham. This route uses 13 miles of London Underground infrastructure between Amersham and Harrow on the Hill, where train protection is provided by tripcocks and neither SELCAB ATP or TPWS are effective. The Class 168, 172 and locomotive hauled services tend to operate on the route between London Marylebone and Birmingham Moor Street/Oxford via High Wycombe where both TPWS and SELCAB ATP are used. Therefore, the cab upgrade should prioritise trains mainly operating on the London Marylebone to Birmingham Moor Street/Oxford via High Wycombe route.

- **ATP Obsolescence risk** – The SELCAB ATP equipment is not identical across all fleets due to differences in maximum speed. CRCL's obsolescence risk is greatest on the 100mph capable fleets since there are no spare speedometers and new ones are no longer manufactured. There is less of a problem on the 75mph maximum speed fleets. Therefore, the cab upgrade should prioritise the 100mph capable trains.

- **Existing Train Protection equipment** – The train protection equipment and TPWS standard fitted across the fleet varies with Mk3 DVTs, Class 68 locomotives and Class 168/3 units trains operating without ATP. Within these sub-fleets the Mk3 DVTs have Mk1 TPWS equipment. The Class 68 locomotives and Class 168/3 units already have Mk4 TPWS equipment. Therefore, the cab upgrade should target the Mk3 DVTs as a priority since they have the oldest TPWS equipment and do not benefit from any ATP protection.

4.9.2 It is concluded that the cab installation of Mk4 TPWS can be prioritised so that the sub-fleets with the following features are fitted first to maximise the risk reduction early:

1. Higher annual mileage
2. Higher maximum speed.

3. Utilisation on the London Marylebone to Banbury via High Wycombe route.
4. Fleet with the highest ATP obsolescence risk.
5. Fleets without any ATP equipment.

4.9.3 This leads to the following priorities (1 = highest):

1. Mk3 DVT
2. Class 168
3. Class 172
4. Class 165

5 Final Option Selection

5.1.1 It is concluded that Option A (Allowing trains with irreparable ATP to remain in service) is the SFAIRP approach supporting the case for this Exemption.

5.1.2 It is concluded that neither fleet reformation or limiting trains with irreparable SELCAB ATP to non-ATP infrastructure are practical measures to reduce FWI risk mainly because they are likely to increase risk during train service perturbation by reducing operational flexibility on an already operationally constrained railway.

5.1.3 It is concluded that the early risk reduction benefits of Enhanced TPWS can be best gained by starting at London Marylebone and working northward to Aynho junction.

5.1.4 It is concluded that the priorities for the on-train TPWS upgrade to Mk4 TPWS to maximise the risk reduction benefits early are (1= highest priority):

1. Mk3 DVT
2. Class 168
3. Class 172
4. Class 165

5.1.5 This strategy mitigates the FWI risk increase resulting from irreparable SELCAB ATP during the Exemption period.

6 Safety Assurance

6.1 Common Safety Method for Risk evaluation and Assessment (CSM-RA)

6.1.1 CSM-RA is a framework that describes the common mandatory European risk management process for the rail industry. Further information can be found in ORR document - *Guidance on the application of Commission Regulation (EU)* 402/2013 – September 2018.

6.1.2 CRCL has reviewed the entirety of the ATP Obsolescence Project applying the CSM-RA methodology and has developed a preliminary system definition for the project. This preliminary system definition was used to assist in analysing what risks were being changed by the level of impact on safety that could be expected.

6.1.3 The change has been subject to a significance assessment in line with CSM-RA requirement and recorded in Table 2 below.

Change Description	
Delivery and operation of Enhanced TPWS (onboard) and removal of SELCAB ATP from use.	Yes (Chiltern AsBo) (Reference Document 4)

Table 2

6.1.4 The CSM Significance Assessment found that the removal of ATP equipment from use is a "Significant" change. Therefore, the CSM process is being applied and an AsBo is being appointed to oversee it.

6.2 Operational Safety Plan

6.2.1 An Operational Safety plan for the Exemption period is provided in Appendix 1. This details the operational management approach to minimise risk during the Exemption period.

7 Stakeholder Engagement / Consultation

7.1.1 A number of stakeholders have been engaged / consulted, and others will be subsequently informed.

7.1.2 The following stakeholders have been a key part of the exemption development and have provided letters in support of the exemption request:

- Network Rail Infrastructure Limited (NR).

7.1.3 Following stakeholders have been identified and engaged in preparation of this exemption application:

- Department for Transport (DfT)
- Office of Road & Rail (ORR)
- Railway Safety & Standards Board (RSSB)
- Trade Unions (ASLEF, RMT, UNITE)
- Train Operating Companies (TOCs), including Trade Unions:
- Transport for London /London Underground
- Freight Operating Companies (FOCs)
- Angel Trains
- Eversholt Rail Group
- Porterbrook Leasing

7.1.4 The following CRCL internal stakeholders have been identified and engagement as required:

- Managing and Executive Directors
- Chiltern Railways Safety Committee
- Operational Safety and Standards Group

8 Reference Documents

1. Chiltern Route Train Protection – Railway Safety Regulations 1999 Exemption Application Report, Network Rail, April 2020.
2. Rule Book GE/RT8000, RSSB, December 2019.
3. Risk Assessment of Chiltern Railways ATP Obsolescence, J2050 Rev02, Sotera Risk Solutions, April 2020.
4. Chiltern Railways Engineering Report R351, SELCAB ATP Removal – Assessment of Verification Route, Issue 01, January 2020.

9 Appendix 1 Operational Safety Plan

9.1 Purpose

9.1.1 The Operational Safety plan details how the train protection risk mitigated by SELCAB ATP will be managed during the Exemption period. This is the period from July 2020 to the end of Exemption sometime in 2023 when Enhanced TPWS will be fully operational and SELCAB ATP will be removed from service.

9.2 Underlying Commitment

9.2.1 CRCL and NR commit that during this exemption period that where-ever reasonably practical that trains fitted with SELCAB ATP will be operated with it working.

9.3 Train Protection Operation and Monitoring

9.3.1 The Chiltern route will operate in accordance with the Railway Rule book GE/RT8000 (Reference Document 2) and other group standards during the Exemption period.

9.3.2 CRCL commits that the SELCAB ATP system will be operated in accordance with its Defective On-Train Equipment plan.

9.3.3 NR and CRCL will meet as a minimum annually in accordance with rail industry processes to monitor the train protection risk on the Chiltern route. This meeting shall determine the train protection risk profile and propose any additional controls or local interventions that are required to manage the risk to ALARP level. The meeting shall consider:

1. Whether the modelling assumptions in the Exemption are still valid.
2. Train Protection precursor incidents such as SPADS, adverse SORAT scores and adverse reliability of train protection equipment.

9.4 Enhanced TPWS Roll out

9.4.1 NR commits to the deployment of Enhance TPWS, starting at Marylebone and working North. Deployment is expected to start in late 2020 and be complete by end 2023.

9.4.2 NR will report to the ORR every 6-months on progress against this plan.

9.5 Changes to NR Infrastructure

9.5.1 NR commits that any changes to the infrastructure during the Exemption period will maintain the Enhanced TPWS fitment unless a better form of train protection (for example ETCS) is provided instead.

9.6 On-Train TPWS Upgrade

9.6.1 CRCL commits to the following indicative milestone plan for the Mk4 TPWS on-train upgrade:

- All Mk3 DVTs modified by 31st December 2022
- All Class 168s modified by 31st December 2022
- All Class 172s modified by 31st December 2023
- All Class 165s modified by 30th June 2024

9.6.2 *Important Note:* The current Chiltern franchise terminates on 31st December 2021 and CRCL cannot commit a future franchisee that is not CRCL, to make this commitment in the future franchise. However, it is expected that the DfT/ORR may require this for any new franchisee.

9.6.3 CRCL will report to the ORR every 3-months on progress against this plan.

9.7 Changes to the Chiltern Fleet

9.7.1 CRCL commits that any fleet cascades or new fleets that it undertakes during the Exemption period will include Mk4 TPWS cab equipment to maintain the higher level of protection provided by this TPWS upgrade.

9.7.2 *Important Note:* The current Chiltern franchise terminates on 31st December 2021 and CRCL cannot commit a future franchisee that is not CRCL, to make this commitment in the future franchise. However, it is expected that the DfT/ORR may require this for any new franchisee.

9.8 Exemption End Point

9.8.1 This exemption will no longer be required once the following conditions are met:

1. The exemption sought by Reference Document 1 is granted.
2. CRCL has upgraded its whole fleet for Mk4 TPWS cab equipment.
3. NR has largely fitted Enhanced TPWS to the Chiltern Route. (There are some locations where it is not possible to fit additional TPWS equipment without first de-commissioning the ATP equipment).
4. The CSM-REA process for ATP withdrawal for use is complete.

9.8.2 It is currently planned that the exemption will not be required after 30th June 2024. If CRCL or NR believe that the conditions above will not be met before this date, then they shall consult with the ORR on the best way forward. This may include a new short-term exemption.