Safety of Driver Controlled Operation (DCO)

June 2018

Executive Summary

In 2017, RSSB published a report on train dispatch risk which showed the difference in risk between different methods of train dispatch.

This report considers, in addition to train dispatch, the other scenarios where auxiliary on-board staff would traditionally be expected to play a part, including on-board assaults to passengers, protecting the line in an emergency, and dealing with or preventing uncontrolled evacuation.

All of these risks are small and not significant when compared to the general risks associated with managing and operating the railway.

Considering the overall risk from these four areas, the introduction of DCO is not expected to increase safety risk and may result in a small decrease in safety risk. Duty holders have a legal obligation to assess safety risk and to manage safety risk so far as is reasonably practicable.

Given implementation in accordance with these established safety management processes, there is no safety reason to prevent the further adoption of DCO.

Further, it is recommended that, where trains have auxiliary staff such as on-board supervisors, train operators should consider training these staff to use the GSM-R radio (particularly the REC functionality) in an emergency. In situations where the auxiliary person is unavailable at start of service, then the train should continue into service as DOO (Driver Only Operated), as this option is the lowest risk overall (when the knock-on risk of cancelling the train is also considered).

1 Introduction

Train operators need to be able to staff their trains in different ways to suit different scenarios. Long distance, intercity services will typically need more staff on-board to offer appropriate customer service, such as catering, while shorter distance, metro-style services may be able to operate with just the driver. Historically, staff on-board might have also had a role in managing safety, so understanding their contribution to risk management is important.

The purpose of this report is to provide train operators with an informed understanding of both the size of the risk presented to them in scenarios where auxiliary on-board staff would traditionally be expected to play a part, and show how the risk differs between operating with or without them. It builds on work RSSB published in 2017 which showed the difference in risk associated with train dispatch.

2 Terms

This report will make reference to different ways of operating trains – below are some definitions to aid consistency:

Driver-and-conductor operated	The conductor – or guard - is responsible for closing the doors and determining that it is safe to start the train. The conductor is normally responsible for releasing the doors as well.
Driver controlled operation (DCO)	The train driver is responsible for door operation and determining that it is safe to start the train, although other auxiliary members of staff may be provided on the train
Driver only operation (DOO)	The train driver is responsible for door operation and determining that it is safe to start the train, and is the only member of staff on the train

3 Scope

The purpose of this study is to quantify the change in safety risk from moving from trains with driver-and-conductor to services under driver controlled operation (DCO).

It focusses on the conductor's ability to mitigate risk in the following areas:

- Dispatch risk, including SPADs that could be affected by the dispatch process
- On-board assaults
- Protecting the line in an emergency
- Dealing with or preventing uncontrolled evacuation

Other potential safety benefits of conductors that have not been quantified include:

- Reducing the consequence of accidents, for example by contacting the emergency services or giving first aid to passengers.
- Prevention of terrorism by acting as another pair of trained eyes or as someone for passengers to report security concerns to.

This is because either the effect is difficult to quantify or in the case of security, prone to rapid changes in threat level. Many of the benefits of the conductor, particularly around security and preventing uncontrolled evacuation can be delivered using on-board auxiliary members of staff.

There are a range of other potential benefits of the conductor which are outside the scope of this study, for example making the train service accessible to people of reduced mobility, revenue protection and providing information to passengers and customer service. The conductor (or other on-board staff) may also increase the perception of safety and security for passengers, which in turn is also beneficial to both the passengers and indirectly to the operator through increased revenue.

4 Risks that a conductor or other on-board staff influences

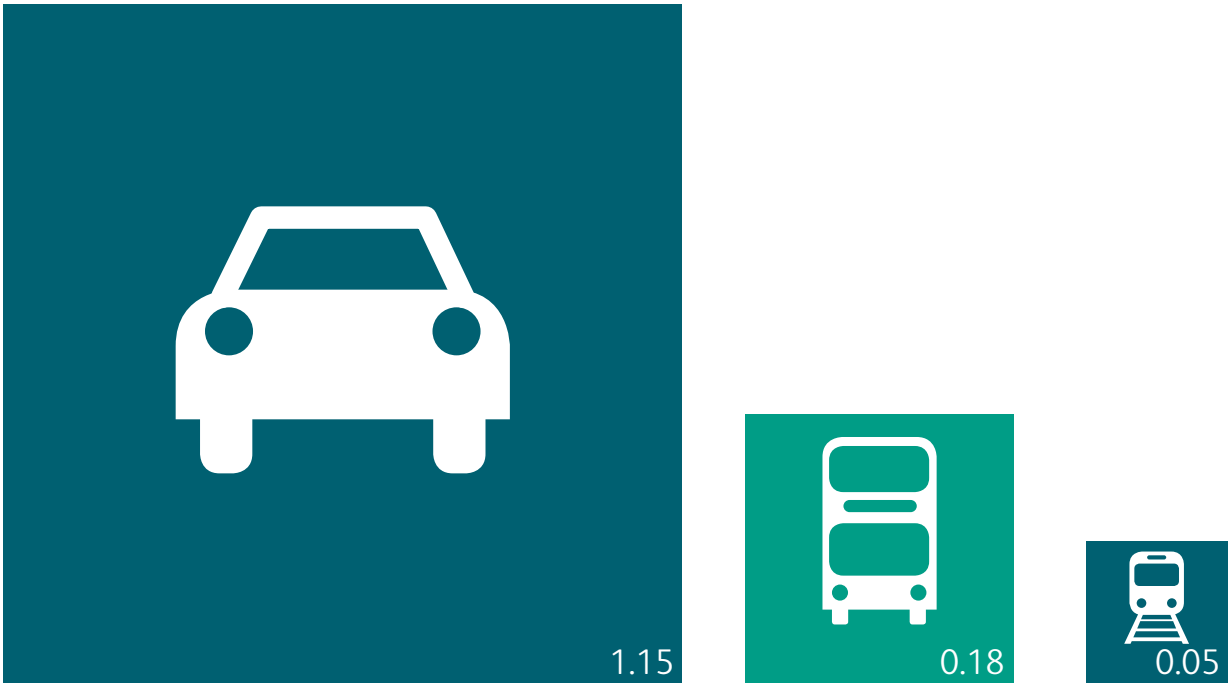
Compared to other forms of transport, rail travel is very safe. Figure 1 indicates that the rate of fatalities for car travel are around 20 times higher than for rail travel. The usual measure for harm in the mainline rail industry is 'fatality and weighted injury' (FWI) which is a way of measuring the level of harm or risk in a consistent way, by combining the fatalities, major injuries and minor injuries in one unit of measurement. Each injury type is scored in a way that is 'statistically equivalent' to one fatality. The weightings can direct intervention towards those incidents and accidents that lead to the highest levels of risk without ignoring the types of incident that typically have less severe outcomes.

The Safety Risk Model (SRM) [1] estimates that the overall risk from mainline railway operations in Great Britain is 132 fatalities and weighted injuries (FWI) / year (excluding suicides).

Risk to passengers and public at the platform train interface (PTI) accounts for approximately 13 FWI /year. The risk associated with train dispatch is 1.8 FWI /year.

Train accident risk is approximately 7.9 FWI /year for which the risk of secondary collisions (mitigated by protecting the line in an emergency) is about 0.47 FWI /year. The dispatch related risk due to SAS SPADs is 0.06 FWI / year.

Figure 1: Traveller fatality rates for car, bus/coach and rail transport modes



Passenger fatality rates per billion passenger km
Annual Safety Performance Report 2016/2017, RSSB

On-board assaults by passengers (on passengers) accounts for 4.5 FWI /year.

These risks are considered in the following sections, and shown graphically, relative to overall risk, in figure 2.

4.1 Dispatch risk (including SAS SPADs)

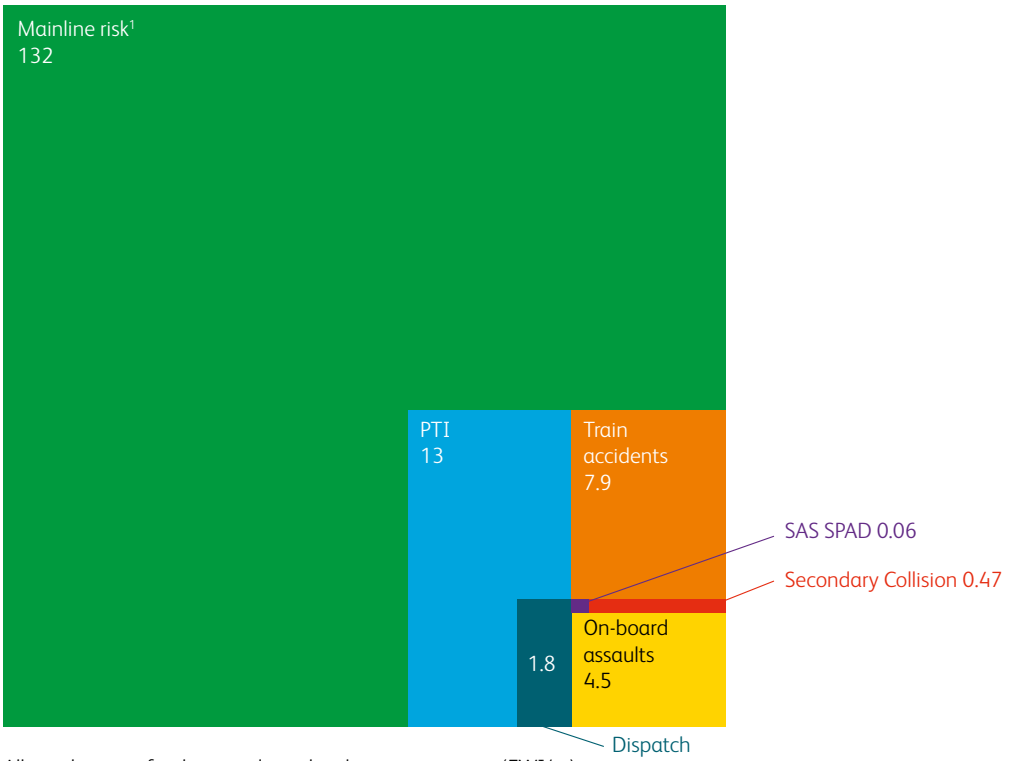
Some work has already been done to understand the risk associated with train dispatch, notably [2] in 2017. This study has not duplicated any of this work but has extended the analysis.

Dispatch risk covers all personal accidents to passengers and members of the public associated with train dispatch, including:

- Injuries while they are boarding or alighting a train
- Coming into contact with a train while on the platform
- Falling between a stationary or departing train and the platform

It also includes the risk of collision following signals passed at danger (SPADs) when starting against signal (SAS) at platforms which can be related to train dispatch.

Figure 2: Risk from dispatch, assaults, secondary collisions and SAS SPADs



All numbers are fatalities and weighted injuries per year (FWI/yr)

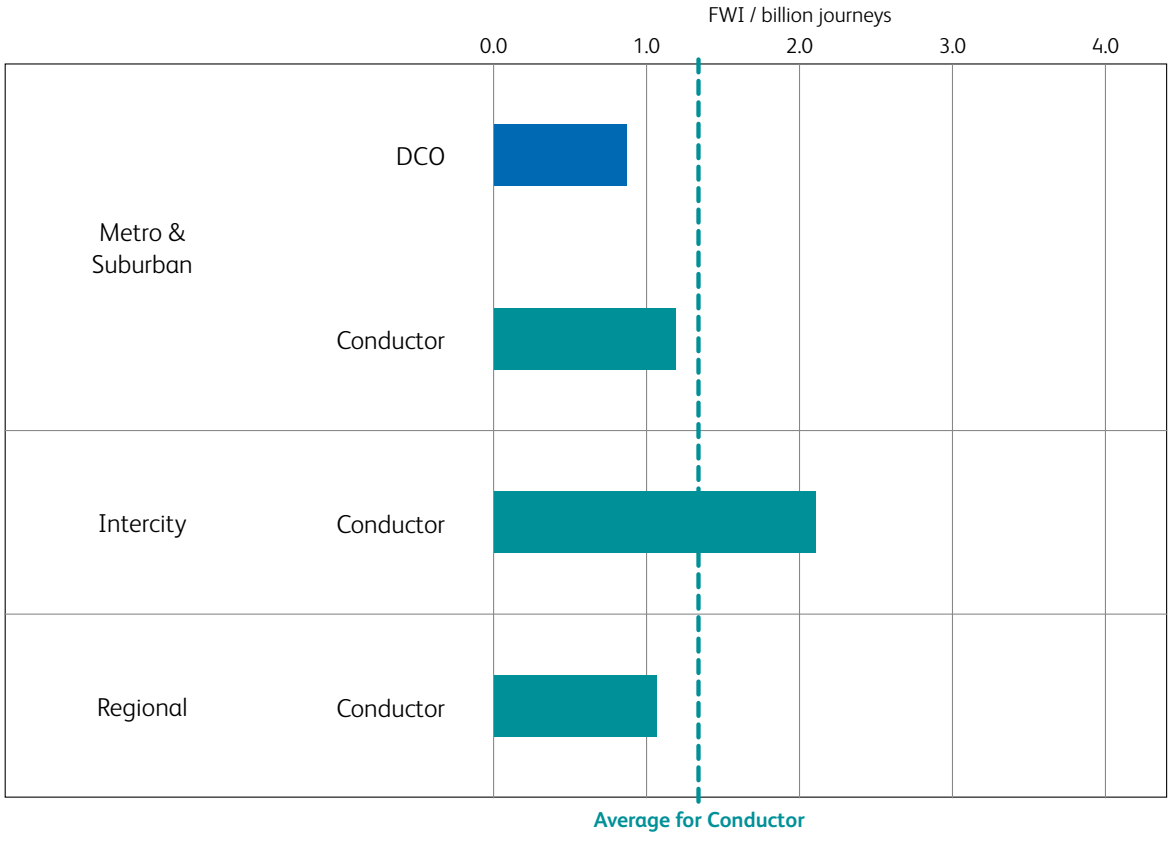
[1] Mainline risk on this chart includes a wide range of risks, examples include risks to passengers such as slips, trips and falls, risk at the platform-train interface, assaults and abuse, on-board injuries, train accidents as well as injuries to the workforce such as electric shock, and public trespass. It does not include suicides.

Data from the industry's Safety Management Intelligence System (SMIS) for the six-year period 2010-2015 was used in this study which is the same data set as used in the 2017 report on train dispatch [2]. One of the difficulties in comparing risk associated with conductor operation with DCO operation is that the DCO services are mainly on commuter routes, whilst long-distance services are almost entirely conductor operated. Hence any differences between the observed risk of DCO and conductor operated services might be the result of the different types of operation, rather than a result of the presence of the conductor.

To try to understand this effect the risk has been grouped by type of operator: metro and suburban; intercity and regional. This is a simple allocation and does not take account of the fact that some of the larger TOCs have services that may fall into more than one category. Metro and suburban operators include companies that cover the London and South East commuter network and Merseyrail. Intercity operators refer to companies such as Virgin Trains (West Coast and East Coast), East Midlands Trains, Great Western Railway and the open access operators. Regional operators refer to companies such as Northern, Scotrail and Arriva Trains Wales.

Figure 3 shows the risk for each operator group. To allow for a comparison between DCO and conductor operations, the risk has been normalised by passenger journeys. The average rate of risk from train dispatch (including both risk at the passenger train interface and

Figure 3: Dispatch risk (PTI and SAS SPADs) by type of operation



SAS SPADs) is 1.13 FWI per billion passenger journeys, which equates to 1.86 FWI per year.

The data suggests that driver dispatch (0.87 FWI per billion passenger journeys) is lower risk than conductor dispatch (1.35 FWI per billion passenger journeys). Some possible reasons for this include:

- Passengers on commuter routes may be more experienced and familiar with the way the trains are operated, and less likely to have an accident
- Passengers on intercity routes may have more luggage and be more prone to having an accident at the platform-train interface (PTI)
- When there are large numbers of passengers, some elements of the risk at the PTI (eg being struck by the closing doors) may only affect the last few passengers to board through any given door. This may lead to the risk on very busy services to appear lower when normalised by passenger journeys.

Differences in the rates of reporting of injuries, between trains with conductors and those without, is not believed to be a major factor in explaining these results. This is because the pattern is broadly similar when considering just the more serious injuries (fatalities and major injuries), which would be expected to be consistently reported [2].

However, even within metro and suburban train operators, driver dispatch is still lower risk than conductor dispatch (1.19 FWI per billion passenger journeys). Duty Holders have a legal obligation to assess safety risk and to manage safety risk so far as is reasonably practicable. Given implementation of DCO in accordance with these established safety management processes, dispatch risk is not expected to increase, and there may be an overall decrease in safety risk.

4.2 Protecting the line in emergency

Secondary collisions occur following a train accident, where another train collides with derailed vehicles fouling an adjacent line. Notable train accidents in the UK where a secondary collision has occurred are Great Heck (2001) and Clapham (1988). It has been estimated from the Safety Risk Model [1] as about 0.47 FWI/year or about 5 % of train accident risk.

The analysis assumes that if a driver is available then they will first make a GSM-R Railway Emergency Call (REC) if possible, and then the driver (and conductor if present) carry out all the tasks in the Rule Book exactly as they are written currently. The following aspects are considered in the model:

- Whether the driver initiates pre-emptive REC before the accident.
- Whether or not the train has a conductor on it.
- Whether the driver is incapacitated during the accident and not able to use the GSM-R radio.
- Whether the train's cab radio is broken during the accident.
- Whether the driver is injured during the accident so that they cannot leave the cab.
- Whether there is another cab with a working radio which other members of train staff may use.
- Whether the driver or conductor may stop trains by placing Track Circuit Operating Clips on the track (and whether they are effective eg in axle counter areas).
- If the driver is incapacitated, whether the conductor can use the cab radio to make a REC.
- Whether a lineside telephone may be used to contact the signaller.
- The time taken for a driver or conductor to walk along the track to the braking distance of the next oncoming train to flag it down.

An average protection time is calculated which can then be compared with the next oncoming train's braking distance and average headway to determine a probability that the oncoming train will be able to stop before a collision occurs. The probability that a train may be able to stop on sight is also included and an overall probability of a collision occurring is calculated. This probability is then converted into a risk value using consequences derived from the Safety Risk Model (SRM) [1].

Because the event tree explicitly considers the presence of the conductor, the risk can be calculated both with and without a conductor present. If services do have a conductor, then the risk of a secondary collision following a train accident (collision/derailment) is 0.79 FWI/billion train km. If services do not have a conductor then the secondary collision risk is 1.24 FWI/billion train km. These are shown in figure 4.

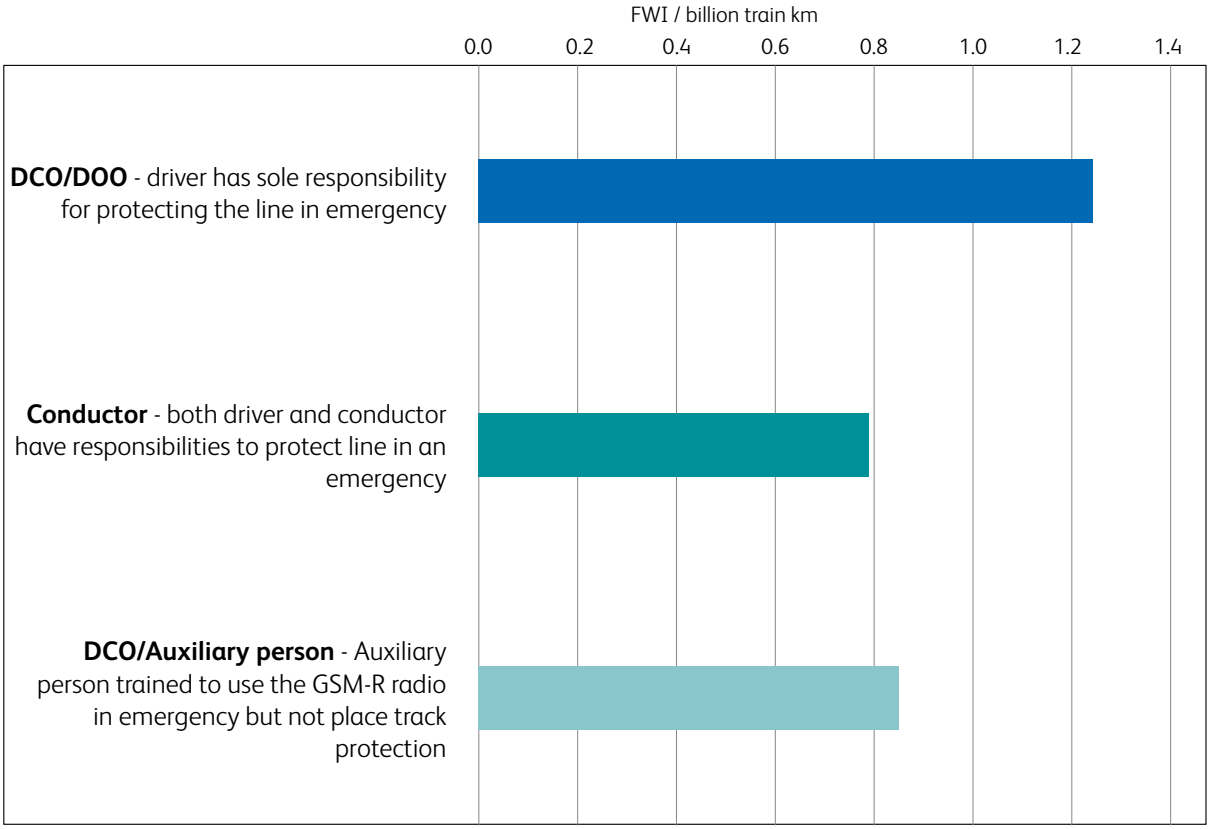
About 90 % of the benefit of the conductor is from using the GSM-R radio. If there was an auxiliary person on a DCO train that was trained to use the GSM-R radio REC functionality, then the risk would be 0.85 FWI / billion train km or about 0.20 FWI / yr. It is recommended that any auxiliary person on a DCO train is trained to use the GSM-R radio in an emergency. Consideration of knock-on risk if the auxiliary person is not available is given in section 6.

These are small levels of risk, and the difference for DCO can be almost completely mitigated by training auxiliary on-board staff to make a Railway Emergency Call (REC).

4.3 Assaults

Physical and verbal assaults by passengers on other passengers on-board the train amount to about 4.5 FWI per year. The visible presence of the conductor (or other on-board staff) could potentially reduce the likelihood of assaults and other anti-social behaviour. British Transport Police (BTP) data for the single year 1 October 2016 to 30 September 2017 has been analysed. From this data there were approximately 2,200 on-board assaults in that year period.

Figure 4: Protecting the line in an emergency

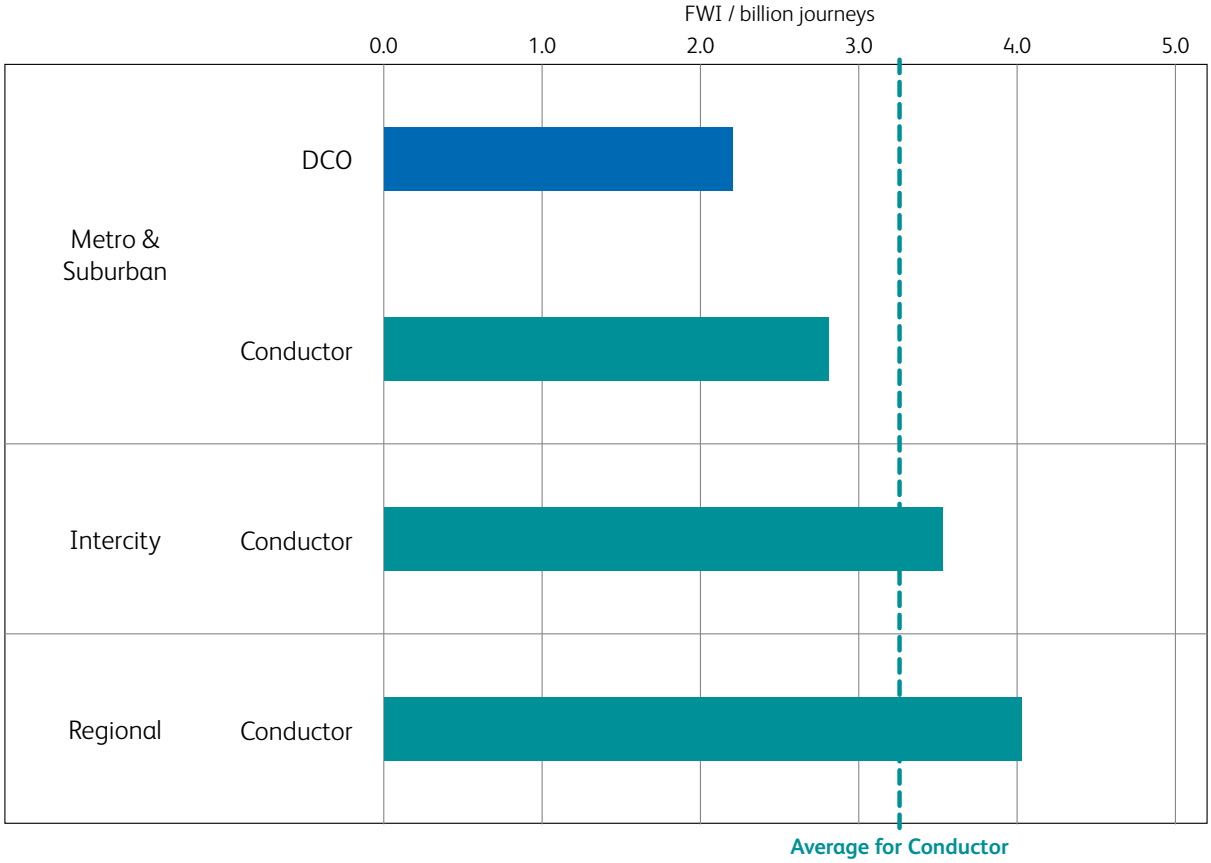


The reporting of on-board assault events is usually at a station (normally the station at the end of the journey) rather than the train the passenger was travelling on. Where all trains at a station are DCO or conductor operated, then it can be directly inferred what type of train the assault occurred on. Where there is a mixture DCO and conductor operated trains at the station where the assault was recorded, then the incidents were apportioned based on passenger journeys. Also, even if the assault occurred on a DCO train, there may have been other staff present on the train, for example ticket inspectors or security staff.

Notwithstanding these limitations with the data, figure 5 shows the on-board assault risk for the different types of train operation. The risk from on-board assault for DCO operations is 2.2 FWI per billion journeys, whilst the average for the conductor operations is 3.3 FWI per billion journeys. For conductor operated trains the risk is higher for regional operators and lowest for the metro and suburban operators. The rate of assaults per passenger journey is 50% higher for conductor operated trains when compared to the rate for DCO. For metro and suburban TOCs only, the rate of assaults is still 30% higher on conductor operated.

It is not tenable that the presence of a conductor has a detrimental effect on the risk from assaults but there are other factors that could explain the results.

Figure 5: On-board assault risk by type of operation



First, the risk figures are normalised by passenger journeys. Passengers on intercity trains are typically undertaking longer journeys, are on the train for longer, and are therefore exposed to a greater risk from assaults. Second, there may be regional variations in both the rate of assaults and the rate of under-reporting. Third, the presence of the conductor might affect the reporting of assault incidents, although this was not a significant factor with incidents relating to dispatch.

Train operators with restrictive alcohol policies appear to have lower rates of assaults than other similar train operators.

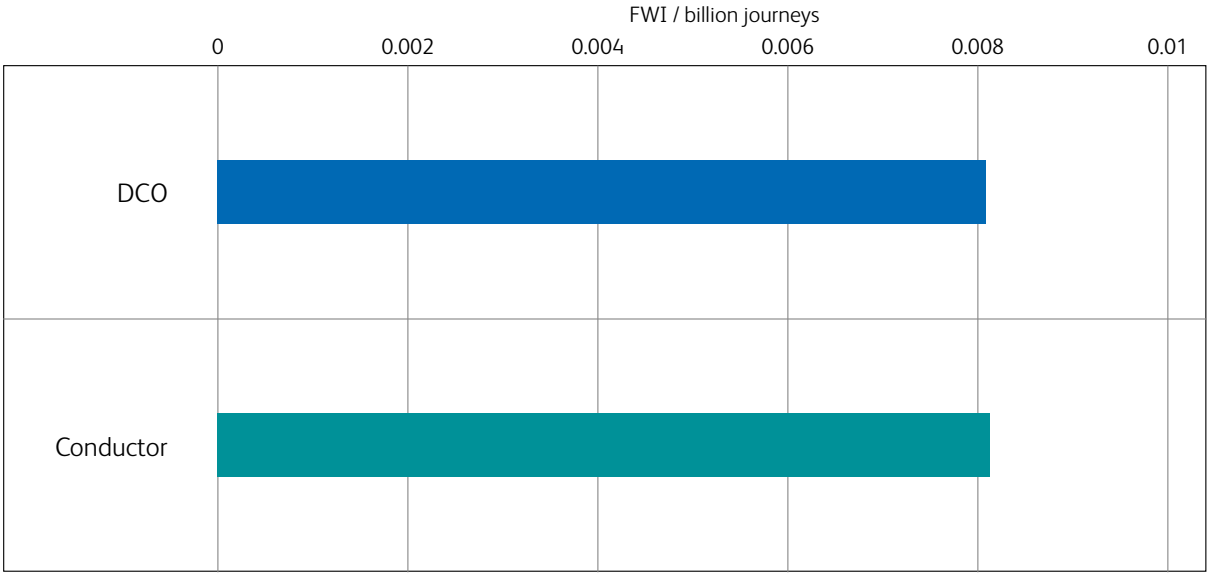
It can be concluded that, if the presence of the conductor does have a positive effect on the rate of assaults, then it is a very small effect when compared to other factors that influence the rate of assaults.

4.4 Uncontrolled evacuation

The presence of a conductor on the train could mitigate the risk of uncontrolled evacuation by passengers, particularly if the train has been stationary for some time. For DOO trains, the GSM-R can be used to make a call over the train's public address to manage customer expectations and mitigate this risk. Uncontrolled evacuation events are recorded in SMIS as trespass events. A search of SMIS events was undertaken and events where key words relating to either window, droplight, evacuation, alighting, detrain, door release, train door or exit train considered. A further filter was applied excluding events:

- where the evacuation was controlled / planned;
- where the passenger exited whilst the train was moving;
- where passengers exited immediately after the train had stopped, for example after using the PCA.

Figure 6: Uncontrolled evacuation events



It was found that there were 19 events over a 7.5-year period (about 2.5 per year) where it is believed that the presence of a conductor or auxiliary person could reduce the likelihood of uncontrolled evacuation. For these 19 events, there was only one injury (a major injury after coming into contact with the 3rd rail), so the risk has been estimated at 0.013 FWI year. These events are shown in figure 6 for DCO and conductor operation as there is insufficient data to split the events by type of train operations.

There are an insufficient number of events to draw definitive conclusions from the data although the rate of self-evacuation from DCO trains appears to be very similar for conductor operated trains.

In addition to getting accurate information to passengers many other factors affect whether passengers detrain or not, including: the length of time the train is detained; environmental conditions inside the train; environmental conditions outside the train; and distance to station or destination.

In conclusion the risk to passengers from uncontrolled evacuations is small and there is no evidence that the presence of a conductor or auxiliary person makes a significant difference to the rate of uncontrolled evacuations.

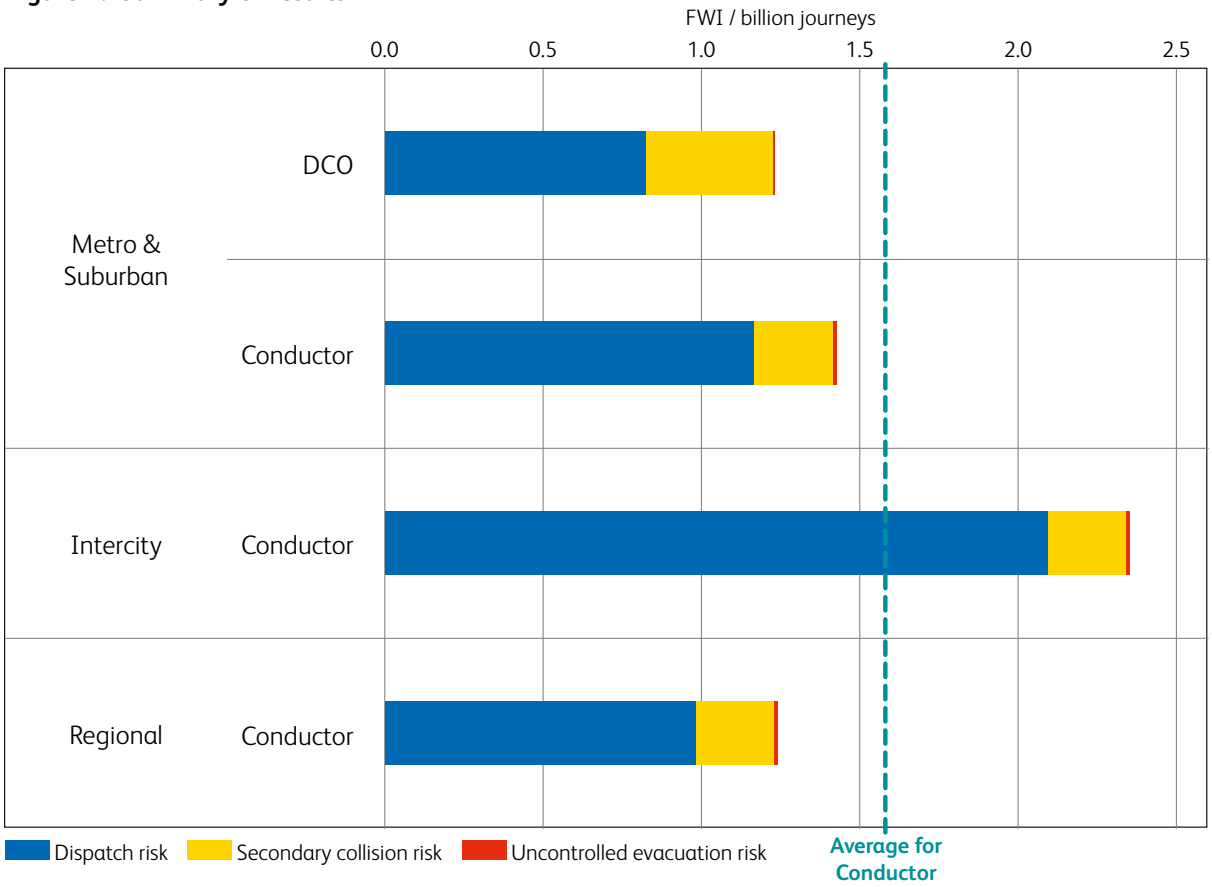
5 Summary of results

The results from the previous four sections can be summarised in figure 7.

For on-board assault risk, the analysis shows that DCO trains have a lower risk than conductor operated trains. However, all other risk affecting factors being equal, there is no reason that passenger assault risk should be lower on DCO trains. Consequently, the level of assault risk has been assumed to be the same on DCO trains as on conductor operated trains and excluded from figure 6.

It is important to understand that there is a difference between the safety performance of DCO and conductor operated trains and the change in risk that would be expected to occur if a given train service converted from conductor operation to DCO. Our best estimate of this change is when considering the safety performance of similar types of operation, e.g. metro and suburban operators only.

Figure 7: Summary of results



6 Auxiliary Person

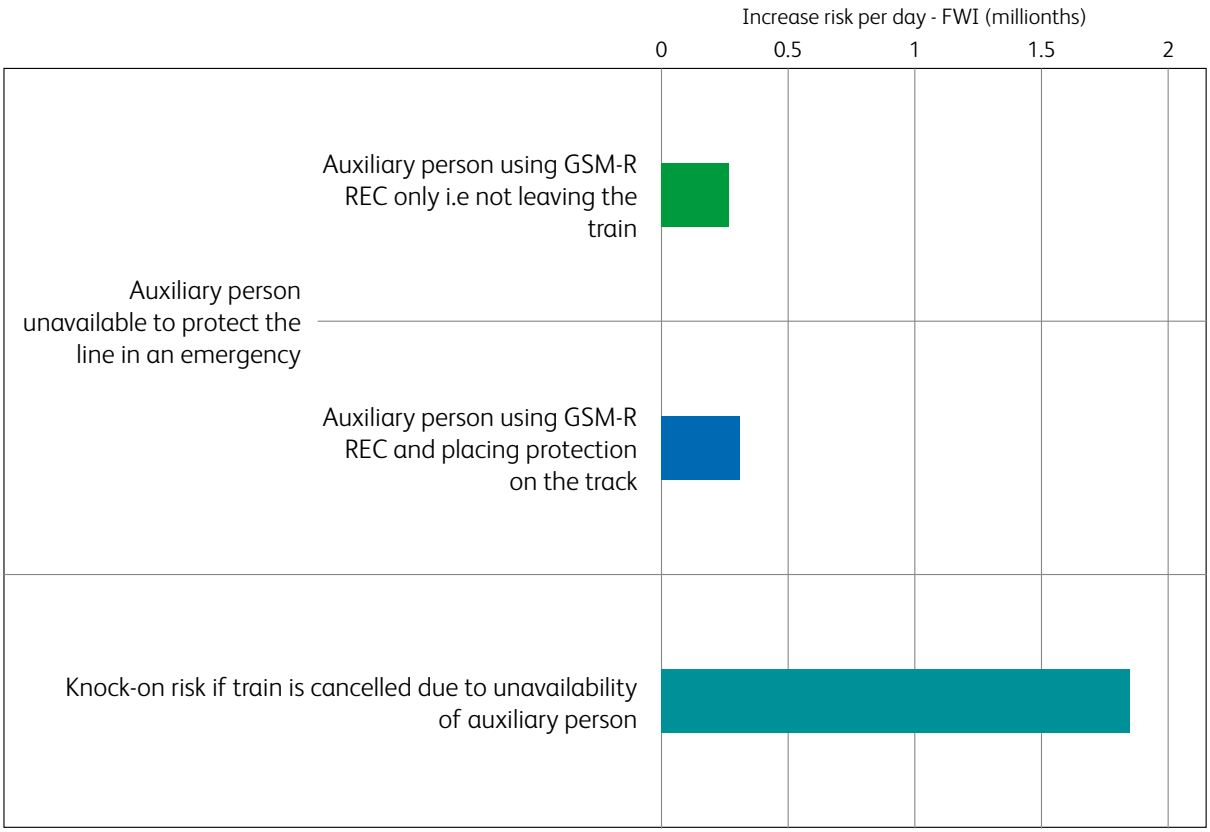
When operating as DCO where an auxiliary person, such as an On-Board Supervisor is normally provided, then if the auxiliary person is unavailable for a particular service and a replacement can't be found, then the train could either be cancelled or the train could continue in service with just the driver (DOO).

If the auxiliary person is trained to be able to use the GSM-R REC functionality, then entering service as DOO will lead to a small increase in risk, due to the albeit unlikely scenario of the train being involved in an accident where the driver is incapacitated and cannot use the GSM-R radio. For the purposes of calculating this risk, it is estimated that the frequency of derailments and collisions where the adjacent line is blocked, the driver does not make a "pre-emptive" REC and the driver is incapacitated following the collision/derailment is approximately 1 event every 15 years.

However, if the train is cancelled then there will also be small increase in "knock-on" risk in the following areas:

- PTI risk due to increased boarding and alighting and potentially crowding on platforms;
- Slips, trips and falls due to turning trains around en-route, extra time in stations, crowding and changes of platform;
- Increase in staff assault risk because of passenger frustration during delays and cancellations.

Figure 8: Unavailability of auxiliary person



The unavailability of the auxiliary person is assumed to be at the start of service and affect the services worked by that auxiliary person for the rest of the day, although some credit for being able to plan has been taken into account for later cancellations. The results are shown in figure 8 (because the risks are small they have been expressed as millionths of an FWI).

If the auxiliary person is not available to protect the line in an emergency, then the additional knock-on risk from cancelling the train is about six times the risk of continuing in service as DOO, regardless of whether the auxiliary person is trained to place protection on the track or just use the GSM-R REC functionality.

Although the differences in risk are small, we can still conclude that, for DCO operation, if the auxiliary person is not available then it is safer to continue in service as DOO, rather than cancelling the train.

7 Conclusions

The work has analysed a number of other risk areas, in addition to dispatch risk and the following conclusions can be made:

1. Dispatch risk – From this analysis, DCO trains have lower overall dispatch related passenger safety risk. There is no safety reason to prevent the further adoption of DCO, given that it must be implemented in accordance with established safety management processes where the duty holder has a legal obligation assess and manage the implementation risk so far as is reasonably practicable.
2. On-board assault risk - the analysis implies that there is no additional assault risk for passengers on-board DCO trains, and indeed these trains appear to be lower risk. If the conductor/auxiliary person has a benefit in reducing on-board assaults, it is small compared to other factors influencing this risk.
3. Uncontrolled evacuation – The risk is small, and rates are similar between DCO and conductor operations.
4. Protecting the line in an emergency – A conductor that can protect the line in an emergency does provide a safety benefit. Most of the benefit of a conductor is from being able to operate the GSM-R radio, rather than applying track protection, and an auxiliary person trained to use the GSM-R REC functionality provides almost the same benefit. The benefit is small and is smaller than the knock-on risk from cancelling the train if the auxiliary person was unavailable.

Duty Holders have a legal obligation to assess safety risk and to manage safety risk so far as is reasonably practicable. Implementation of DCO in accordance with these established safety management processes, is not expected to increase safety risk, and may result in a small decrease in safety risk overall. However, the decision on what sort of operation to implement ultimately rests with the duty holders concerned, and their need to satisfy the legal requirements, whilst respecting the interests of stakeholders and meeting wider commercial objectives.

8 Recommendation

Following this work, two recommendations are made.

1 If an auxiliary person is normally provided for a given service then:
   - Train operators should consider training the auxiliary person to use the GSM-R radio (particularly the REC functionality) in an emergency;
   - If the auxiliary person is unavailable then the train should continue into service as DOO, as this option is the lowest risk overall.

2 RSSB should review the requirements for emergency protection in module M1 of the Rule Book to ensure that the rule book requirements manage the risk from secondary collision effectively.

9 References

[1] RSSB, 2014. Safety Risk Model: Risk Profile Bulletin, version 8.1, London: RSSB.

[2] RSSB, 2017. Risk associated with train dispatch Summary of risk analysis and consolidation of current knowledge

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