MISCELLANEOUS PROJECT REPORT MIS049

HGV and LGV frontal shunts on the Strategic Road Network

Interim report for Phase 1

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Executive Summary

Highways England has an aspirational long-term vision that by 2050 no one should be harmed while travelling or working on the SRN. In order to monitor progress towards this vision, Highways England has a Key Performance Indicator (KPI) to reduce the number of killed or seriously injured (KSI) casualties on its network by 50%. The Commercial Vehicle Incident Prevention (CVIP) programme, which aims to identify risks associated with commercial vehicles and drivers and the design and evaluation of interventions to prevent incidents involving these vehicles, will deliver measurable impact against this KPI, and contribute to the wider outcomes and objectives outlined in the strategy.

One of the largest collision types identified for commercial vehicles on the SRN is frontal shunt collisions, where the front of the commercial vehicle impacts the rear of another vehicle. These collisions account for around a third of collisions involving HGVs and LGVs on the SRN and thus reducing these figures could make a significant contribution to achieving Highways England's targets.

This project aims to understand the root causes of these collisions (Phase 1 – this report) and identify countermeasures or interventions which could help to prevent them in the future (Phase 2 - to be delivered later in the project).

The causes identified in Phase 1 are summarised in the Ishikawa (or cause and effect) diagram in Section 6.1 on page 104 of this report. This diagram demonstrates that there are many causes associated with shunt collisions, many of which are inter-related. A large proportion of the causes seem to relate to the behaviour of HGV/LGV drivers, but other factors including the vehicles, other road users, the road/environment and organisational factors also play their part.

Phase 2 will develop a list of recommended countermeasures to address these causes through a rapid evidence review, a workshop for road safety experts to discuss interventions, and a prioritisation workshop with stakeholders to guide Highways England's next steps.

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1 Introduction

Highways England has an aspirational long-term vision that by 2050 no one should be harmed while travelling or working on the SRN. In order to monitor progress towards this vision, Highways England have a Key Performance Indicator (KPI) related to the number of killed or seriously injured (KSI) casualties on its network. In RIS2 the KSI target requires a 50% reduction from the 2005-09 baseline. The Commercial Vehicle Incident Prevention (CVIP) programme, which aims to identify risks associated with commercial vehicles and drivers and the design and evaluate of interventions to prevent incidents involving these vehicles, will deliver measurable impact against this KPI, and contribute to the wider outcomes and objectives outlined in the strategy.

One of the largest collision types identified for HGVs on the SRN is frontal shunt collisions, where the front of the HGV impacts the rear of another vehicle. There were 472 of these incidents in 2018 and 466 equivalent collisions involving LGVs. As a result, reducing these figures could make a significant contribution to achieving Highways England's targets. This project aims to understand the root causes of these collisions (Phase 1 – this report) and identify countermeasures or interventions which could help to prevent them in the future (Phase 2).

1.1 Report structure

This report is structured as follows:

- Section 2 presents the method used for the literature review, along with the identified causes of HGV/LGV frontal shunts and any countermeasures mentioned in the papers reviewed.
- Section 3 presents the results of the analysis from the GB national collision database, Stats19, for these collisions on the SRN.
- Section 4 presents the results of analysis of the in-depth collision database, HE Fatals, which collects data on the events of fatal collisions on the SRN.
- Section 5 presents the method and results for a task which engaged with 20 drivers and managers from a range of organisations to gain further insight into the causes of frontal shunt collisions.

Within each section key findings are presented in orange boxes.

It should be noted that it is common for multiple causes to be identified within each collision and thus there will be inter-relationships between causes. Where possible these have been identified and noted.

Section 6 presents a summary of the causes identified in the form of Ishikawa (or cause and effect) diagrams, and summarises the next steps for Phase 2 of this work. The Ishikawa diagrams present a hierarchy of the strength of evidence for each cause (from strong to weak), based on the prevalence of the cause in the data and whether the same cause was identified across multiple sources. It is not however possible to attribute a numerical figure to the prevalence of each cause.

2 Literature review

A literature review was carried out to assess the existing body of evidence about the causes for commercial vehicle frontal shunt collisions.

2.1 Method

An overview of the literature review is given in the flow diagram below.

Search terms (see Appendix A) were defined by the project team based on our experience of the topic area and similar reviews.

This task utilised TRL's bespoke literature search tool to search relevant databases both specific to the transport sector (e.g. TRID) as well as other sectors, such as behavioural psychology (e.g. ScienceDirect) and more general sources such as Google Scholar.

Our formal review process records the results of the review in a consistent and methodical format. Specifically, for this review we recorded the following information for each paper:

- Study title
- Study authors
- Study year
- Publication method
- Country the study relates to
- Short summary of method
- Vehicle groups covered (HGVs, LGVs, other vehicle types)
- Type of data is used in the study
- Identified causes (and quantification of proportion of casualties/collisions for each cause, if possible)
- Any other relevant information to consider in review.

In total, 1245 papers were identified in the initial search (including duplicates across the search sources). Of these 97 were considered relevant based on the title alone; following a review of the abstracts 59 of these were taken forward to full review. Based on a full review 42 articles were identified as being of sufficient quality and relevance to be included in the literary review. An additional 21 potentially relevant papers were identified through their reference in these articles. After a review of their content, 15 of these were selected based on their relevance to HGV/LGV shunts and the quality of the articles. As a result, the total number of papers reviewed in full and included in the literature review is 57.

2.2 Literature findings

In the United States (US) in 2016 commercial motor vehicles (CMV) were involved in 11.8% of fatal crashes and 7.4% of non-fatal crashes. Most fatalities in CMV crashes were the occupants of cars and this is mainly attributed to the vulnerability of people traveling in smaller and lighter vehicles when in collisions with larger and heavier vehicles (Adminaite-Fodor & Jost, 2020; Sagar et al., 2020). In Finland, same direction accidents (i.e. shunts) represented 7.7% of fatal HGV involved crashes (Häkkänen & Summala, 2001). In these shunt crashes, HGV drivers were deemed principally responsible for 40.4%.

In order to get a good overview of the potential factors that contribute to shunt accidents for heavy and light goods vehicles (HGV and LGV) the literature review included insights from a range of sources. If shunt accidents were not specified (as in the US study above), it was assumed that some of the accidents would be shunt related (as shown in the Finland study) and thus some more general collision studies related to causes for LGV and HGV collisions were included. In addition, even though most of the literature focussed on HGVs, we included some studies which covered other vehicle types if we felt that they would help increase our understanding of the topic.

The review took the perspective that road transport has the characteristics of a complex socio-technical system where the behaviour of drivers is informed by technical, psychological and social factors (Newman & Goode, 2015). Accidents are then caused by multiple contributing factors, and not just the decisions and actions of the driver. Safety is maintained through a process of information feedback between the different levels of the system (Newman & Goode, 2015). The causes of shunt accidents can therefore be addressed at a variety of levels, increasing the opportunities for introducing effective interventions. This approach aligns with the widely used 'safe system' approach in road safety, to which Highways England is also committed.

Adapting the findings of Newman and Goode (2015), the causes of HGV shunts can be grouped into the following contributory factors: equipment, road environment and environmental conditions; drivers and other actors on the road; HGV companies; and regulatory bodies. We used this structure to summarise the findings from the literature review. Since there is a great deal of interaction and feedback between different factors, there are some overlap between the different subsections.

2.2.1 Equipment, road environment and environmental conditions

This section of the literature review focuses on the aspects of the driver's environment which they respond to and have little direct control over.

2.2.1.1 Equipment/vehicle factors

The design and age of vehicles have an impact on collision rates. For instance, the layout of mirrors impact driver behaviour. Mole and Wilkie (2017) found that reaction times to objects viewed in mirrors increased as the distance of the mirrors increased from the driver's central point of view. They found that the total time to scan the six mirrors in their array was four seconds. They observed that these four seconds of eyes off road caused a delay in driver response times that increased braking and stopping distances and recommended that mirrors are reserved for blind spots where no other modification was possible (Mole & Wilkie, 2017). One paper suggested that older vehicles have a 4.5 times higher accident involvement in comparison with newer vehicles, with accidents involving older vehicles having a four times higher probability of resulting in a fatality (Christoforou et al., 2010).

The review also found that the way in which equipment was maintained and used had an impact on accident rates. For instance, in Australia mechanical failure is a contributory factor in about one in 20 crashes. Of these tyre failures represent 55% (NTARC, 2019). NTARC (2019) noted that this finding related mainly to tyres being overinflated during maintenance procedures. Not following recommended operating procedures was also shown to be an issue; drivers used the adaptive cruise control (ACC) system in adverse weather conditions against manufacturer guidelines (Grove et al., 2015). In further research, Grove et al. (2019) found that different types of driver controls (ACC, standard cruise control and manual) had an impact on off-road glancing behaviour: when drivers engaged cruise control, they tended to spend longer periods of time looking away from the road. This was found to be mainly due to an increase in the duration, rather than frequency, of off-path glances (Grove et al., 2019).

Key findings

- The positioning of HGV mirrors has an impact on the amount of time the driver looks away from the road to scan the mirrors.
- Older HGVs have a higher accident involvement rate than newer HGVs.
- Mechanical failures can be caused by poor maintenance of HGVs, overinflated tyres are a particular issue.
- Not following manufacturers' guidelines for the safe use of technology can cause collisions.
- Additional driver controls (e.g. cruise control) can result in longer periods of off-road glances by drivers.

2.2.1.2 Road environment

Traffic conditions

Traffic conditions impact crash risk (Hong et al., 2019; Hyun et al., 2019; Michalaki et al., 2016; Weng et al., 2015); for example:

- As the proportion of HGVs in motorways traffic increases, collision rates increase (Hong et al., 2019; Michalaki et al., 2016; Weng et al., 2015).
- A combination of high traffic volume and high within-lane speed variation (Choudhary et al., 2018; Li et al., 2018) plus a short truck-non-truck headway (Hyun et al., 2019) can lead to a higher crash risk.
- Limited spacings between vehicles reduce reaction times and the options to manoeuvre in response to a sudden change (Li et al., 2018).

In their study of the M1 between London and the Midlands, Choudhary et al. (2018) found that if the traffic volume increased to more than 216 vehicles per five-minute interval, increases in within-lane speed variations are more likely to lead to a crash where HGVs are involved. The increased severity of crashes under these conditions is likely due to the high-speed conditions of motorways. Also, as the average speed and between-lane speed variations increased, so did the crash risk for both HGVs and other vehicles (between-lane speed variations trigger light vehicles to change lanes or to overtake which can contribute to the crash risk (Choudhary et al., 2018)).

Pavement conditions

If the pavement surface is wet or dry, the likelihood of fatal crashes increased, while icy and slushy conditions increased the risk of injury and single-fatality crashes but decreased multiple-fatality crashes (Pan et al., 2019). Issues with glare, due to increased periods of sunshine, have also been linked to higher crash risks (Choudhary et al., 2018; Makalachi et al., 2016). Bunn et al. (2019) found that at-fault CMV crashes in the US that involving reported sleepiness or fatigue were more likely to occur on dry pavement.

Roadworks/work zones

Research has shown that the presence of road works (or work zones) increase collision rates. Weng et al. (2015) analysed 12,978 sets of vehicle trajectory data at two sites in Singapore. They found that truck-not-truck rear-end collision rates increased when the vehicles were driving in the nearest lane to the road works, and when an increase in traffic flow occurred. Work intensity (the amount of people and equipment in the work zone) did not have a significant impact on truck-car collision rates but did increase truck-truck, car-car and car-truck collision rates (Weng et al., 2015).

Impact Protection Vehicles (IPVs) are used to reduce the risk associated with collisions between road users and vehicles, hazards on the carriageway, maintenance operations and incidents. The design of IPVs is intended to provide effective long-distance advance warning of an obstruction on the highway for road users. Wood, Reeves and Lawton (2012) found that in the UK, HGVs appear to be over-represented in shunt collisions with IPVs on motorways, in particular during the daytime.

Road design

The importance of rest breaks has been demonstrated by Lenné et al. (2019) and Soccolich et al. (2013). Lenné et al. (2019) showed that participants' self-rated drowsiness was associated with crash risk; a 26% increase in the likelihood of a crash was seen for every unit increase in the Karolinska Sleepiness Scale. Some research has shown that a rest break could reduce the occurrence of safety-critical events in the hour following a break by up to 50% compared with the hour preceding the break (Soccolich et al., 2013). At the same time, increased driving time and distance tended to increase speeding behaviour (Zhou & Zhang, 2019). This shows the importance of having places for drivers to exit the road safely and take preventative action when, or preferably before, they are tired. Michalaki et al. (2016) found that as the number of Motor Service Stations (MSAs) went up per 100 miles of British motorways, collision rates decreased, while Bunn et al. (2019) found that crashes related to sleepiness/fatigue were more likely to occur 20 or more miles away from the nearest rest stop. An association between full truck parking facilities and downstream night-time truck crashes was found in Kentucky (Pigman & Winchester, 2015).

The design of road furniture and road layout have also been shown to impact risk. For instance, Pan et al. (2019) found that fatal crash risk increased at night in the absence of street lighting, suggesting that visibility was an important factor. However, streetlights tend to be more likely present on main roads where other safety features are incorporated, which may be contributing to the increased safety at sites with lighting. Slopes greater than 3.2% and longer than 1,000m have been shown to create a situation where fully laden HGVs could only reach a maximum of 50km/h (Cerezo & Conche, 2016). This created a speed differential between the HGVs and other road users travelling at 80-90 km/h which is thought be a contributing factor to rear-end collisions (Cerezo & Conche, 2016).

Key findings

- An increase in the proportion of HGVs in traffic increases collision rates.
- High traffic volume, increased traffic speed, increased speed variations within- and between-lanes increase the collision rate.
- Road surface conditions were found to influence crash risk, with dry roads typically found to have a higher risk.
- The presence of road works increases collision rates. Driving in the nearest lane to the works and increased traffic flow were significant contributory factors.
- HGVs are over-represented in IPV collisions, particularly during the day.
- The presence of service areas reduces collision rates, presumably because they allow HGV drivers to exit roads safely and take rest breaks.
- Roads with streetlights have lower night-time collision rates than unlit roads, although there are possibly differences in site selection which explain this.
- Sloped roads contribute to a speed difference between HGVs and other vehicles, and this increases the risk of shunt collisions.

2.2.1.3 Environmental conditions

Weather conditions

Precipitation has been shown to increase the risk of collisions (Choudhary et al., 2018; Michalaki et al., 2016). For instance, Michalaki et al. (2016) found an increase in all types of vehicle collisions, and Hong et al. (2019) found an increase in HGV collisions, during rain and snowfall conditions. They suggest that the increase during periods of precipitation could be due to lower visibility and an increased risk of skidding (Michalaki et al, 2016). The findings by Choudhary et al. (2018) support this and add that the effect is higher for light-vehicles than for HGVs, possibly due to better HGV driver training.

At the same time, fatal crashes are less likely to happen on a snowy or rainy day; drivers are likely to be more cautious, slow down, concentrate more and keep their eyes on the road more in these conditions (Michalaki et al., 2016). Single-fatality crashes are more likely to happen when the weather conditions are good (Pan et al., 2019). Michalaki et al. (2016) found that for all vehicle types, driving on motorways, hours of sunshine per month have a positive relationship with collision rates. Therefore, good weather and road conditions could contribute to drivers concentrating less on the road and driving with less care and attention (Choudhary et al., 2018; Michalaki et al, 2016).

Seasonality, weekend distribution and time-of-day effects

Motor carriageway and HGV fatality collision rates show strong seasonality (Evgenikos et al., 2016; Michalaki et al., 2016). Motorway collisions in England for all vehicle types tend to peak during October and November (Michalaki et al., 2016) while HGV related fatalities tend to be the highest in Europe between September and October (Evgenikos et al., 2016). January and February show the lowest incidence rates of motorway collisions for all vehicle types (Michalaki et al., 2016), including HGVs (Hong et al., 2019), and HGV fatalities (Evgenikos et al., 2016). Evgenikos et al. (2016) suggest that this could be due to a decrease in traffic, based on severe weather conditions in European countries.

In most European countries, HGV-related fatalities were similar across weekdays with a minor increase on Mondays and Tuesdays (Evgenikos et al., 2016). Similarly, NTARC (2017) found that in Australia, Mondays and Tuesdays had higher HGV incident rates than other days of the week. This applied even when data were corrected for traffic volume; the risk of having a crash on a Monday was over 20% above the weekly average. They attributed this to a disproportionate number of inappropriate speed related accidents on Mondays. Correcting for traffic volumes, they found that the risk of an HGV being involved in this type of accident was 66% higher than that of the weekly average. In contrast, Mondays and Tuesdays had the lowest risk of fatigue crashes (NTARC, 2017). In the UK (on the M1), HGV traffic accidents also tended to peak on Mondays but contrary to Europe and Australia, there was a secondary peak on Fridays (Michalaki et al., 2015).

In Europe, significantly fewer people were killed during weekends in HGV related accidents, reflecting a change in the level of exposure of these vehicles, with reduced commercial activities and restrictions which reduce HGV activities over weekends (Evgenikos et al., 2016). However, NTARC (2017) found that if traffic volume is corrected for, the risk of an HGV fatigue related crashes was double that of the weekly average.

Driving at night-time (Bunn et al., 2019) and specifically between midnight and 6 am (Newman & Goode, 2015) increased the accident risk for all types of vehicles. NTARC (2017) reported a disproportionate amount of fatigue related incidents during this time period (40% of all fatigue accidents). Adjusting for traffic volumes, driving between midnight and 6am was three times riskier than the daily average, while the risk of a fatigue crash during business hours was half that of the daily average.

Severity of crashes was reported to increase between 3 am and 6 am (Pan et al., 2019). Night-time driving specifically also increased the severity of rear-end crashes (Champahom et al., 2020) with single-and multi-fatality crashes more likely to occur between 3 am and 6 am (Pan et al., 2019). Hong et al. (2019) found a decreased probability of truck-involved crashes in Korea between 5 am and 8 am.

Key findings

- Rain and snowfall increase the risk of accidents for both HGVs and other vehicles. However, fatal crashes are less likely, with changes in driver behaviour suggested as a possible explanation.
- Crash rates increase with increased hours of sunshine. A possible explanation is that drivers become relaxed and less cautious, or select higher speeds.
- In the UK, HGV collision rates tend to peak in October and November. The lowest incidence rates are in January and February and this may be due to hazardous weather conditions reducing the amount of HGV operations.
- Driving between midnight and 6 am tends to increase HGV accident risk and the severity of crashes. Fatigued driving is a risk factor during night-time driving as well as weekend driving.
- Inappropriate speed related accidents are disproportionately represented at the start of a working week, during Mondays and Tuesdays.

2.2.1.4 Countermeasure recommendations

Several potential countermeasures for these causes were identified from the literature:

- Making both HGV/LGV and other vehicle drivers aware of the conditions that could increase their chance of being involved in accidents (Choudhary et al., 2018; Reason, 2000).
- Warning signs to remind drivers to obey the speed limit or apply speed enforcement during good weather conditions (Pan et al., 2019).
- Frequent signage indicating the miles to the next MSA could possibly also act as a cue to remind drivers to take a rest break and prevent them from stopping on the hard shoulder (Michalaki et al., 2016).
- Crash risks differ by traffic conditions. Understanding this could support the implementation of traffic management countermeasures and freight industry interventions (Choudhary et al., 2018).

2.2.2 HGV/LGV driver and other road user behaviours

Häkkänen and Summala (2001) found that the two most common causes of truck driver at-fault collisions were error in attention, anticipation or estimation (50.8%) and error in operating the vehicle (26.3%). This suggests that the decisions that truck drivers make and their level of performance contribute to collisions. However, truck driver behaviour and performance are exhibited within the context of a variety of other considerations including the behaviour of other road users. This was demonstrated by the finding that in the US between 2001 and 2003, in 56% of HGV involved crashes the car driver was coded as at-fault

(FMCSA, 2005). It is therefore important to see how the interactions between various factors contribute to collisions.

2.2.2.1 Decision-making

In 2017 crash statistics for Australia found that HGV driver error was coded as the primary cause in 54% of crashes (NTARC, 2019). The most frequent error categories being inadequate following distance (30%), followed by inattention and distraction (23%) and inappropriate vehicle positioning (18%). They found that most accidents coded as HGV driver error due to inadequate following distance were shunt accidents (NTARC, 2019). Similarly, Piccinini et al. (2017) found that the primary causal factors for rear-end collisions were short headways and small gap acceptance for lane changes, but also added to this the unpredictable behaviour of other road users. These findings support the results of Stuster (1999) that attributed truck driver at-fault collisions to following too closely, unsafe speed, inattentive driving and failure to slow down in response to environmental problems.

Using simulation modelling (cellular automata) Jetto et al. (2020) aimed to analyse how differences in anticipating the speed of the vehicle in front could impact on the likelihood of rear-end collisions during congestion. In line with the findings of Davis and Swenson (2006), their modelling showed that differences in anticipatory behaviours could lead to variations in vehicle speeds that could cause rear-end collisions (Jetto et al., 2020). This contributes to the understanding of why collision rates and severity rates may differ under different traffic conditions.

Key findings

- Errors in decision making that contribute to HGV accident rates include inadequate following distance, inattention and distraction, inappropriate vehicle positioning and driving at an unsafe speed.
- Differences in anticipating the behaviour of other vehicles can lead to variations in vehicle speeds that could result in a shunt accident.

2.2.2.2 Distraction and inattention

Driver inattention can be defined as a mismatch between the driver's current allocation of resources and that demanded by the activities critical for safe driving (Engström & Monk, 2013). Inattention can then be broadly categorised as insufficient attention and misdirected attention. Insufficient attention is based on how much attentional resource is allocated to the task, while misdirection is based on how attentional resources are distributed between activities (Engström & Monk, 2013).

The impact of inattention on driver performance can be seen in the study of McManus et al. (2016). They conducted a simulator study and found that CMV drivers were 4.14 times more at risk of a collision if they were engaged in a secondary visually based task, and that older drivers may be more vulnerable to this effect due to a decrease in the speed of visual processing. Further, their study showed that there is a link between the risk of a collision and the speed of visual processing (as measured by the Useful Field of View assessment) of CMV drivers. Every 20ms slower reaction time on the assessment was associated with 1.25 times increase in the risk of collision during the simulated drive (McManus et al., 2016). When comparing the percentage of glances to the forward roadway, when engaging in tasks that were visually distracting, participants in a simulator study were shown to decrease roadway scanning and increase the duration of distraction as their time spent on the secondary task increased (Lenné et al., 2019).

Pipkorn and Piccinini (2020) found that in 70% of crash and near-crash events HGV drivers were looking away from the road ahead (an off-path glance). These off-path glances had a mean duration of 1.10s and the drivers mainly looked towards their mirrors. In particular, when a driver had a short headway combined with an off-path glance in a rapidly changing event, it led to rear-end crash and near-crash events. The activation of the lead vehicle's brake lights tended to trigger the off-path glance towards mirrors and did not significantly impact on driver braking behaviour. Instead their braking reaction was based on the imminence of the accident (Pipkorn & Piccinini, 2020).

Key findings

- A driver engaging in a secondary visual task increases off-road glances and the duration of these tends to increase with time-on-task.
- A short headway combined with an off-path glance increases the collision risk.
- Braking behaviour is typically based on the driver's perception of the imminence of a collision.

2.2.2.3 Fatigue/sleepiness, medical conditions or impairment

Fatigue refers to a degradation in the performance of tasks due to inadequate sleep, physical exertion, extended time-on-task, and other factors (Stern et al., 2019). A key problem with studying fatigue is the ability to directly and objectively identify and measure it (Stern et al., 2019; Zhou and Zhang, 2019); as a result, it is argued that police crash reports are likely to underreport fatigue as a causal factor (Stern et al., 2019).

Driver fatigue is a prominent factor in HGV accidents (Hartenbaum et al., 2006; NTARC, 2017) with 13% of drivers being coded as fatigued at the time of a crash (Federal Motor Carrier Safety Administration, 2005). Simulator data showed that when participants were fatigued, they were 2.5 times more likely to crash (Lenné et al., 2019). Driving while drowsy and having an underlying illness has also been shown to increase the likelihood of CMV drivers committing traffic violations (Hong et al., 2019).

The importance of adequate sleep on fatigue is illustrated by the Chen et al. (2016) study. This found that sleep between one and five am, sleeping at least seven to nine hours and sleeping towards the end of an off-duty period reduced safety-critical event rates more than a shorter sleep period at the early stage of a non-work period. Sparrow et al. (2016) showed that during duty cycles preceded by a restart break with only one night-time period, drivers reported greater subjective sleepiness and experienced more lapses of attention and increased lane deviation at night. Therefore, both the amount of sleep and when it takes place are important factors in fatigue.

The impact of extended time-on-task on fatigue was illustrated by Soccolich et al. (2013). With each added hour that a driver spent driving, there was an incremental increase in safety-critical events. It was found that during the average workday US commercial vehicle drivers tended to drive 66% of the time and spent 23% on non-driving work tasks such as loading or unloading, paperwork, waiting and vehicle maintenance. The 11th hour of time-on-task showed a significant increase of safety-critical events compared with hours one and two (Soccolich et al., 2013). It was concluded that performing non-driving work tasks has an impact on the increased occurrence of safety-critical events while driving later during a 14-hour workday.

Soccolich et al. (2013) found that breaks from driving helped to reduce safety-critical event rates of truck drivers. A break was classified as consisting of at least 30 minutes of non-driving activity which could include either work or rest tasks or both. The hour after a break saw a reduction of 28-50% in safety critical events compared with the hour before the break. Non-working breaks were associated with the largest reduction in safety-critical events of 51%, while breaks that included work-related tasks reduced the safety-critical event rate by more than 30% (Soccolich et al., 2013).

Underlying medical conditions can also contribute to inadequate sleep. Obstructive sleep apnoea (OSA) is associated with an increase in crash risk due to insufficient sleep (Stern et al., 2019) and is related to medical conditions such as hypertension, obesity and coronary heart disease (May et al., 2016; National Academies of Sciences, Engineering & Medicine, 2016; Stern et al., 2019). In their simulator study of non-professional drivers, May et al. (2016) found that the driving performance of participants with undiagnosed sleep apnoea deteriorated significantly more over time compared with those drivers without sleep apnoea. Even though both groups showed a deterioration in driving performance over the 60 mins, the apnoea group demonstrated a greater increase in lane position variability as the drive progressed. Sleep apnoea is of particular concern to commercial vehicle drivers since it is estimated that 20% of CMV drivers in the US have at least mild OSA (Stern et al., 2019) and there is no reason to believe that deterioration in performance due to OSA related fatigue would not affect commercial vehicle drivers (National Academies of Sciences, Engineering and Medicine, 2016).

Bunn et al. (2019) found that in crashes where fatigue/sleepiness were reported, commercial vehicle driver injuries tended to be more severe. However, fatigue/sleepiness is also associated with a reduction in the tendency for drivers to wear a seatbelt, which could have contributed to the driver injuries (Bunn et al., 2019). More generally, truck drivers tend to wear seatbelts less often than car drivers (Adminaite-Fodor & Jost, 2020); this finding is also supported by UK DfT seatbelt surveys which suggest drivers of ‘other vehicles’ (which includes LGVs and HGVs) are less likely to wear a seatbelt than car drivers (DfT, 2019).

Key findings

- The amount of sleep, and when it takes place in the duty cycle and 24-hour period, impacts on reported tiredness and collision rates.
- Extended periods of time-on-task (including non-driving activities) increase the occurrence of safety-critical driving events later in the workday.
- Thirty-minute breaks are associated with a significant reduction in safety-critical events in the hour after a break compared to the hour before a break. Taking non-working breaks were associated with the largest reduction in safety-critical events.
- Underlying medical conditions, such as OSA, heart conditions and obesity, contribute to deterioration in driving performance and fatigue.
- HGV driver injuries are more severe in crashes where fatigue is reported. Fatigue/sleepiness is associated with a reduction in the use of seatbelts by HGV and LGV drivers.

2.2.2.4 Driving patterns

Studies have shown that a small number of drivers tend to be disproportionately involved in near-crash and crash events (Piccinini et al., 2017; Zhou & Zhang, 2019). For instance, in their naturalistic study, Piccinini et al. (2017) found that 80% of crash and near crash events were caused by 30% of delivery and light commercial vehicle drivers. Similarly, based on speeding, fatigue driving and jerky driving behaviour, Zhou and Zhang (2019) found distinct patterns of driving behaviour where 40% of Japanese truck HGV drivers clustered into the dangerous or very dangerous groups.

Wåhlberg (2012) found that the acceleration and deceleration rates of drivers tended to remain stable over a three-year observation period. Changes in behaviour were linked to the daily experience of driving rather than learning from involvement in a collision. Wåhlberg argues that this provides some support for the theory of 'accident proneness', where driving behaviour and relative accident involvement tend to remain stable over time (Wåhlberg, 2012). Similarly, Hong et al. (2019) found that truck drivers who engaged in improper passing and unsafe headway driving behaviour had an increased crash risk probability of 66.1% and 70.1% respectively.

Key findings

- A small number of drivers tend to be overrepresented in near-crash and crash events.
- Driving behaviour and the relative likelihood of having an accident tend to remain stable over time.

2.2.2.5 Socio-economic and demographic factors

Studies consistently show that HGV drivers under the age of 25 have a higher risk of being involved in an accident than those in other age groups (Guest et al., 2014; Pan et al., 2019; Sagar et al., 2020). Sagar et al. (2020) found that young HGV drivers (<25 years old) with a low median household income were at a higher risk of being involved in accidents than their older and more wealthy peers. Pan et al. (2019) showed that truck drivers under the age of 25 are most likely to be in multiple-fatality crashes and they suggest that this could be due to a lack of experience and a greater likelihood to engage in dangerous actions. Similarly, Guest et al. (2014) found that for both rigid and articulated trucks, Australian drivers below the age of 34 had significantly higher crash incidence rates than their reference group of 45-54-year-old drivers. Being younger than 30, having less experience and having an illness were found to be associated with an increase in being 'principally responsible' for a crash (Häkkänen & Summala, 2001).

Results for older HGV drivers vary. For instance, Sagar et al. (2020) found no significant increase in accident rates for those drivers over the age of 65 but suggested that this could be due to the influence of other socioeconomic variables that they used in their model. Guest et al. (2014) found the same result, and suggested that decline in sensory and cognitive functioning with age could be compensated for by the process of self-selection (meaning that those drivers with the largest declines in driving ability choose to avoid driving) and the avoidance of risky situations. They suggest that older drivers may choose their employment to reflect their driving choices such as not driving long-haul, long-hours, in bad weather conditions or during night-time (Guest et al., 2014). On the other hand, Pan et al. (2019) found that HGV drivers over the age of 75 were more likely to be involved in multiple-fatality crashes and that it could be due to slower reaction times and more underlying health conditions. This is to some extent substantiated by the results that showed a decline in visual speed processing with age by McManus et al. (2016).

However, truck drivers younger than 60 have an increased likelihood of being involved in improper passing behaviour, while drivers between the ages of 30 and 60 tend to commit fewer speed violations (Hong et al., 2019). Interestingly, drivers of all ages tended to violate safe distance regulations, with drivers between 40 and 50 years having the highest probability of unsafe distance violations (Hong et al., 2019).

The literature did not provide any analysis regarding gender differences. Researchers stated that the small numbers of female HGV drivers made it difficult to get statically meaningful results (Guest et al., 2014; Sagar et al., 2020).

Key findings

- Drivers under the age of 30 years are at a higher risk of being involved in an accident. Lack of experience, underlying health conditions, low median income and proneness to dangerous driving are common reasons for this.
- Results for older HGV drivers are less clear.
- Type of driving violation tends to be age dependent.

2.2.2.6 *Driver training*

In the US drivers with operator driving licences (Class D) can operate an HGV or HGV plus a towed vehicle with a combined weight of 11 tons or less (New York State DMV, 2020) while drivers with commercial driving licences (Classes A to C) complete advanced knowledge and skills tests to operate CMVs (FMCSA, 2020; New York State DMV, 2020). Pan et al. (2019) found that drivers with class A, B and C commercial driving licences are significantly less likely to be involved in fatal crashes than drivers with class D operator driving licences and those with invalid driving licenses. The authors argue that drivers selected to receive further training may be those that are seen as being trustworthy to drive heavier and more hazardous loads. This seems to support the findings of Hong et al. (2019) that truck drivers who carry a trailer or drive a specialised freight truck tend to engage less in improper passing violations. In contrast, the drivers of medium or small sized trucks were found to be more likely to commit speed violations.

Key findings

- Drivers with advanced training, are less likely to be involved in fatal crashes. This may be due to the training selection process that favour drivers who behave more responsibly.

2.2.2.7 *Drivers of the other (shunted) vehicle*

Hyun et al. (2019) showed that the vehicle interactions between leading and following vehicle types are associated with changes in crash risk, and that crash risk differs by traffic conditions. Stuster (1999) found that in the majority of HGV-car collisions, the behaviour of car drivers contributed to the interaction, with only an estimated 24% solely contributable to HGV drivers. This is consistent with the research of the Federal Motor Carrier Safety Administration (2005) which found that in 56% of HGV-car crashes the car was assigned the ‘critical reason’. ‘Driver recognition’ and ‘decisions’ were the two most used codes for drivers of both classes of vehicles involved in an HGV-car crash. For truck drivers, these two reasons accounted for three quarters of the cases, while they accounted for half of the passenger vehicle cases (Federal Motor Carrier Safety Administration, 2005). Some of the unsafe driving acts by car drivers included driving inattentively, changing lanes in front of a truck and then braking, changing lanes abruptly in front of a truck, unsafe passing with insufficient headway, pulling into traffic in front of a truck without accelerating sufficiently, driving between large trucks and merging improperly into traffic (Stuster, 1999). This supports the finding of Parker et al. (1995) linking a lack of thoroughness of decision making by car drivers to active shunts.

The impact of other drivers on contributing to crash conditions can also be seen in a study by Davis and Swenson (2006). They found that the combined impact of relatively small individual differences in following distances, reaction times, speeds and deceleration behaviour of vehicles driving in a queue can determine if a stopping shockwave results in an unavoidable collision further on in the queue. They concluded that if a following headway of two seconds was maintained by all drivers in their case-studies, the accidents would not have occurred (Davis & Swenson, 2006). Choice of headway is therefore a significant factor in the likelihood of rear-end crashes in queuing traffic (Buckle et al., 2011; Hyun et al., 2019). Buckle et al.

(2011) found that over 90% of drivers in high traffic flow conditions maintained headways of less than one second. A similar result was found by Peeta et al. (2005) where car-truck interactions were characterised by following headways of less than two seconds. Males, younger driver, drivers with a prior history of accidents and drivers who scored higher on sensation seeking or anger traits tended to adopt shorter headways on average (Buckle et al., 2011).

Research conducted by the Federal Motor Carrier Safety Administration (2005) analysing the factors contributing to accidents based on US crash codes found that legal drug use was common for both HGV and passenger vehicle drivers, while illegal drug use was only a factor for the drivers of passenger vehicles. Similar findings were seen for drivers in the European Union (EU) (Adminaite-Fodor & Jost, 2020). In addition, passenger vehicle drivers were coded twice as often as HGV drivers as being fatigued (Federal Motor Carrier Safety Administration, 2005).

Simulator research has shown that the design features of a lead vehicle impact on the ability of participants to judge distances as well as whether the vehicle is closing or separating (Dinakar et al., 2018; Muttart et al., 2017). Brighter taillights during night-time scenarios were consistently judged to be closer and participants' ability to discern lead vehicle closing or separating deteriorated with a decrease in taillight brightness (Dinakar et al., 2018). Narrower taillight configurations were consistently judged as further away by both commercial vehicle drivers and non-professional drivers (Muttart et al., 2017). Muttart et al. (2017) concluded that crashes involving a high-speed vehicle closing in on a slower vehicle may in part be due to the limitations of the human visual perception system. This finding is seen in other risky areas of driving involving the judgement of closing speed with small stimuli such as motorcycles, and especially at night (see e.g. Helman et al., 2014).

Key findings

- The behaviour of other road users impacts the collision risk that HGV/LGV drivers are exposed to. Choice of headway of drivers towards the front of a queue of traffic impacts on the collision risk of drivers towards the back of the queue.
- Drivers of passenger vehicles are more likely to be fatigued and coded for illegal drug use than HGV drivers.
- Design and brightness of taillights impact on a driver's perception of distance and closing speed.

2.2.2.8 Countermeasure recommendations

Several potential driver behaviour countermeasures were identified from the literature:

- Davis and Swenson (2006) argued that, since most drivers are not involved in a collision while adopting an insufficient (less than two seconds) headway, it is unlikely that they will change their headway driving behaviour. A more realistic solution to maintain safe headway distances and support braking is therefore not to rely on drivers but to use in-vehicle technologies (Davis & Swenson, 2006).

- Choudhary et al. (2018) recommended in-vehicle crash warning systems for both commercial and private vehicles.
- Li et al. (2018) estimated a 13.7% reduction in rear-end crashes when forward facing collision avoidance technology is used in passenger vehicles based on a one second delay in crash response.
- Truck drivers exhibiting dangerous driving behaviour (speeding, fatigue-driving and jerky driving) should be monitored more closely by their company. Companies could also introduce interventions such as safety education or regulations that could help mitigate dangerous driving behaviour (Zhou & Zhang, 2019).
- Reasonable operation arrangements and schedules could potentially reduce risks (Zhou & Zhang, 2019).
- Training programs could include defensive driving training for truck drivers and training and awareness programs for other vehicle drivers to learn about the limitations of truck performance. Training law enforcement officers regarding unsafe driving around trucks could be included in education programs (Stuster, 1999).
- Educating drivers about sleep habits and the safety benefits thereof could be beneficial to reduce fatigue-related collisions. For instance, it has been shown in the US that when non-work hours were increased from 8 to 10 hours, drivers tended to sleep for longer during their off-duty period (Chen et al., 2016). Having at least two night-time periods in the restart break has also been shown to provide greater opportunity for sleep recuperation and help to mitigate fatigue (Sparrow et al., 2016).
- Companies should incorporate health and well-being policies and programs for their workers (Chen et al., 2016).
- Advances in technology now enable transport operators to strengthen their ability to measure and monitor in-cab driver performance and behaviour in real-time as a way of complementing existing company safety policies and further ensuring they meet OHS requirements (Lenné et al., 2019).
- The Useful Field of View assessment may be a promising measure to identify CMV drivers who may be at risk of multi-vehicle collisions or in need of cognitive training aimed at improving speed of processing. Subtest 3 may also identify CMV drivers who are particularly at risk when engaged in secondary tasks while driving (McManus et al., 2016).

2.2.3 Factors influencing collision severity

This section focuses on factors that influence the severity of crashes that are not already discussed previously:

- Michalaki et al. (2015) found that hard shoulder collisions tend to have a higher severity than main-carriageway collisions, and that the involvement of HGVs and fatigue were the most important factors in further increasing severity.
- Champahom et al. (2020) found that the main factor that increased the severity of rear-end collisions on Thai rural motorways was it taking place during night-time. They

also found the following factors increased the severity of rear-end crashes: if the crash involved a parked car, older drivers, taking place on interior lanes and HGV involvement.

- Pan et al. (2019) found that a difference in the weight between vehicles made the occupants of lighter vehicles more vulnerable to severe injury. The severity of crash outcomes also increased if more vehicles were involved in a crash and if the crash happens between 3 am and 6 am.

Key findings

- Collisions tend to be more severe when they take place during night-time, on the hard shoulder, or involve a parked car. The vulnerability of car drivers increases with age and those in smaller vehicles are more at risk.

2.2.4 Organisational/systemic factors

There is a growing amount of evidence that suggests that organisations have an important role to play in how their drivers operate and that this has a significant impact on accident rates (Hickman & Hanowski, 2011; Nævestad, Blom & Phillips, 2020; Newman & Goode, 2015; Thompson & Stevenson, 2014).

2.2.3.1 Truck company size

Pan et al. (2019) found that in the US large truck companies (those with more than a 100 trucks) tend to have a higher risk of being involved in either damage or multiple fatality crashes. A potential rationale for this is that these companies own larger heavier vehicles that are hard to manoeuvre and require larger headways in order to perform emergency braking. Small companies (those with two to five trucks) have the best safety performance in terms of crash severity (Pan et al., 2019).

No UK studies were found that related to the influence of truck company size on crash risk. However, prevailing wisdom tends to suggest that in the UK larger fleets tend to have better safety practices in place.

2.2.3.2 Payment systems

In their study of 346 long-haul HGV drivers in Australia, Thompson and Stevenson (2014) found that different types of compensation methods were associated with different work practices that contributed to fatigue driving:

Compared with per hour/weekly rates, drivers paid per trip and per kilometre:

- Travelled significantly higher distances per day.
- Reported significantly longer estimated mean hours spent working per week.
- Reported significantly higher usage of caffeine and amphetamines to stay awake while driving.

- Were also more likely to be carrying time-critical loads and less likely to be carrying dangerous goods.
- Slept in their truck on the most recent night prior to interview (per kilometre (69.9%) and per trip rates (74.1%), compared with per hour/weekly rate drivers (55.1%).
- Reported significantly longer driving periods.

Conversely, drivers on per hour/weekly rates reported significantly fewer hours spent driving per day than those paid either per trip or per kilometre and there was also no reported amphetamine use among them (Thompson & Stevenson, 2014).

Key findings

- Drivers paid per trip or per kilometre tend to engage in driving patterns that contribute to fatigued driving.

2.2.3.3 Safety culture and policies

According to Nævestad et al. (2020) an organisation's safety culture refers to '*shared ways of thinking and acting that are relevant for safety*' (p. 326), while safety structure refers to the more formal aspects of safety management such as procedures, routines and organisational charts. Nævestad et al. (2020) found that Norwegian companies with a high level of safety culture also tended to have comprehensive safety structures in place that were seen as meaningful by employees. They found that as safety culture scores increased, HGV accident risk decreased; companies with the highest safety culture scores (Level 4 as measured using a 'Safety Ladder') had accident rates half that of those with a lower score (Level 2). Beyond the safety structure characteristics of Levels 2 and 3, Level 4 companies were also characterised by:

- functioning reporting systems;
- regular reviews of incidents and safety issues with discussion and feedback to employees;
- procedures known and seen as meaningful; and
- systematic training programmes (Nævestad et al., 2020).

The impact of safety structures on accident risk is further illustrated by Hickman and Hanowski (2011). This showed that the combination of in-vehicle monitoring and within-organisation driver behaviour feedback and coaching reduced the mean rate of HGV near-crash events by 37% to 50% (Hickman & Hanowski, 2011). Similarly, Nævestad et al. (2020) found that companies with a high safety culture score provided regular feedback to their drivers on their safety performance and some linked safe driving to a financial bonus. Unsafe driving was followed up and either discussed or training was provided.

Newman and Goode (2015) found that how US road freight transportation companies were managed directly contributed to the decisions and actions of HGV drivers. They were able to link increased crash risk to poorly executed fatigue management programs, use of cell phones to communicate with management during driving and inadequate training programs that did not highlight specific and known driving hazards.

Pan et al. (2019) investigated the impact of a company's inspection value on crash risk. The inspection value reflects a company's prior safety record. This value incorporates historical accident rate and inspection violation data. Companies with medium (30-70) or high (90+) inspection values were significantly more likely to be involved in more severe and multiple-fatality crashes.

Pan et al. (2019) also found that trucks owned by newly registered companies had a higher risk of being involved in a fatality crashes and argued that this may be related to lower levels of experience in fleet management and safety practices.

US trucks owned by interstate companies were more prone to involvement in fatal crashes, while those owned by intrastate companies tended to be involved in damage or injury only crashes (Pan et al., 2019). Interstate truck drivers usually have longer distances to drive which could contribute to fatigue and drowsiness and drivers may not be familiar with the driving behaviour of other drivers in different states (Pan et al., 2019).

Key findings

- Higher safety culture scores tend to decrease accident rates for companies.
- Company based driver training and feedback could potentially help to reduce collision risk.
- Higher inspection values (which incorporate historical collision records and inspection violation records) are linked to an increased risk of a company's trucks being involved in collisions.
- Drivers who drive longer distances are more prone to involvement in fatal crashes.

2.2.3.4 Countermeasure r*ecommendations*

Several potential countermeasures for these organisational factors were identified from the literature:

- According to Edwards et al. (2014) research has demonstrated high levels of lung cancer and respiratory diseases, diet and exercise-related diseases, as well as those related to stress are prevalent in truck drivers. The promotion of healthy lifestyle choices, such as quitting smoking, healthy eating and exercising, could reduce these outcomes. Furthermore, teaching drivers to better handle work stress, through relaxation and coping mechanisms, may have an impact on the level of stress-related disorders (Edwards et al., 2014).
- Truck drivers should be trained to drive in various driving environments where the behaviour of other drivers may be different due to cultural changes (Pan et al., 2019).

- Goal setting as an important part of any intervention aimed at providing individual drivers feedback on their driving behaviour and tracked using in-vehicle technology (Hickman & Hanowski, 2011).
- Organisationally based interventions should support an improvement in the driver's decision-making. Implementation of interventions should also be considered from a systems perspective, facilitating links between employers, employees and regulators (Newman & Goode, 2015).

2.2.4 Regulatory factors

Newman and Goode (2015) showed the impact that US regulatory bodies have on HGV accidents. They found that failure by inspectors to notice deficiencies in the maintenance procedures of HGV companies and insufficient guidance regarding sleep-related disorders contributed to accidents. Also, confusion about how responsibilities for traffic control plans around work zones was shared between the highway patrol and the construction company lead to poorly controlled work zones that increased crash risk (Newman & Goode, 2015).

Key findings

- Operator inspections provide an opportunity for regulators to support HGV companies to improve their safety record.

2.2.5 Discussion

The literature review investigated a wide range of causes and contributory factors to understanding how and why shunt accidents happen. Reason (2000) stated that "*we cannot change the human condition, but we can change the conditions under which humans work*" (pp.796). The aim is then to make the system under which HGV/LGV drivers work robust for all road users. This means that HGV drivers are supported and equipped to make decisions that have the potential to reduce errors (Reason, 2000). What emerged from the review is that there seems to be a lack of clear and practical advice for drivers to support decision making in certain scenarios. For example, it has been shown that fatigue contributes to both the severity of collisions and an increase in collision rates. One way to combat fatigue is for a driver to take a rest break. However, the review did not find any evidence of specific practical advice on how long the driver needs to break for and how they could make that decision. Beyond the low availability of Motorway Service Stations, there is some indication that payment methods and a company's safety culture could also impact fatigued driving behaviour by discouraging breaks.

The evidence therefore suggests that organisations play a crucial role in the decisions that drivers make. Organisational attitudes towards vehicle maintenance, incidents, safety, payment methods, training and feedback processes have all been shown to impact collision rates. Employing a skilled workforce and training them to deal with hazardous situations and conditions could support the ability of drivers to recognise, avoid and/or know how to safely engage with them. This is particularly relevant to drivers under the age of 25 who have been consistently shown to be part of a high-risk group. Knowledge of what, and when, conditions become more hazardous, and incentives to remain vigilant could further support this. Examples of this are that driving in good weather conditions can be as hazardous as driving in bad weather, and that Mondays and Tuesdays have higher incident rates linked to speeding behaviour. Freight scheduling and driver awareness that takes such risk information into account could help lower risk. Companies may also be able to play a role in supporting the health and wellbeing of their drivers to reduce the impact that health conditions could have on fatigued driving.

The impact of other road users was also covered by the literature review. Specifically, when congestion and in-lane speed variation increase, the deficient headways of other road users could result in conditions where a shunt accident is difficult to avoid. Interventions therefore may also need to consider how to manage road use during these conditions and how to inform and train other road users as well as HGV/LGV drivers to improve safety outcomes.

The findings from this literature review have been used to inform and focus the analysis and research carried out in the subsequent tasks: Stats19 analysis (Section 3), HE Fatals analysis (Section 4) and driver engagement (Section 5). Interventions for the identified causes will be considered in Phase 2 of this project.

3 Stats19 analysis

This section contains the results of detailed analysis of Stats19 collision data from 2016-2018 to understand the prevalence and circumstances of LGV and HGV frontal shunt collisions. LGV and HGV frontal shunt collisions are defined from Stats19 data as collisions where at least one LGV or HGV had the first point of impact field recorded as 'front' and at least one other vehicle in the collision had first point of impact recorded as 'back'.

Section 3.1 presents an overview of these collisions on the SRN and the subsequent sections focus on 2-vehicle frontal shunts to explore their characteristics further. Section 3.6 considers multi-vehicle collisions.

3.1 Shunt collisions in context

For the analysis in this section, HGVs are defined as goods vehicles with a maximum gross weight over 3.5 tonnes or where the maximum gross weight was unknown. LGVs are defined using the Stats19 category "Van - goods vehicles 3.5 tonnes or under".

There were 8,877 collisions involving at least one HGV or LGV on the SRN between 2016 and 2018. Of these collisions, 3,155 (36%) were frontal shunt collisions. Table 3.1 shows the total number of collisions and frontal shunt collisions on the SRN involving HGVs and LGVs[1].

Table 3.1: HGV and LGV collisions, SRN 2016-2018

	LGV	HGV	Total
Number of LGV/HGV collisions	3,971	5,584	8,877
Number of LGV/HGV frontal shunts	1,568	1,630	3,155
LGV/HGV frontal shunt proportion	39%	29%	36%

The figures in Table 3.1 show that, for both HGVs and LGVs, frontal shunt collisions account for around a third of collisions involving these vehicles on the SRN.

These 3,155 frontal shunt collisions resulted in 5,500 casualties, of which 11% were killed or seriously injured (KSI).

Table 3.2 shows the total number of casualties from all frontal shunt collisions on the SRN (2016-2018) by severity. The number of casualties from LGV and HGV frontal shunt collisions, and the proportion of the total shunt casualties they account for, are also shown.

[1] The HGV and LGV collision numbers do not sum to the number in the total column because some collisions involve both HGVs and LGVs.

Table 3.2: Casualties from frontal shunt collisions by severity, SRN 2016-2018

	Killed	Serious	Slight	Total
Number of casualties in all frontal shunts	235	1,949	21,643	23,827
Number of casualties in LGV/HGV frontal shunts	117	510	4,873	5,500
Proportion of all frontal shunt casualties which are from LGV/HGV frontal shunts	50%	26%	23%	23%

Half the number of fatalities from shunts on the SRN are from collisions involving an HGV or LGV, despite collisions involving these vehicles only accounting for 23% of shunt casualties in total. The proportion for seriously injured casualties is lower but still substantial; just over one quarter of seriously injured shunt casualties are from HGV/LGV frontal shunt collisions. These figures show that HGV and LGV frontal shunt collisions account for a disproportionate number of high severity shunt casualties.

Stats19 does not record the order in which vehicles in a collision hit one another which makes it difficult to determine collision circumstances for collisions involving more than two vehicles. The number of HGV and LGV frontal shunt collisions split by the number of vehicles involved in the collision is shown in Figure 3-1.

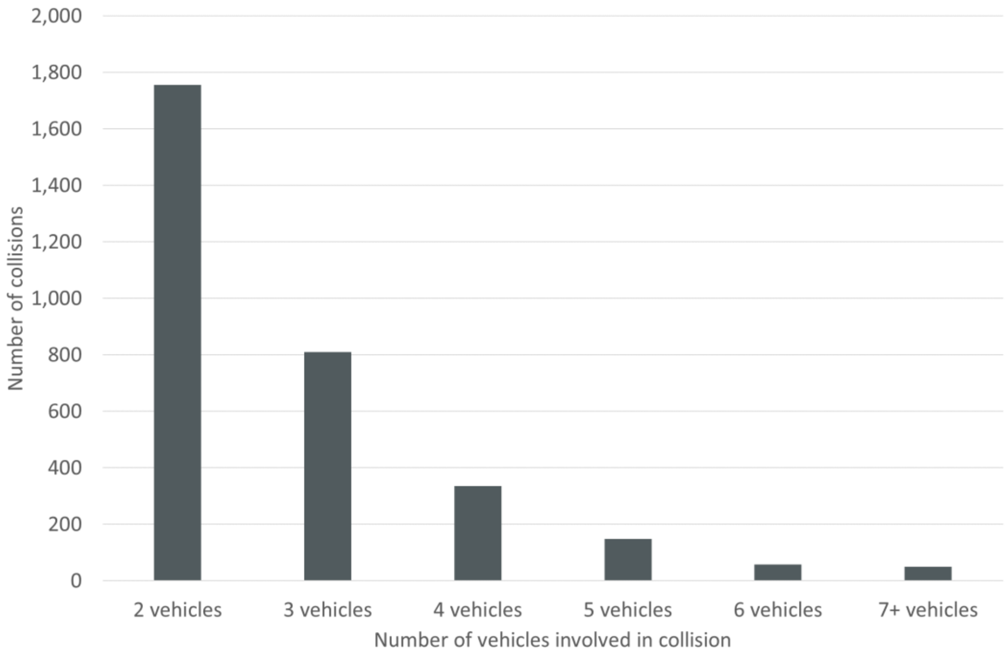


Figure 3-1: Number of LGV/HGV frontal shunt collisions by number of vehicles involved, SRN 2016-2018

Figure 3-1 shows that 1,755 collisions (56% of all HGV/LGV frontal shunt collisions) involved two vehicles. These two-vehicle collisions are the focus of the subsequent in-depth analysis because the collision circumstances and other characteristics can be more easily identified. Frontal shunt collisions involving three vehicles (810 collisions) accounted for 58% of the remaining collisions; these and other multi-vehicle frontal shunt collisions are discussed further in Section 3.6.

There were a total of 2,496 casualties resulting from the 1,755 two-vehicle shunt collisions. Figure 3-2 shows the casualty numbers split by severity and which vehicle they were in (there were only nine pedestrian casualties involved in these collisions and they are not included in the chart).

The LGV definition used up to this point, "goods vehicles 3.5 tonnes or under", includes vehicles such as car-derived vans which can be a lot smaller than other vehicles in this LGV category. For those LGVs where enhanced vehicle data was available (85% of LGVs involved in two-vehicle frontal shunts), the vehicle make and model information in Stats19 was reviewed to identify car-derived vans. Figure 3-2 shows the casualty numbers for car-derived van frontal shunt collisions and LGV frontal shunt collisions (excluding car-derived vans) separately[2].

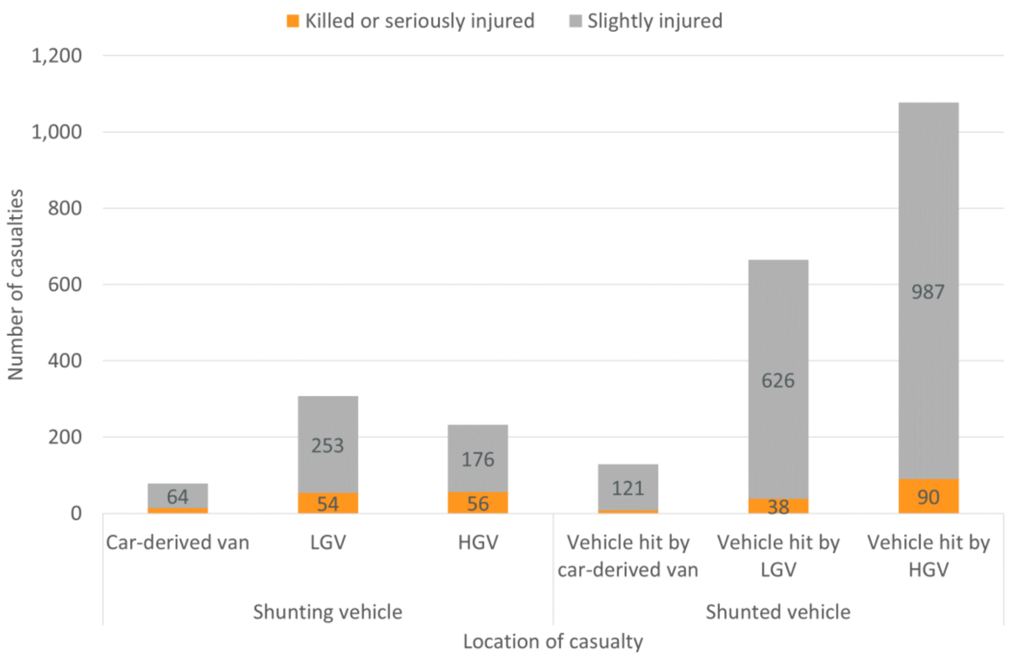


Figure 3-2: Number of vehicle-occupant casualties in two-vehicle car-derived van/LGV/HGV frontal shunt collisions by severity and location, SRN 2016-2018

The number of casualties from frontal shunts involving car-derived vans was smaller than from LGV shunt collisions. However, the proportion of casualties in vehicles hit by car-derived vans which were killed or seriously injured was the same as the proportion of KSI casualties in vehicles hit by LGVs (6%). The KSI proportions for occupants of car-derived vans and LGVs were also equal (18%). This suggests that, whilst the number of shunt collisions involving car-derived vans is smaller, the collisions are of a similar severity to those involving LGVs.

Car-derived vans are of less interest to Highways England than larger LGVs in understanding LGV and HGV frontal shunt collisions and therefore collisions where a car-derived van was the only shunting vehicle involved have been excluded from the analysis in the subsequent

[2] Note that the LGV category includes those vehicles where it was not possible to determine if the vehicle was a car-derived van because enhanced vehicle data was unavailable.

sections. This resulted in 140 two-vehicle collisions and 109 collisions involving three or more vehicles being excluded.

Key findings

- HGV and LGV frontal shunt collisions account for around a third of collisions involving these vehicles.
- Half the number of fatalities and a quarter of the number of seriously injured casualties from shunts on the SRN are from collisions involving an HGV or LGV.
- HGV and LGV frontal shunt collisions account for a disproportionate number of high severity shunt casualties.

3.2 Collision circumstances

This section explores the circumstances of LGV and HGV frontal shunt collisions. As discussed in Section 3.1, only two-vehicle shunts have been included in the analysis in this section and the definition of LGV used excludes car-derived vans. Data for a total of 1,615 collisions have been analysed in this section and in sections 3.3 to 3.5, 688 involving an LGV as the impacting vehicle and 927 involving an HGV.

3.2.1 Collision environment and time

This section presents analysis of environmental factors which may influence frontal shunt collisions, such as weather and whether the collision happened in daylight or darkness. The day and time of frontal shunt collisions have also been analysed. The number of collisions by month was also investigated but no patterns were visible, so the results are not presented.

Figure 3-3 shows the number of LGV and HGV frontal shunt collisions by day of the week.

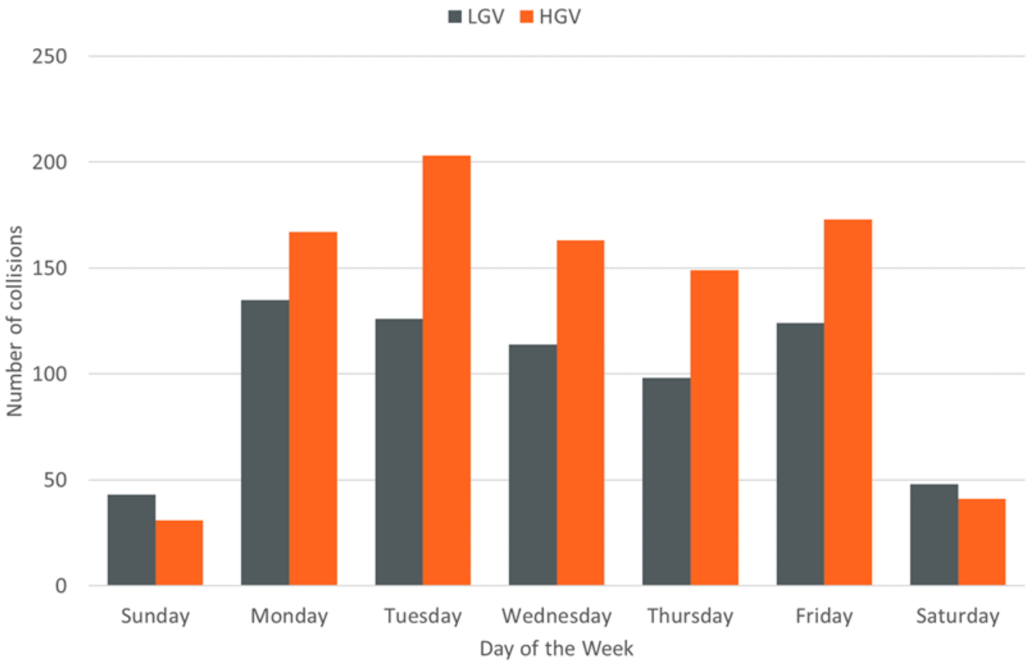


Figure 3-3: Number of two-vehicle LGV/HGV frontal shunt collisions by day of week, SRN 2016-2018

Most of the shunt collisions involving LGVs or HGVs occur during the weekdays (Monday to Friday) with more HGV collisions than LGV collisions occurring during those five days. However, when looking at the weekend there are slightly more LGV collisions than HGV collisions. DfT traffic statistics (DfT, 2020) show that the proportion of LGV traffic travelling on a given weekday is around 16% and this drops to 10% for a weekend day. For HGVs however, the average weekday proportion is 18% and this drops to 6% at weekends. Whilst this data is not SRN-specific, it does suggest that the differences in the distribution of LGV and HGV collision numbers across the week seen in Figure 3-3 are likely to be because of differences in LGV and HGV traffic levels.

The number of LGV/HGV frontal shunt collisions by time of day are shown in Figure 3-4.

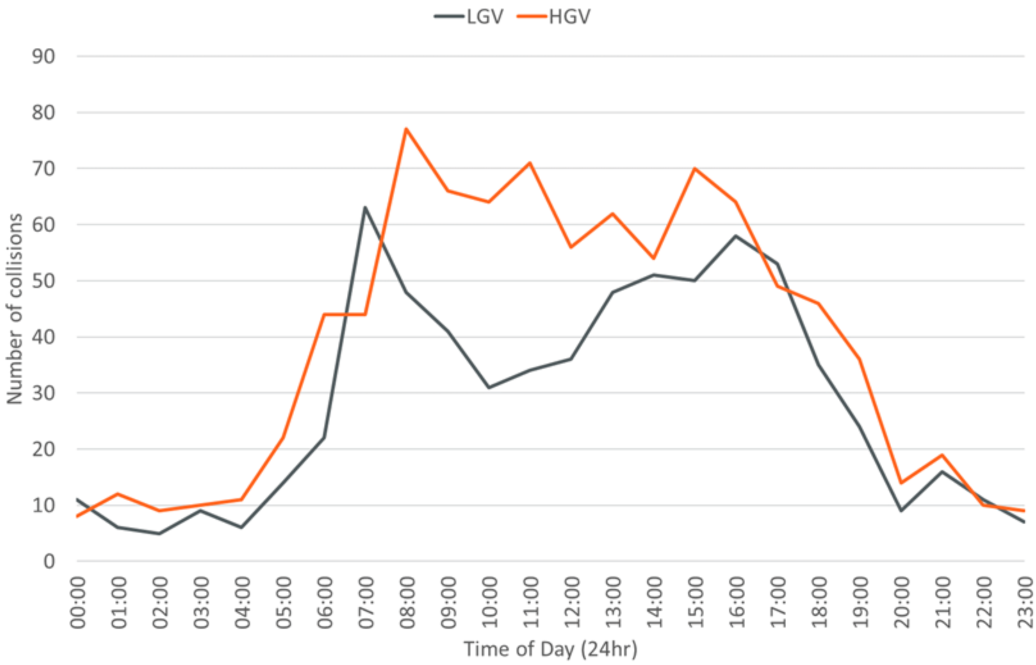


Figure 3-4: Number of two-vehicle LGV/HGV frontal shunt collisions by time of day (24hr), SRN 2016-2018

Figure 3-4 shows that most of the collisions for both LGV and HGV occur during daytime hours, this is to be expected as there are more vehicles on the road during these times. The number of LGV collisions shows two peaks in the rush hour periods between 07:00-08:00 and 16:00-17:00 and a decrease in number of collisions between these periods. The pattern for HGV collisions is slightly different; the number of collisions is more consistent during the day and the rush hour peaks are less prominent.

The weather and lighting conditions at the time of collisions are important to consider because these factors can influence visibility, road surface condition, and the way drivers behave. Figure 3-5 shows the number of frontal shunt collisions for LGVs and HGVs by the weather and lighting conditions at the time of the collision.

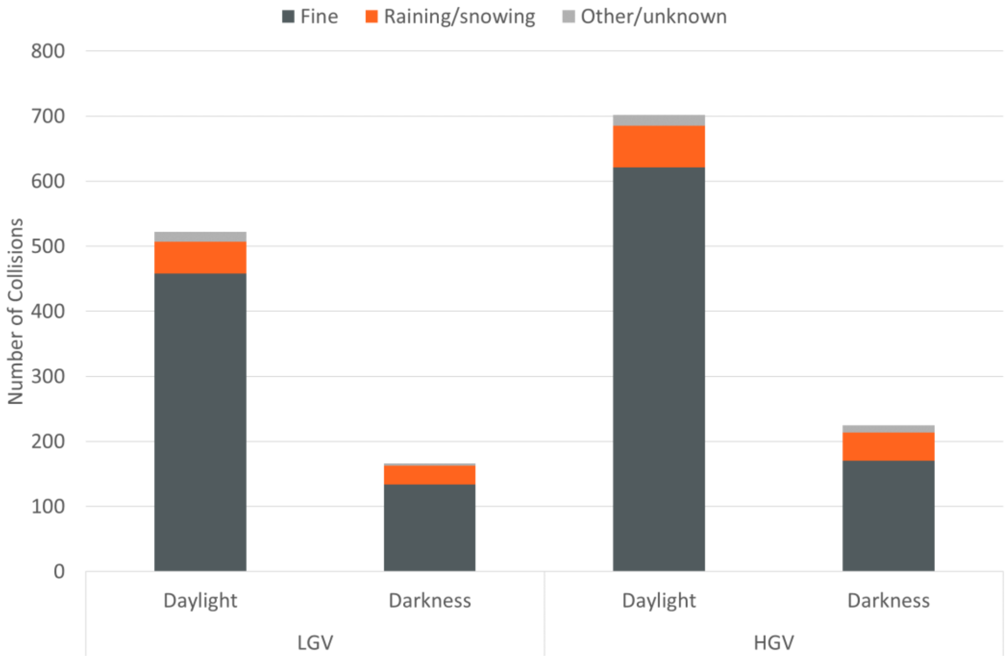


Figure 3-5: Number of two-vehicle LGV/HGV frontal shunt collisions by weather and daylight/darkness, SRN 2016-2018

Figure 3-5 shows that the distribution of collisions by weather and lighting conditions is similar for both LGV and HGV frontal shunts. There are far fewer collisions during darkness than during daylight and this matches with the time of day analysis shown in Figure 3-4. However, there is likely to be lower levels of traffic on the roads during the hours of darkness and so fewer collisions of all types would be expected, meaning that this result is unlikely to be specific to frontal shunt collisions.

Findings from the literature review indicated that darkness may affect the severity of collisions (see Section 2.2.1.3 and this is reflected in the collision data. Seventeen percent of casualties from LGV shunts which happened in the dark were killed or seriously injured compared with 7% from daylight collisions. The figures are similar for HGV shunts; 19% of casualties from collisions in darkness were killed or seriously injured compared with only 9% in daylight.

Most frontal shunt collisions happened in fine weather with only a small number occurring in rain or snow. This agrees with results of analysis of the road condition variable which showed that most LGV and HGV frontal shunt collisions happened when the road surface was dry. Only 26% of LGV shunts and 24% of HGV shunts had the road surface condition in Stats19 recorded as wet/damp and less than 1% of both HGV and LGV shunt collisions had snow, frost or flood recorded.

Key findings

- Most HGV and LGV shunts happen during the day and on weekdays. On weekends, slightly more LGV collisions happened than HGV collisions.
- Most collisions happened in fine weather, in daylight rather than darkness, and when the road surface was dry.
- A higher proportion of casualties from shunt collisions in darkness were killed or seriously injured than from collisions which happened in daylight.

3.2.2 Collision participants

This section explores the types of road users involved in HGV/LGV frontal shunt collisions.

There were slightly more HGVs than LGVs involved in frontal shunts between 2016 and 2018; 57% of two-vehicle shunts involved an HGV as the shunting vehicle and 43% involved an LGV.

Findings from the literature suggested that older vehicles have a higher collision involvement in comparison with newer vehicles and are more likely to result in a fatality (Christoforou et al., 2010). This finding was investigated within the Stats19 data. Vehicle age information was available in Stats19 for 90% of shunt involved LGVs but only 68% of HGVs. Figure 3-6 shows the age distributions for HGVs and LGVs involved in two-vehicle shunts.

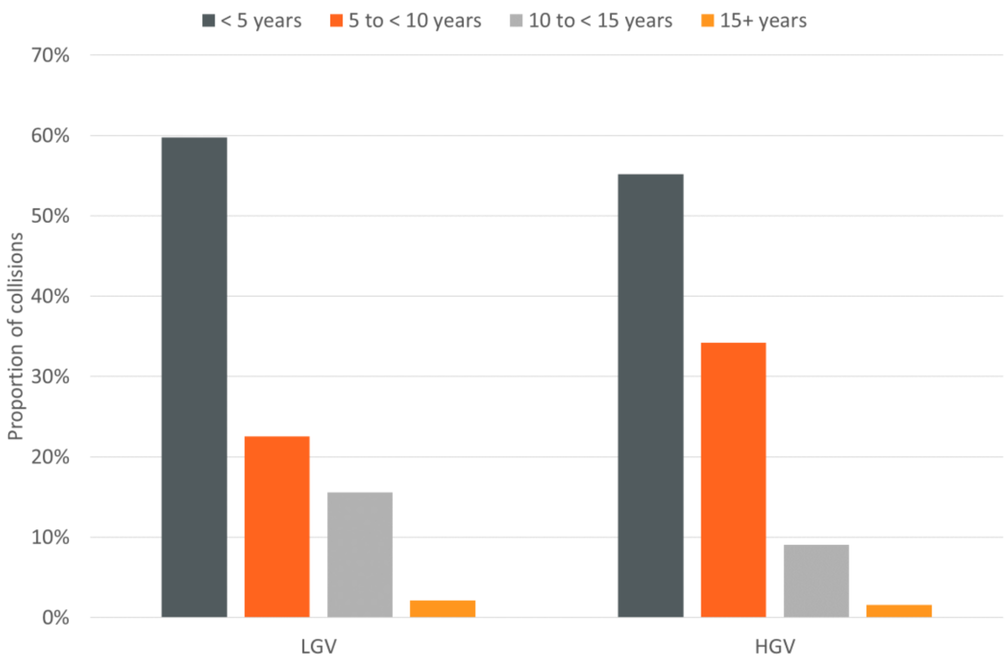


Figure 3-6: Proportion of LGV/HGV frontal shunt collisions by age of LGV/HGV, SRN 2016-2018

For both LGVs and HGVs, the highest proportion of shunts involved vehicles less than five years old. A higher proportion of HGV shunts than LGV shunts involved a vehicle between five and 10 years old. This does not agree with the findings of the literature review (see section 2.2.1.1) but the higher collision involvement of younger vehicles is more likely to be because of the age distribution of HGVs and LGVs using the SRN than increased collision risk for newer vehicles (exposure data showing the number of vehicles on the SRN by vehicle age would be needed to confirm this).

However, the proportion of HGV shunts which resulted in a fatal or serious injury is slightly higher for older vehicles; 18% of collisions involving an HGV between 10 and 15 years old resulted in a KSI casualty compared with 15% of collisions involving an HGV less than five years old, aligning with the results from the literature review. The same pattern is not seen for LGVs, where the proportion of collisions resulting in a fatal or serious injury decreases for older vehicles.

Figure 3-7 shows the number of frontal shunt collisions by the type of vehicle impacted by the LGV or HGV.

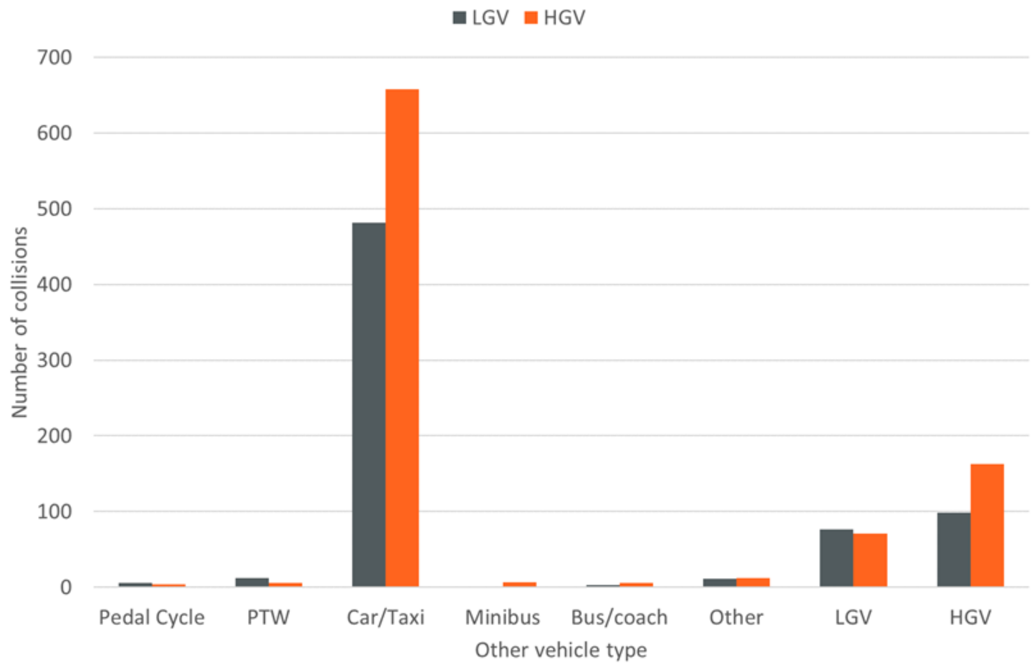


Figure 3-7: Number of two-vehicle LGV/HGV frontal shunt collisions by other vehicle type involved, SRN 2016-2018

The majority of two-vehicle LGV and HGV frontal shunt collisions involved a car or taxi as the other vehicle (70% of both LGV and HGV shunts). LGVs and HGVs were the next most common vehicle types to be impacted in frontal shunts; 11% of LGVs hit another LGV and 14% hit an HGV whilst 18% of HGVs hit another HGV and 8% hit an LGV. Other vehicle types such as pedal cycle, PTW (Powered Two-wheeler), minibus, bus and coach are very rarely the other vehicle during an HGV or LGV frontal shunt collision, but these vehicle types typically make up a much smaller proportion of traffic than cars, taxis and goods vehicles. There were very few pedestrians involved in two-vehicle frontal shunts; only four and three pedestrians were involved in LGV and HGV collisions respectively.

Figure 3-2 in Section 3.1 showed that the number of vehicle-occupant casualties in frontal shunt collisions is much higher in the shunted vehicle than in the HGV or LGV which impacts them. The average number of other vehicle casualties per HGV collision is 1.16 compared with

0.97 for LGVs and the proportion of casualties which are killed or seriously injured in vehicles impacted by HGVs is also slightly higher than for LGVs (8% of other vehicle casualties from HGV shunts are KSI but only 6% from LGV shunts).

Stats19 records the position of casualties within the vehicle for cars and taxis/private hire cars. Figure 3-8 shows casualty position information for casualties in shunted cars, taxis and private hire vehicles involved in two-vehicle HGV/LGV frontal shunt collisions.

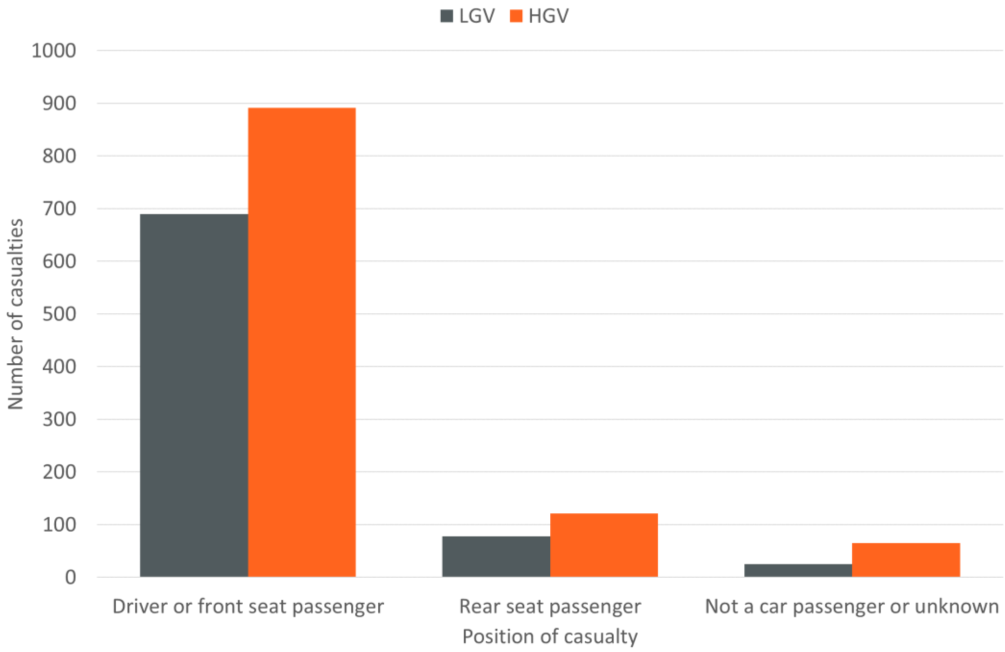


Figure 3-8: Number of car casualties in shunted vehicles in two-vehicle LGV/HGV frontal shunts by position of casualty and type of shunting vehicle (LGV/HGV), SRN 2016-2018

Most casualties in shunted vehicles for which casualty position was recorded were in the front of the vehicle. However, this is likely to be because cars are more likely to have only one or two occupants, rather than because more front seat occupants are more likely to be injured than rear seat occupants.

It is likely that, where they are present, rear seat occupants are more likely to be injured in frontal shunts than front seat occupants. However, Stats19 does not record information about non-injured occupants and therefore it is not possible to know if a higher proportion of those in rear seats or front seats are injured.

Key findings

- Most vehicles involved in shunts with HGVs or LGVs were cars or taxis. Very few pedestrians were injured in two-vehicle HGV/LGV frontal shunts.
- Most LGVs and HGVs in shunt collisions were less than five years old, although this may reflect the distribution of vehicles on the road rather than the fact newer vehicles are higher risk.
- Impacted vehicles are likely to have more casualties in them than the shunting HGV or LGV, and these casualties are slightly more likely to be KSI if the impacting vehicle is an HGV.

3.3 Collision location and vehicle manoeuvres

This section examines the locations of two-vehicle HGV/LGV frontal shunt collisions and the manoeuvres of the vehicles involved to understand whether there are common road layout features which result in a high proportion of these collisions.

3.3.1 Road class and type

Figure 3-9 shows the number of shunt collisions on the SRN by road type: motorway, dual carriageway A road, and single carriageway A road.

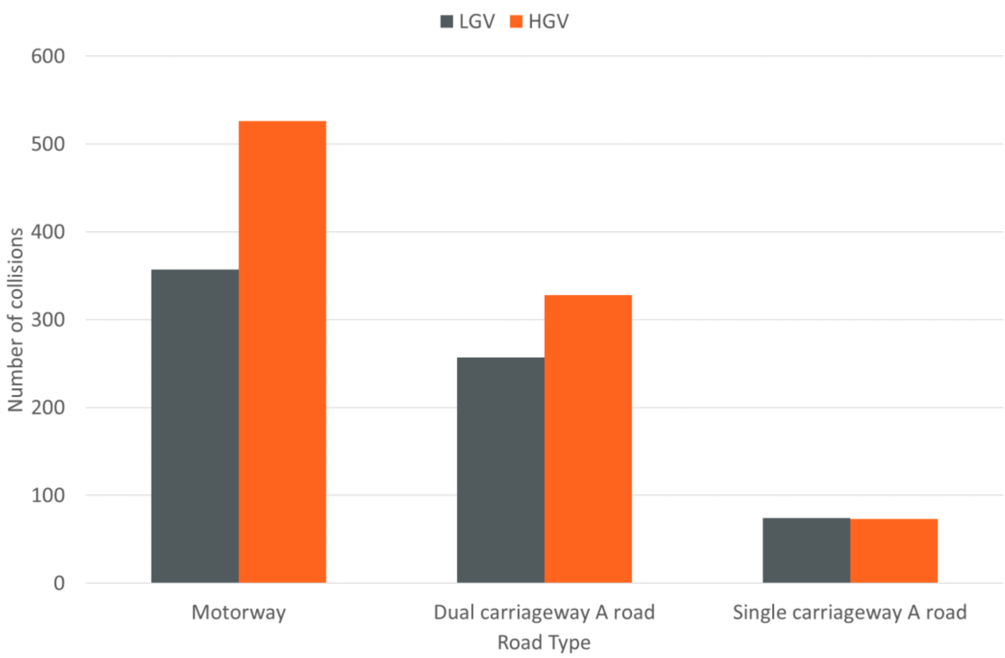


Figure 3-9: Number of two-vehicle HGV/LGV frontal shunt collisions by road type, SRN 2016-2018

Motorways have the highest number of frontal shunt collisions, followed by dual carriageway A roads; single carriageway A roads have far fewer. There were more HGV frontal shunt collisions than LGV collisions on both motorways and dual carriageways but on single carriageway roads the number of HGV and LGV shunt collisions are much more similar.

The small number of collisions on single carriageway A roads is likely to be partially because there is much less of this type of road on the SRN than there is motorway and dual carriageway (only 19% of SRN road length is single carriageway). Also, the level of HGV traffic on single carriageways is likely to be lower than on other road types which would help explain why there is less difference between the numbers of LGV and HGV collisions on these roads.

When comparing collision numbers across road types, it is important to account for differing traffic levels on the different road types. The Department for Transport (DfT) publish figures for traffic on roads managed by Highways England (DfT, 2020). The total LGV and HGV traffic figures for SRN motorways and A roads between 2016 and 2018, as published by DfT, are shown in Table 3.3[3].

Table 3.3: LGV and HGV traffic (billion vehicle kilometres) on the SRN, 2016-2018 (DfT, 2020)

Road class	LGV traffic	HGV traffic
Motorway	43.8	34.1
A road	24.9	14.4

Table 3.3 shows that there is more LGV traffic on the SRN than HGV traffic and this is true on both motorways and A roads. Despite this, Figure 3-9 shows that there are more HGV frontal shunt collisions than LGV frontal shunt collisions on motorways and on A roads in total.

The collision data in Figure 3-9 and the traffic figures in Table 3.3 have been used to calculate the number of two-vehicle frontal shunt collisions per billion vehicle kilometres travelled for LGVs and for HGVs. These collision rates are shown in Figure 3-10.

[3] Note that the definition of LGV used in the DfT traffic figures does include car-derived vans.

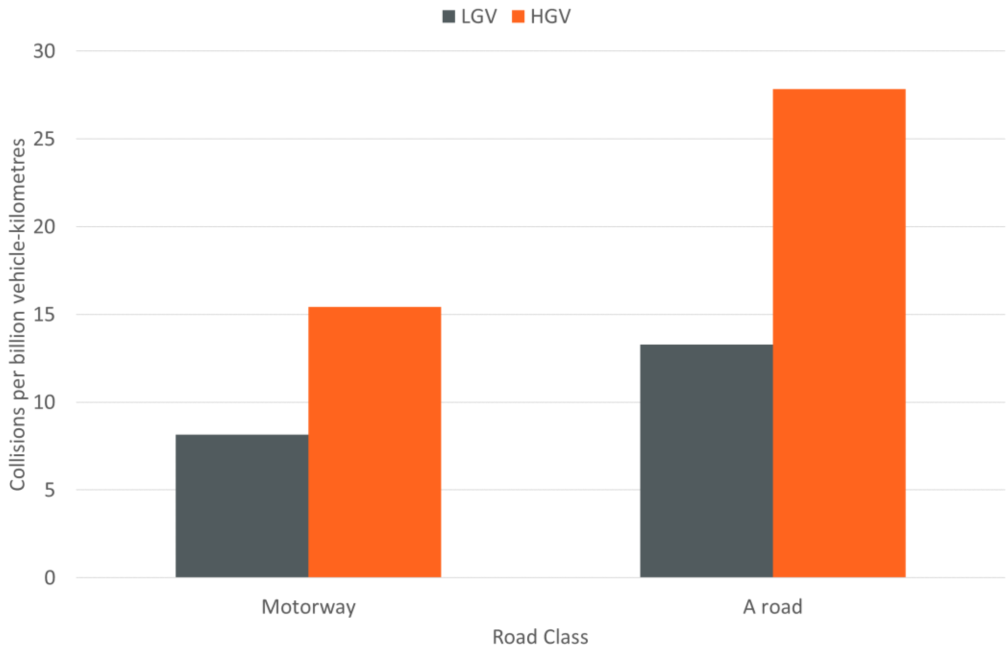


Figure 3-10: Number of two-vehicle LGV/HGV frontal shunt collisions per billion vehicle-kilometres travelled by LGVs/HGVs, by road class, SRN 2016-2018

Figure 3-10 shows that the frontal shunt collision rate on A roads is higher than on motorways for both LGVs and HGVs. This suggests that frontal shunt collisions are more likely to happen on A roads than on motorways, even though the total number of motorway collisions is higher than the number of collisions on non-motorways (see Figure 3-9). Also, the collision rates for HGVs on both road classes are higher than for LGVs, despite the figures in Table 3.3 showing that there are more LGVs travelling on the SRN than HGVs. This suggests that HGVs are more likely to be involved in frontal shunt collisions.

Road type can influence collision severity because of the speed at which vehicles travel on different roads and the characteristics of the roads. Figure 3-11 shows the proportion of HGV/LGV shunt collisions on each type of road which were fatal or serious and the proportion which were slight.

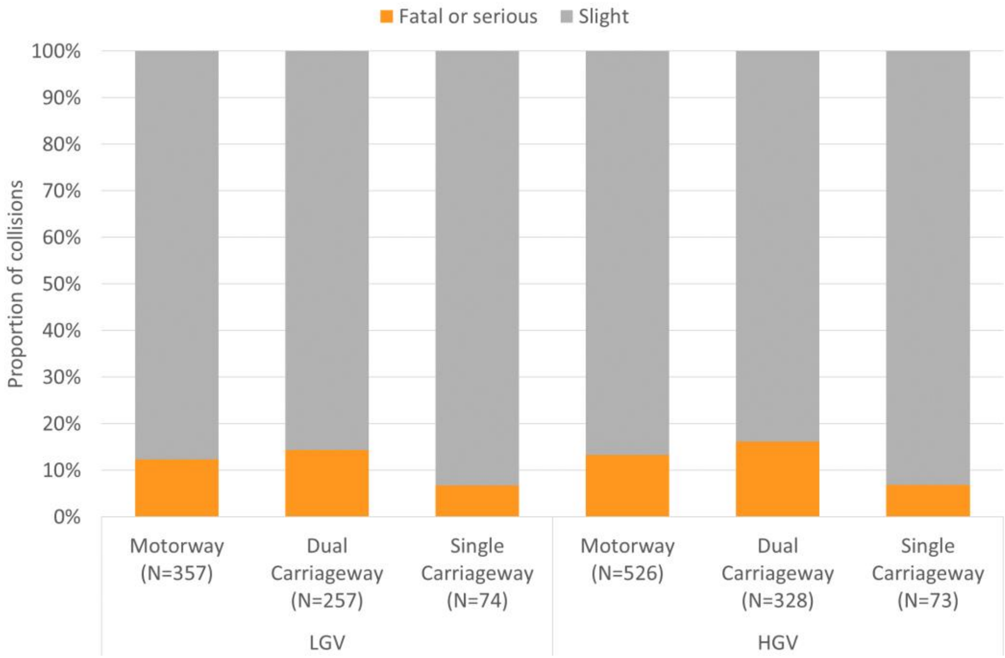


Figure 3-11: Number of two-vehicle LGV/HGV frontal shunt collisions by road type and collision severity, SRN 2016-2018

Figure 3-11 shows that a large proportion of two-vehicle frontal shunt collisions result in slight injuries. Dual carriageways have a higher proportion of fatal and serious outcomes for both LGV and HGV collisions, although motorways are only slightly lower. Single carriageways have the lowest fatal or serious proportion; this is likely to be because of the lower speeds generally travelled on these roads.

Stats19 does not record what speeds vehicles were travelling at when they were involved in a collision, but the speed limit of the road is recorded. This variable was analysed, and the results are shown in Figure 3-12.

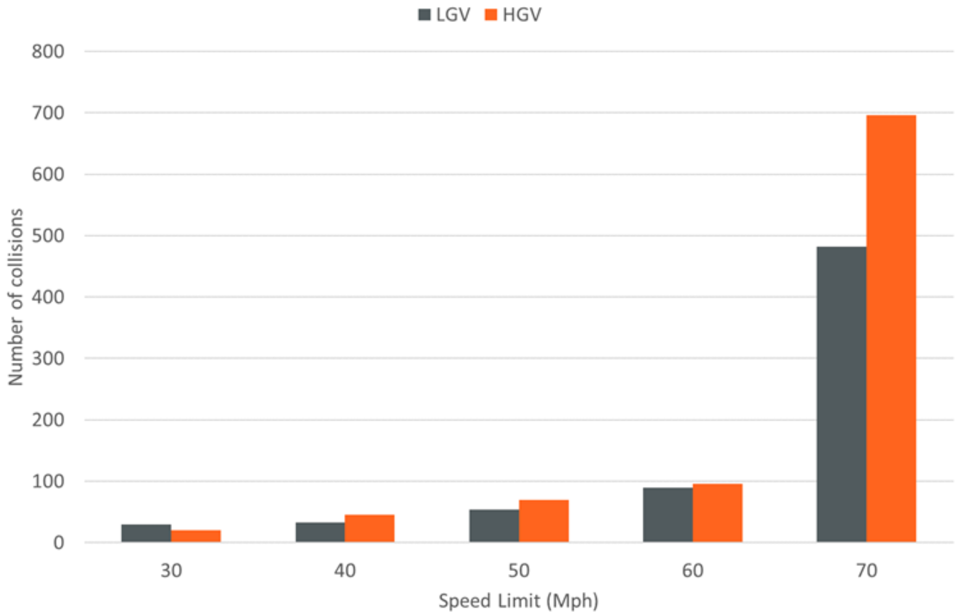


Figure 3-12: Number of two-vehicle LGV/HGV frontal shunt collisions by speed limit (mph), SRN 2016-2018

This analysis showed 70% of LGV shunt collisions and 75% of HGV shunt collisions happened on roads where the speed limit was 70mph (reflecting the larger collision numbers on motorways – see Figure 3-9 - where this is the national speed limit). In contrast, only 4% and 2% of LGV and HGV shunts respectively happened on 30mph roads. However, the speed limit of the road does not necessarily reflect the speed at which traffic was travelling at the time of the collision; for example, if traffic on a 70mph motorway was queuing when a shunt occurred it would be travelling much slower than the 70mph limit.

As well as road type and speed limit, some other location-related factors were explored. Findings from the literature review (discussed in Section 2.2.1.2) suggested that the presence of roadworks could increase collision rates. However, analysis of the Stats19 field 'Special conditions at site' showed that only 6% of HGV frontal shunts (58 collisions) and 5% of LGV frontal shunts (35 collisions) happened where roadworks were present.

Regarding the location of the shunted vehicle at the time of the collision, there were 25 HGV frontal shunt collisions (3%) involving an HGV impacting the rear of a vehicle which was in a layby and three collisions where the shunted vehicle was entering or leaving the layby. This figure is slightly lower for LGVs, with 18 collisions involving a shunted vehicle entering, leaving or in a layby.

The presence of pedestrian crossings at shunt locations was investigated to see if shunts were more likely to happen if a vehicle slowed or stopped suddenly because of a pedestrian crossing the road. Only 16 LGV collisions and nine HGV collisions (2% and 1% of the respective totals) were at locations where there was a pedestrian crossing. This, together with the small number of pedestrian casualties from frontal shunts discussed in Section 3.2.2, suggests that the pedestrians do not commonly feature in HGV/LGV shunt collisions on the SRN.

Key findings

- The highest number of HGV/LGV frontal shunts are on motorways but A roads have higher shunt collision rates than motorways for both HGVs and LGVs.
- Collision rate analysis shows that HGVs are more likely to be involved in frontal shunt collisions than LGVs.
- The proportion of shunt collisions which are fatal or serious is smaller for single carriageway roads than for other road types.
- Roadworks, laybys and pedestrian crossings do not appear to have a substantial effect on the number of frontal shunts.

3.3.2 Junctions

This section explores how many HGV/LGV frontal shunts happen at junctions on the SRN and any common characteristics of junction shunt collisions and the junctions involved.

Figure 3-13 shows the junction detail for all two-vehicle HGV/LGV frontal shunts.

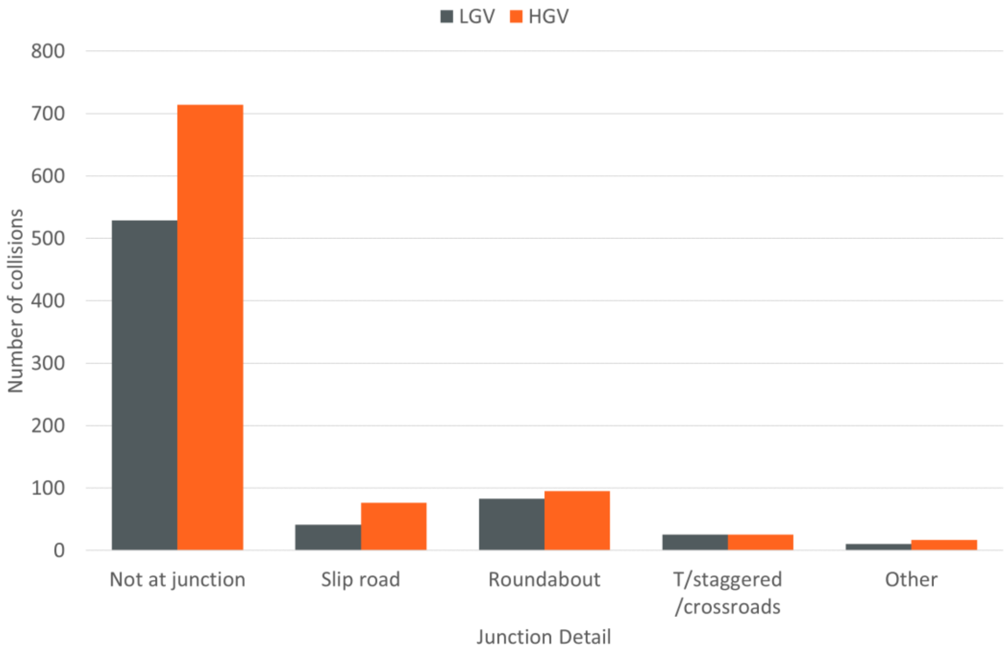


Figure 3-13: Number of two-vehicle LGV/HGV frontal shunt collisions by junction detail, SRN 2016-2018

Of the 688 LGV shunt collisions and the 927 HGV shunt collisions analysed, only 23% of each took place at, or within 20 metres of, a junction. For those collisions which did happen at junctions, the largest number of both LGV and HGV shunts were at roundabouts. There were almost twice as many HGV shunts as LGV shunts on slip roads, suggesting that this location may be a particular problem for HGVs.

Figure 3-14 shows the severity of collisions at the different junction types.

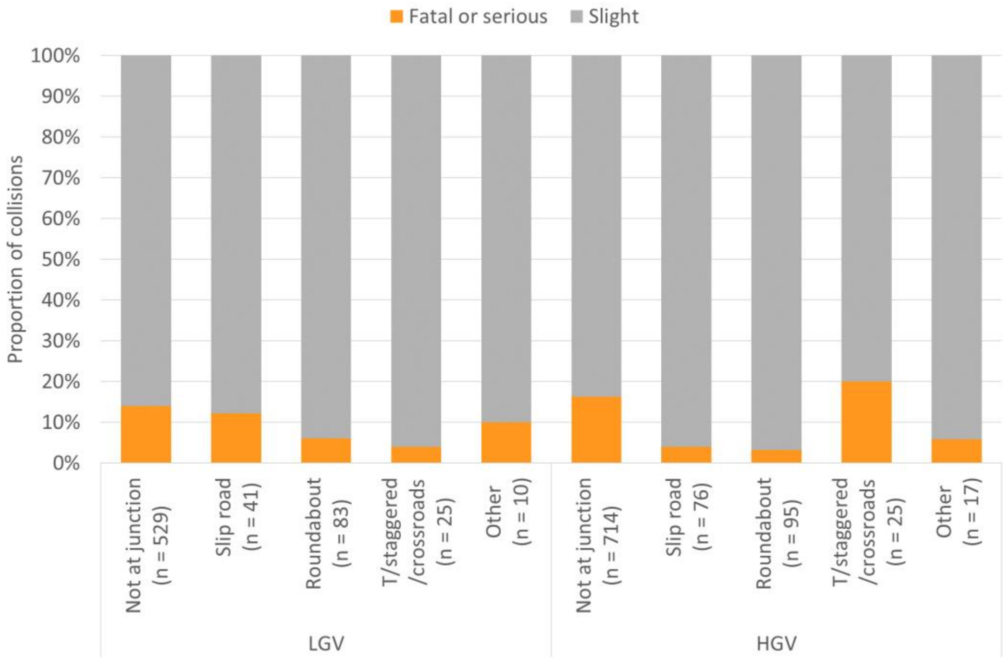


Figure 3-14: Number of two-vehicle LGV/HGV frontal shunt collisions by LGV/HGV junction detail and collision severity, SRN 2016-2018

For junction collisions, the proportion of collisions which are fatal or serious is generally lower than for non-junction collisions, possibly due to the reduced speeds expected at junction locations. The proportion of non-junction collisions which are fatal or serious is 14% for LGV shunts and 16% for HGV shunts. For junction collisions, slip roads have the highest proportion of fatal or serious collisions for LGV shunts (12%), followed by 'other' and then roundabouts (6%). For HGV shunts at junctions, 'T/staggered/crossroads' has the highest fatal or serious proportion; five out of 25 collisions at junctions of this types were fatal or serious. In contrast to the results seen for LGV shunts, only 4% of shunts on slip roads were fatal or serious.

For the 159 LGV and 213 HGV frontal shunt collisions which took place at junctions, Figure 3-15 shows the location of the HGV or LGV within the junction at the time of the collision.

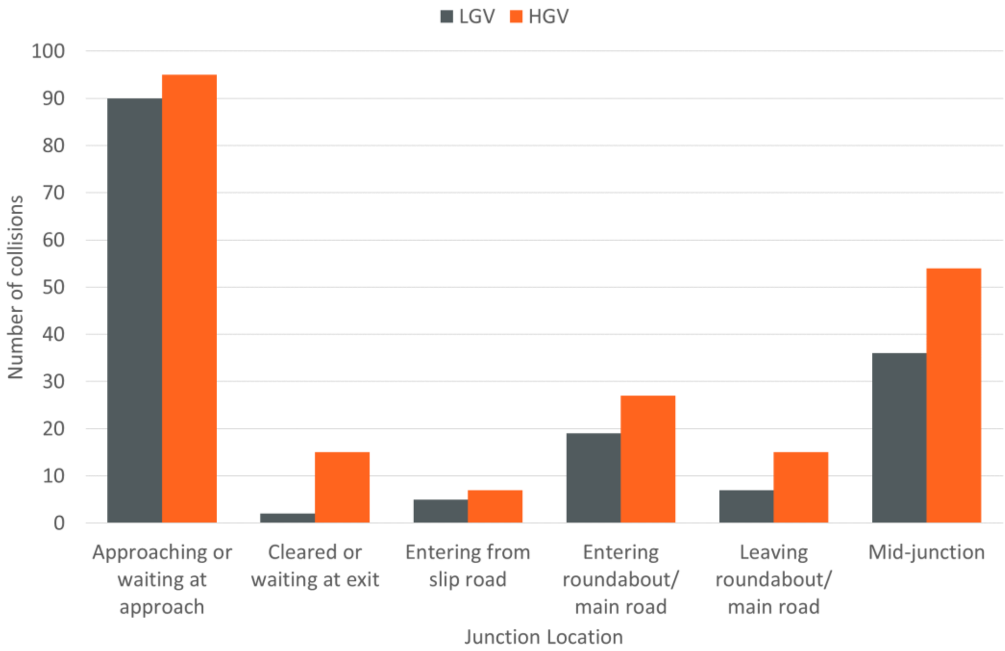


Figure 3-15: Number of two-vehicle LGV/HGV frontal shunt collisions by junction location of LGV/HGV, SRN 2016-2018

The majority of both LGV and HGV shunt collisions at junctions took place whilst the HGV/LGV was approaching the junction or waiting at the junction approach. These collisions may be happening in queues approaching junctions or because a vehicle has slowed down when approaching a junction and the HGV or LGV behind has not reacted appropriately. There is a much larger number of HGV shunts happening when the HGV had cleared the junction or was waiting at the exit (15 collisions) than LGV collisions in the same situation (2 collisions).

Over 95% of both LGV and HGV frontal shunt collisions occurred where the LGV/HGV and other vehicle had the same junction location recorded. The distribution by junction location for these collisions was the same as that for all collisions shown in Figure 3-15.

Key findings

- Only 23% of both LGV and HGV frontal shunt collisions took place at junctions.
- The number of HGV shunts on slip roads was almost double the number of LGV shunts in these locations, suggesting these locations may be harder to navigate for these larger vehicles.
- Non-junction collisions were generally more severe than junction collisions.
- Most HGVs and LGVs in shunt collisions at junctions were approaching the junction or waiting at the junction approach when the collision occurred.

3.3.3 *Vehicle manoeuvres*

This section considers the manoeuvres of the goods vehicles and other vehicles involved in HGV/LGV shunts to identify common collision configurations. Figure 3-16 shows the manoeuvres of HGVs and LGVs in two-vehicle frontal shunts.

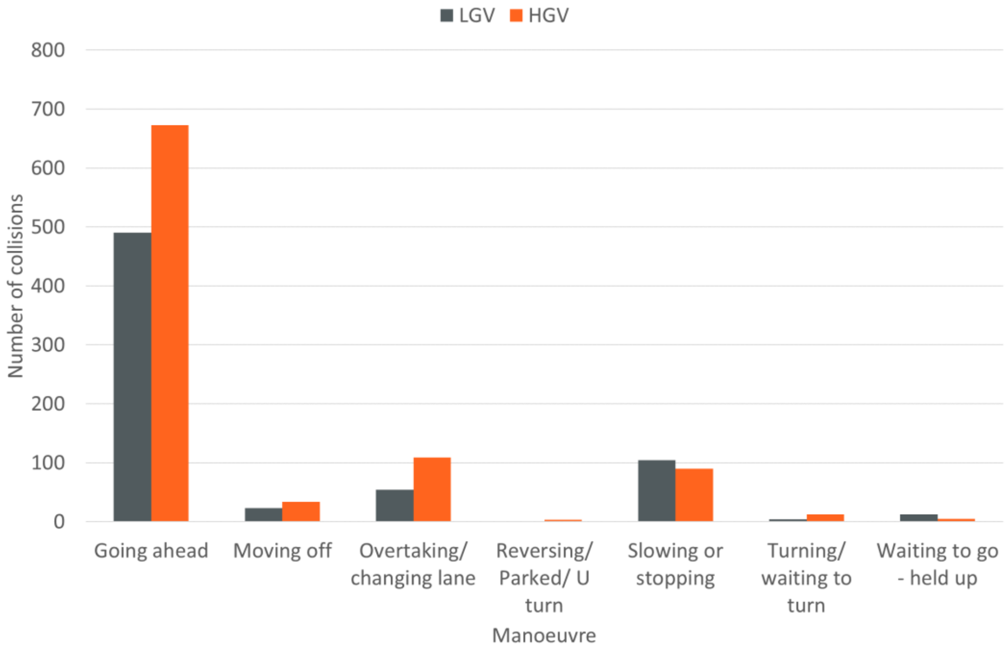


Figure 3-16: Number of two-vehicle LGV/HGV frontal shunt collisions by HGV/LGV manoeuvre, SRN 2016-2018[4]

Most two-vehicle frontal shunt collisions for both LGV and HGV vehicles occur when the vehicle manoeuvre is 'Going ahead'; the number of collisions in the other six categories are small in comparison. 'Overtaking/changing lane' is more common for HGVs and 'Slowing or stopping' is slightly more common for LGVs.

Fourteen percent of LGV shunts and 16% of HGV shunts where the goods vehicle was 'Going ahead' were fatal or serious. The manoeuvre with the second highest proportion of fatal or serious collisions was 'Overtaking/changing lane' (15% of LGV collisions and 11% of HGV collisions where this manoeuvre was recorded). The proportion of collisions which were fatal or serious was much lower for the other manoeuvres. This is likely to be because 'Going ahead' and 'Overtaking/changing lane' are both manoeuvres which occur at higher speeds than the others. This means that if an HGV or LGV impacts another vehicle whilst doing either of these manoeuvres, the outcome may be more severe than if they were, for example, slowing down.

Figure 3-17 shows the manoeuvres of the vehicles which were impacted by HGVs and LGVs in frontal shunts.

[4] Vehicle manoeuvre was unknown for one HGV

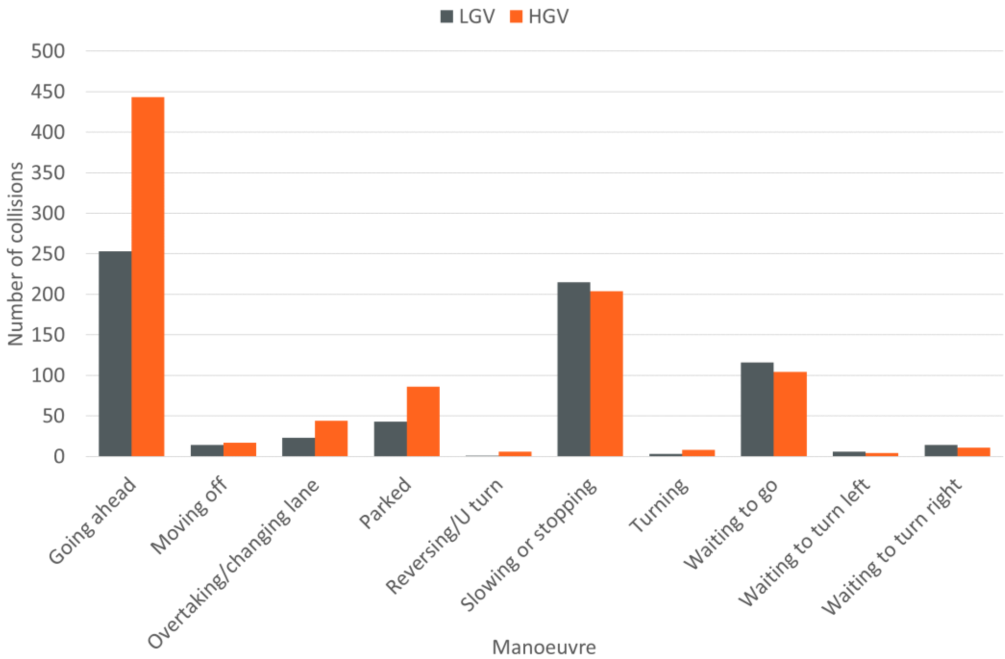


Figure 3-17: Number of two-vehicle LGV/HGV frontal shunt collisions by other vehicle manoeuvre, SRN 2016-2018

'Going ahead', 'Slowing/stopping' and 'Waiting to go' are the most common manoeuvres for shunted vehicles in both LGV and HGV frontal shunt collisions. The proportion of collisions where the other vehicle is slowing, stopping or waiting to go is much higher than the proportion of collisions where HGVs or LGVs are performing these manoeuvres (see Figure 3-16). This suggests that frontal shunt collisions are occurring when a vehicle slows or is stationary and an HGV or LGV fails to slow down sufficiently in response and therefore impacts the rear of the slowing or stationary vehicle in front.

Table 3.4 shows the most common manoeuvre combinations for shunted vehicles and LGVs. The same information for HGVs is shown in Table 3.5.

Table 3.4: Most common manoeuvre combinations in two-vehicle LGV frontal shunt collisions, SRN 2016-2018

LGV manoeuvre	Shunted vehicle manoeuvre	Number of collisions	Proportion of total LGV shunt collisions
Going ahead	Going ahead	212	31%
Going ahead	Slowing or stopping	132	19%
Slowing or stopping	Slowing or stopping	75	11%
Going ahead	Waiting to go – held up	71	10%
Going ahead	Parked	37	5%

Table 3.5: Most common manoeuvre combinations in two-vehicle HGV frontal shunt collisions, SRN 2016-2018

HGV manoeuvre	Shunted vehicle manoeuvre	Number of collisions	Proportion of total HGV shunt collisions
Going ahead	Going ahead	339	37%
Going ahead	Slowing or stopping	140	15%
Overtaking/Changing lane	Going ahead	90	10%
Going ahead	Parked	78	8%
Going ahead	Waiting to go – held up	57	6%

The most common combination of HGV/LGV and shunted vehicle manoeuvres is 'going ahead' for the HGV/LGV and 'going ahead' for the shunted vehicle. This combination is recorded in 31% of LGV shunts and 37% of HGV shunts. 'Going ahead' for the HGV/LGV and 'Slowing or stopping' for the shunted vehicle are also commonly recorded together. This aligns with the conclusions mentioned above that shunts are occurring because a vehicle is slowing and an LGV or HGV is failing to react accordingly. These types of collisions may be happening when approaching queuing traffic or a junction.

The next two charts explore the common manoeuvres of vehicles involved in frontal shunts at junctions. Figure 3-18 shows the manoeuvres of the HGV/LGV and Figure 3-19 shows the manoeuvres for the shunted vehicle.

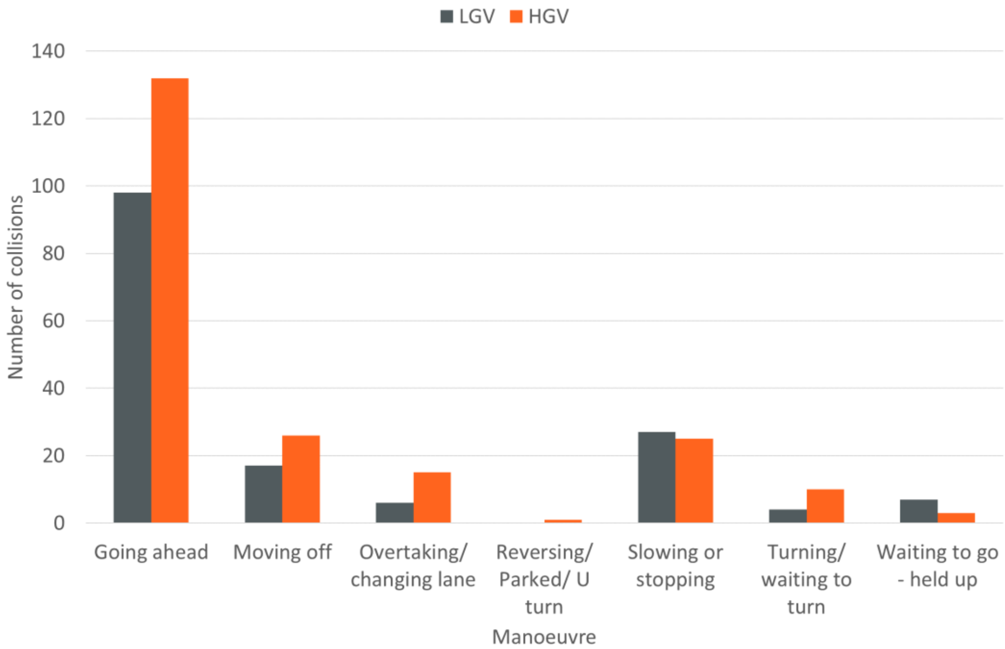


Figure 3-18: Number of two-vehicle LGV/HGV frontal shunt collisions at junctions by HGV/LGV manoeuvre, SRN 2016-2018[5]

'Going ahead' is the most common manoeuvre recorded for HGVs and for LGVs in shunts at junctions; this is the same as for all locations. However, this manoeuvre was recorded for HGVs and LGVs in around 60% of junction collisions compared with around 70% of collisions at all locations. 'Slowing or stopping' and 'Moving off' were also both commonly recorded for HGVs and LGVs in junction shunts.

[5] Vehicle manoeuvre was unknown for one HGV

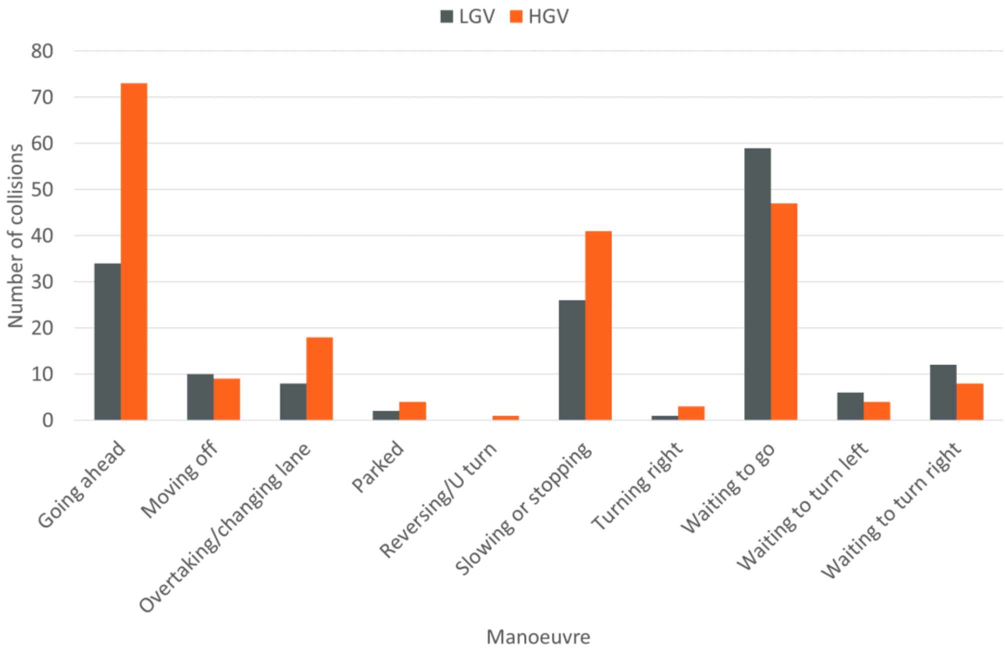


Figure 3-19: Number of two-vehicle LGV/HGV frontal shunt collisions at junctions by other vehicle manoeuvre, SRN 2016-2018

Again, similarly to the analysis of other vehicle manoeuvres at all location shown in Figure 3-17, 'Going ahead is the most commonly recorded other vehicle manoeuvre in shunts at junctions. 'Slowing or stopping' and 'Waiting to go' are also very commonly recorded but the proportion of collisions where the shunted vehicle had 'Waiting to go' recorded is higher at junctions than at all locations and the proportion where the shunted vehicle was slowing or stopping is correspondingly lower.

There are some small differences between the manoeuvres of shunt-involved vehicles at junctions when compared to all locations, but overall, the common manoeuvres are the same.

Key findings

- 'Going ahead' is the most common manoeuvre recorded for HGVs, LGVs and shunted vehicles in frontal shunt collisions.
- A high proportion of shunted vehicles were slowing or stopping or waiting to go.
- The combination of an HGV/LGV going ahead and a shunted vehicle slowing or stopping was recorded in 19% of LGV shunts and 15% of HGV shunts.
- The common manoeuvres recorded in shunts at junctions are similar to those recorded for all shunts.

3.3.4 Cluster analysis

GIS analysis was carried out to identify potential collision hotspots for further investigation to further understand what road characteristics and features may be contributing towards HGV/LGV shunts. This section shows the results of the GIS analysis and more detail about the main collision clusters identified. The cluster analysis presented here only included two-vehicle HGV/LGV shunts.

Using the Stats19 extract with the attached OSGB X and Y coordinates the data could be imported into GIS software. Around each collision point a 50m circular buffer was created for clustering; 50m was chosen as it produced a sensible number of high frequency clusters. Each circular buffer had the number of collisions within it counted and then with this count a style or colour was added to facilitate identifying the highest risk areas of the network (where several similar shunt collisions happened within an area). Figure 3-20 shows the SRN with areas of interest (three or more collisions within the cluster) highlighted in red.

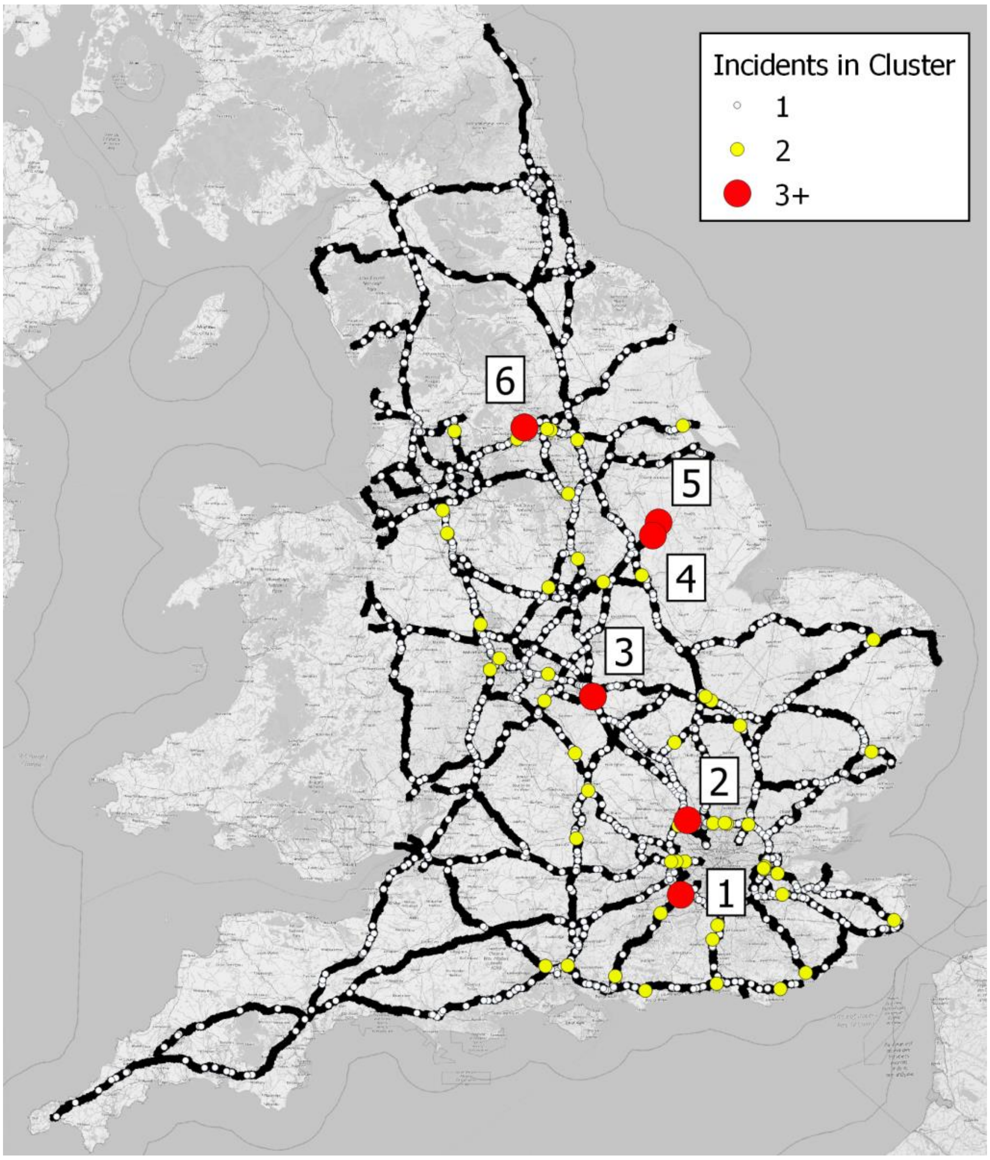


Figure 3-20: 50m clusters of two-vehicle HGV/LGV frontal shunts, SRN 2016-2018

There were six clusters which contained three or more collisions. However, three of these were discarded after being examined in more detail. This was because the collisions were on different carriageways, or because some collisions within in a cluster were on a grade-separated roundabout but others were on the main carriageway underneath. The remaining three clusters (Clusters 3, 4 and 5 in Figure 3-20) were all on roundabouts and they are shown in detail in Figure 3-21. Collisions are represented by red dots and the black lines indicate which roads are part of the SRN.

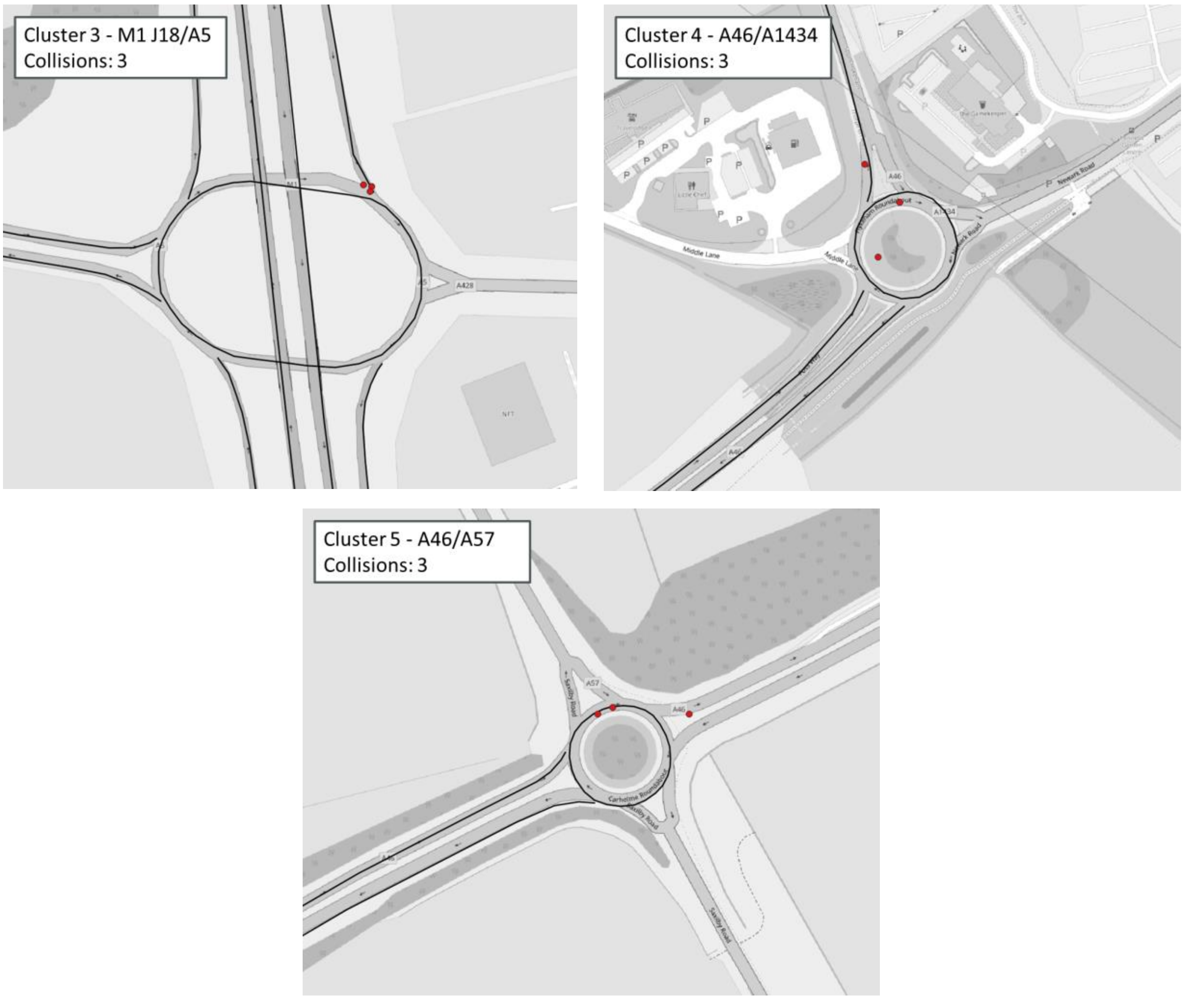


Figure 3-21: Clusters containing three or more two-vehicle HGV/LGV frontal shunts, SRN 2016-2018

Cluster 3 is on the grade-separated roundabout at junction 18 of the M1 and comprises two LGV shunts and one HGV shunt. All three collisions happened where the slip road coming off the M1 meets the roundabout and in all the collisions the HGV or LGV had vehicle manoeuvre recorded as ‘Going ahead’ and the other vehicle was waiting to go ahead. This suggests that these collisions may have happened because the goods vehicle failed to slow down sufficiently when approaching the junction. None of the shunting vehicles had any contributory factors recorded relating to the road environment or things which may have affected their vision. All three collisions resulted in only slight injuries, suggesting that they happened at low speed.

Cluster 4 is on Hykeham Roundabout on the A46 near Lincoln and comprises two LGV shunts and one HGV shunt, all of which resulted in slight injuries. One collision happened on the roundabout itself, one on the northern A46 roundabout exit and one on the northern A46 approach[6]. The collisions which happened on the approach and exit to the roundabout appear likely to be queuing collisions; one involved an LGV going ahead and another vehicle slowing and in the other both vehicles were moving off. The collision which happened on the roundabout involved an HGV going ahead and another vehicle changing lane. None of the vehicles involved in any of the collisions had contributory factors recorded relating to the road environment or affected vision; all the contributory factors recorded related to driver behaviour.

Cluster 5 is also on the A46 near Lincoln, at Carholme Roundabout, and comprises one LGV shunt and two HGV shunts. The vehicles in these collisions were all recorded as approaching or entering the roundabout. In all three collisions the HGV or LGV was slowing or moving off and the other vehicle was slowing or waiting to go ahead. This suggests that these collisions are likely to have happened in queuing traffic and the injury severity (all three were slight collisions) supports this by suggesting that these were low speed collisions. Only one collision had contributory factors recorded in Stats19 and the HGV in this collision had 'vision affected by dazzling sun' and 'vision affected by vehicle blind spot' recorded.

The cluster analysis agrees with the results of junction location analysis in Section 3.3.2 and suggests that HGV/LGV shunts are common at places where vehicles are slowing or stopping as they approach junctions.

3.4 Driver information

This section covers information about the drivers of the LGVs and HGVs involved in two-vehicle frontal shunt collisions. The purpose of this analysis is to help identify potential target audiences for any communications campaigns or interventions.

Figure 3-22 shows the age distributions for male and female LGV and HGV drivers involved in shunt collisions. It should be noted that driver age is not always recorded in Stats19 and was missing for around 10% of both LGV and HGV drivers.

[6] This collision shows as being in the middle of the roundabout on the map because of an inaccuracy in the coordinates. The Stats19 record for this collision suggests it happened as the vehicles were approaching the roundabout from the north on the A46.

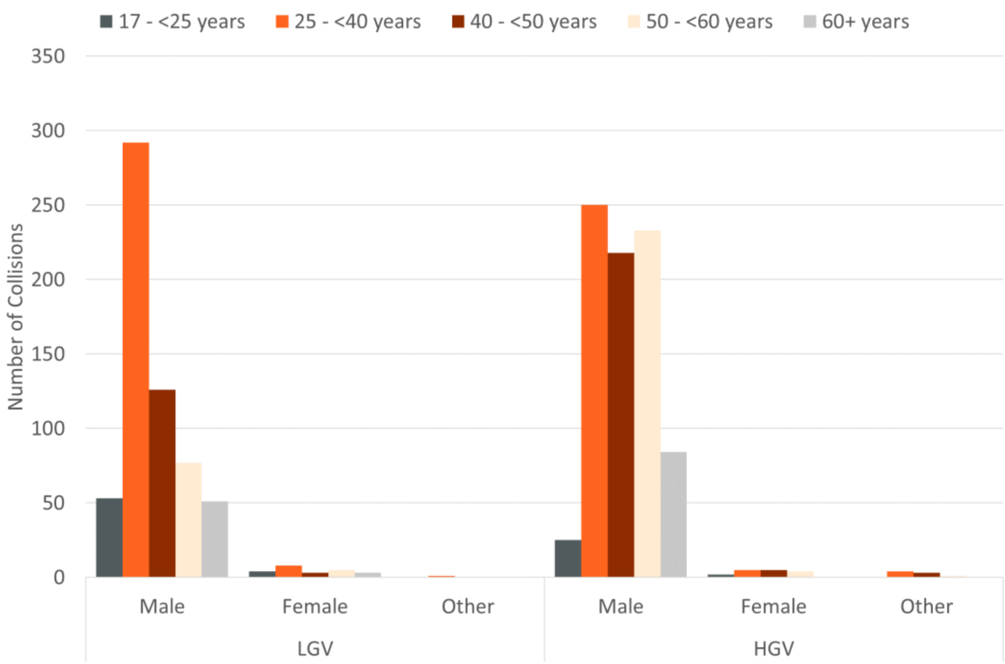


Figure 3-22: Number of two-vehicle LGV/HGV frontal shunt collisions by LGV/HGV driver age and gender, SRN 2016-2018

The majority of LGV and HGV drivers involved in frontal shunt collisions are male. Within the male category the most likely age category for HGV drivers involved in shunts is either 25-40, 40-50 or 50-60 whereas for LGVs the 25-40 age group dominates. This pattern is reflected at a smaller scale in the female data.

Exposure data is important to understand whether the distribution of frontal shunt collisions by driver age matches the driving population and hence whether there are age groups which are more likely to be involved in these collisions.

HGV driver age information from the FTA Skills Shortage Report (Repgraph Limited, 2018) published by Logistics UK (formerly the Freight Transport Association) has been used to calculate the proportion of HGV drivers in the UK in four age groups for Q4 2017. These data are shown in Figure 3-23 below alongside the proportion of HGV drivers involved in two-vehicle frontal shunts by age group.

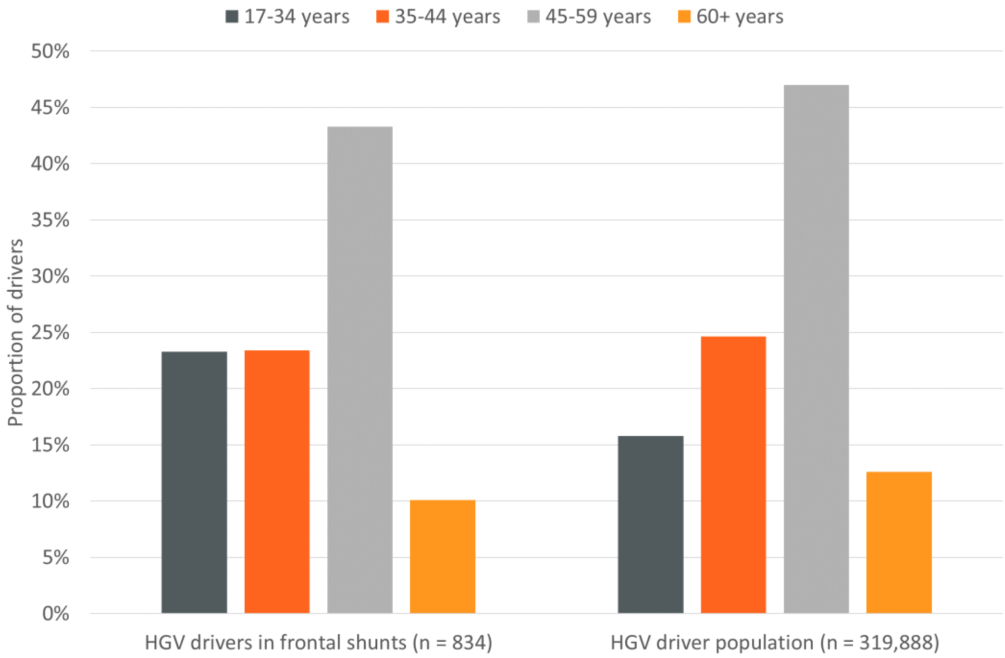


Figure 3-23: Proportion of HGV drivers in two-vehicle HGV frontal shunts and proportion of overall HGV driver population by age group

For drivers over 35 years old, the proportion of frontal shunt involved drivers in each age group is very similar to the HGV driving population. This shows that drivers in these age groups are not involved in disproportionate numbers of frontal shunt collisions.

However, the proportion of shunt involved drivers in the 17-34 age group is noticeably larger than the proportion of HGV drivers in this age group. This suggests that these younger drivers are over-represented in frontal shunt collisions.

Table 3.6 shows the number of HGV frontal shunt collisions per HGV driver for each age group.

Table 3.6: Number of HGV frontal shunt collisions per HGV driver, by driver age group

Driver age group	Frontal shunt collisions per driver
17-34 years	0.0038
35-44 years	0.0025
45-59 years	0.0024
60+ years	0.0021

The figures in Table 3.6 support the conclusions drawn from the data in Figure 3-23. The 17-34-year-old age group has the highest rate of collisions per driver, indicating that drivers in this age group are at higher risk of being involved in frontal shunt collisions than the other age groups. This finding replicates the finding from the literature review (see Section 2.2.2.5). The collision rate decreases as drivers get older, suggesting that inexperience and/or differences in behaviour (e.g. higher speeds, close following) may be factors in HGV frontal shunt collisions.

The majority of shunt-involved LGVs and HGVs were right-hand drive (RHD), 99% and 92% respectively. The higher percentage of left-hand drive (LHD) HGVs compared to LGVs is most likely due to the HGV import and export traffic to and from Europe where left-hand drive is more prominent.

Breath test result data was recorded in Stats19 for 66% of LGV drivers and 67% of HGV drivers in frontal shunts. Analysis of these data are shown in Figure 3-24.

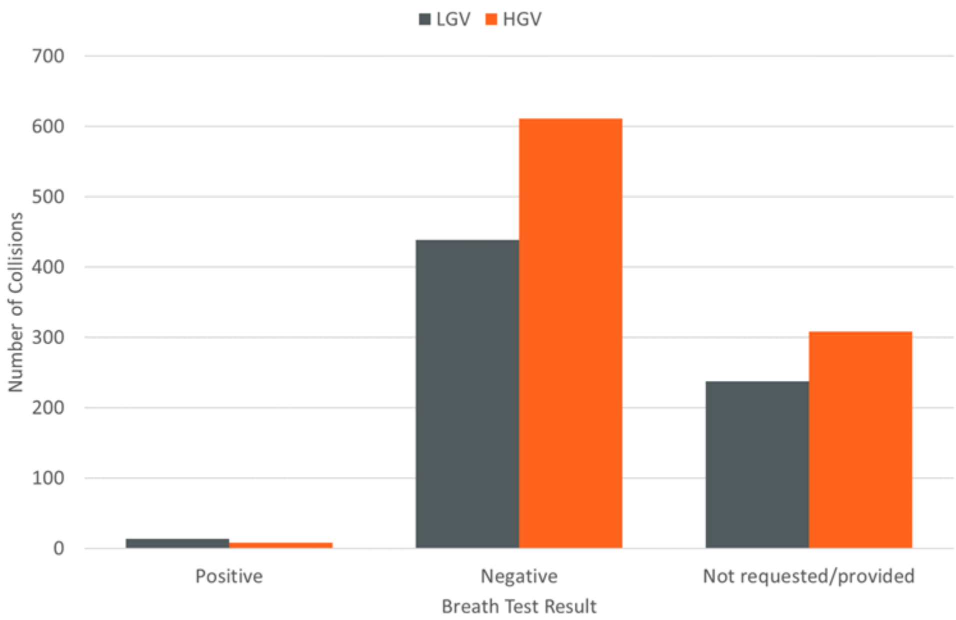


Figure 3-24: Number of two-vehicle LGV/HGV frontal shunt collisions by LGV/HGV driver breath test result, SRN 2016-2018

Only a very small percentage of drivers which had a breath test result recorded tested positive for alcohol. This was true for both LGV and HGV drivers although a slightly larger proportion of drivers in LGV shunt collisions tested positive than those in HGV collisions; 3% of LGV drivers (13 drivers) and 1% of HGV drivers (8 drivers) tested positive (out of those where a test result was recorded).

The final driver demographic variable analysed was Index of Multiple Deprivation (IMD) decile. Figure 3-25 shows the number of frontal shunt collisions by the IMD decile of the LGV or HGV driver.

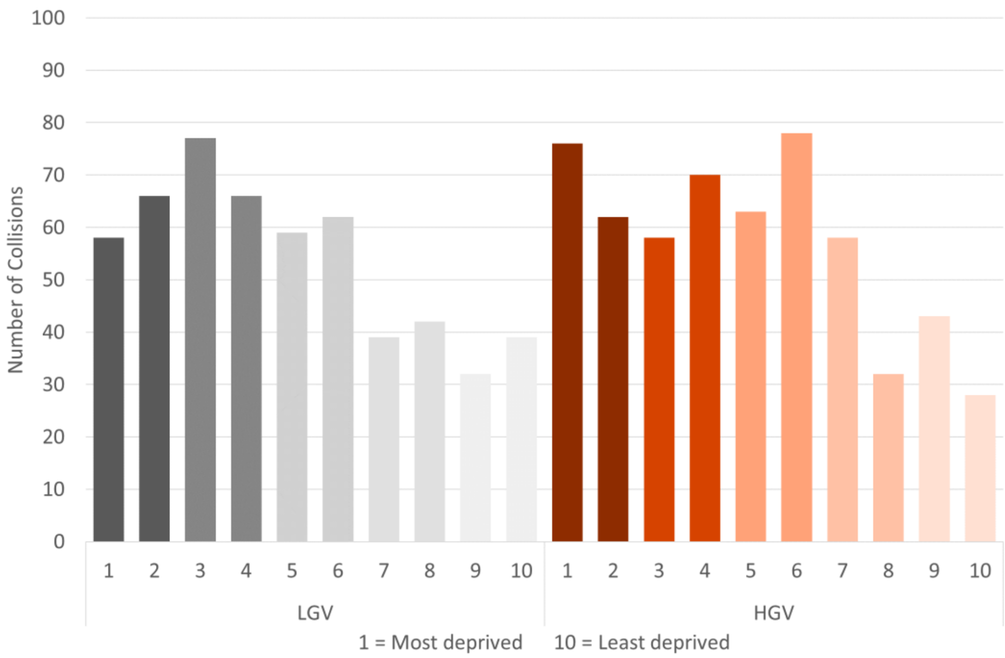


Figure 3-25: Number of two-vehicle LGV/HGV frontal shunt collisions by LGV/HGV driver Index of Multiple Deprivation (IMD), SRN 2016-2018

There are fewer LGV and HGV shunt collisions involving drivers from less deprived deciles. This may be because the LGV and HGV driver populations contain fewer drivers from these deciles but, without data about the IMD deciles of all HGV/LGV drivers, it is not possible to determine this for certain. The results shown in this chart do suggest that interventions should be targeted at those drivers in the lower (more deprived) deciles.

Key findings

- The vast majority of HGV and LGV drivers involved in shunt collisions are male.
- Shunt-involved LGV drivers are most likely to be between 25 and 40 years old.
- HGV drivers between the ages of 17 and 34 are over-represented in frontal shunt collisions and have the highest rate of collisions per driver.
- Higher numbers of HGV and LGV shunt-involved drivers were from more deprived IMD deciles than were from less deprived deciles.

3.5 Contributory factors

This section presents analysis of the contributory factor data recorded in Stats19. For each collision recorded in Stats19, up to six factors are recorded which the police believe contributed to the collision. It is important to note that, as contributory factors are recorded by the police after the collision, there is some subjectivity in the data.

Not all collisions are attended by the police and have contributory factors recorded. Therefore, only the subset of frontal shunt collisions where the police were in attendance and at least one contributory factor was recorded are analysed here. Again, the analysis in this section is limited to two-vehicle collisions and car-derived vans have been excluded.

Figure 3-26 shows the ten most common contributory factors recorded for LGVs and for HGVs in two-vehicle frontal shunts. The proportion presented for each factor is the proportion of frontal shunt collisions where the police attended and where at least one contributory factor was recorded for the goods vehicle. The proportions have been calculated separately for LGVs and HGVs.

For example, there were 500 LGV frontal shunt collisions where the police attended and where at least one contributory factor was recorded for the LGV. Of these 500 collisions, 48% had the factor 'Failed to judge other's path/speed' recorded.

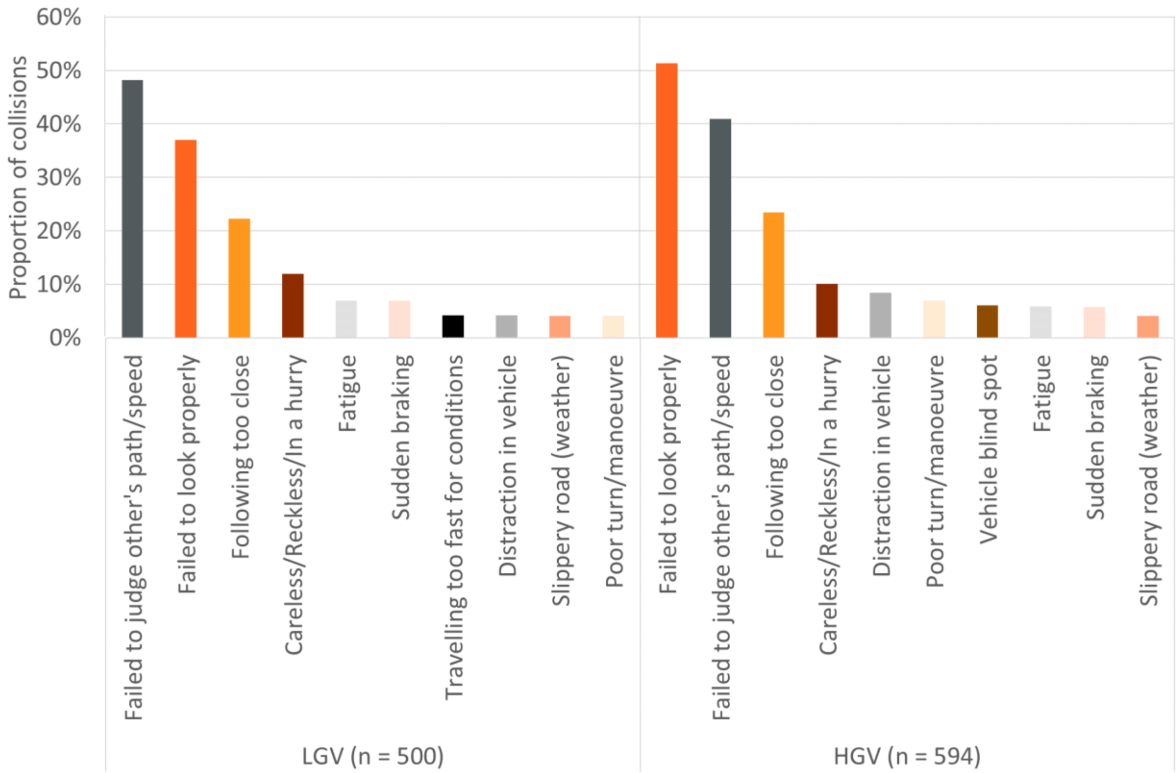


Figure 3-26: Top ten contributory factors recorded for LGVs and HGVs involved in two-vehicle frontal shunts (proportion of collisions with police attendance and at least one contributory factor recorded for the HGV/LGV presented), SRN 2016-2018

LGV frontal shunts and HGV frontal shunts both had the same four contributory factors as the most commonly-recorded: 'Failed to look properly', 'Failed to judge other's path/speed', 'Following too close' and 'Careless/reckless/in a hurry'. 'Failed to look properly' was the most recorded contributory factor in HGV frontal shunt collisions whereas 'Failed to judge other's path/speed' was recorded in the most LGV frontal shunts.

These two contributory factors are very commonly recorded in most types of collisions. Therefore, the other factors which were frequently recorded alongside these two in frontal shunt collisions have been explored and are shown in Figure 3-27. The chart shows the top five factors which are most commonly recorded for a goods vehicle alongside each of the main four common factors mentioned above (‘Failed to look properly’, ‘Failed to judge other’s path/speed’, ‘Following too close’ and ‘Careless/reckless/in a hurry’).

The proportions shown in Figure 3-27 have been calculated within each of the main four factors; for example, 40% of the 525 collisions where a goods vehicle had ‘Failed to look properly’ recorded also had ‘Failed to judge other’s path/speed’ recorded for the same vehicle.

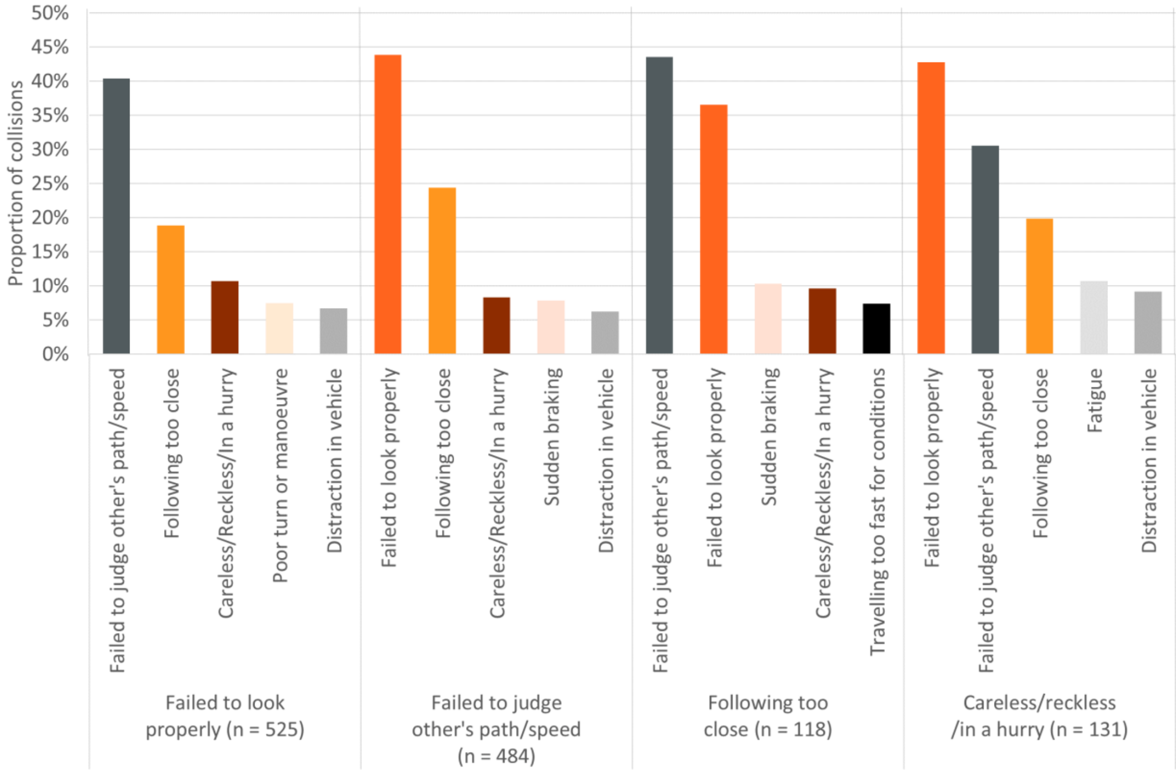


Figure 3-27: Top five factors recorded with each of ‘Failed to look properly’, ‘Failed to judge other’s path/speed’, ‘Following too close’ and ‘Careless/reckless/in a hurry’ for HGVs and LGVs in two-vehicle frontal shunt collisions (proportions presented within each of these four main factors), SRN 2016-2018[7]

Figure 3-27 shows that the four factors which were identified in Figure 3-26 as most common overall (‘Failed to look properly’, ‘Failed to judge other’s path/speed’, ‘Following too close’ and ‘Careless/reckless/in a hurry’) are very often recorded alongside each other. One of ‘Failed to look properly’ and ‘Failed to judge other’s path/speed’ is the most common factor recorded with each of the main four.

‘Sudden braking’ was recorded in 10% of collisions where ‘Following too close’ was recorded which is to be expected because if a goods vehicle was following the vehicle in front too closely and the vehicle in front braked, the goods vehicle would have to brake suddenly.

‘Distraction in vehicle’ is commonly recorded with ‘Failed to look properly’ and ‘Failed to judge other’s path/speed’. This suggests that drivers may be being distracted by something

[7] HGVs and LGVs are not considered separately in this chart.

in their vehicle, such as an entertainment or navigation system, and this is limiting their focus on the road and vehicles around them.

'Fatigue' was recorded in 10% of collisions where 'Careless/reckless/in a hurry was recorded' suggesting that goods vehicle drivers may be driving carelessly because they are fatigued.

Figure 3-28 shows the ten most commonly recorded contributory factors for vehicles impacted by LGVs/HGVs in two-vehicle frontal shunt collisions. The proportion presented for each factor is the proportion of frontal shunt collisions where the police attended and at least one contributory factor was recorded.

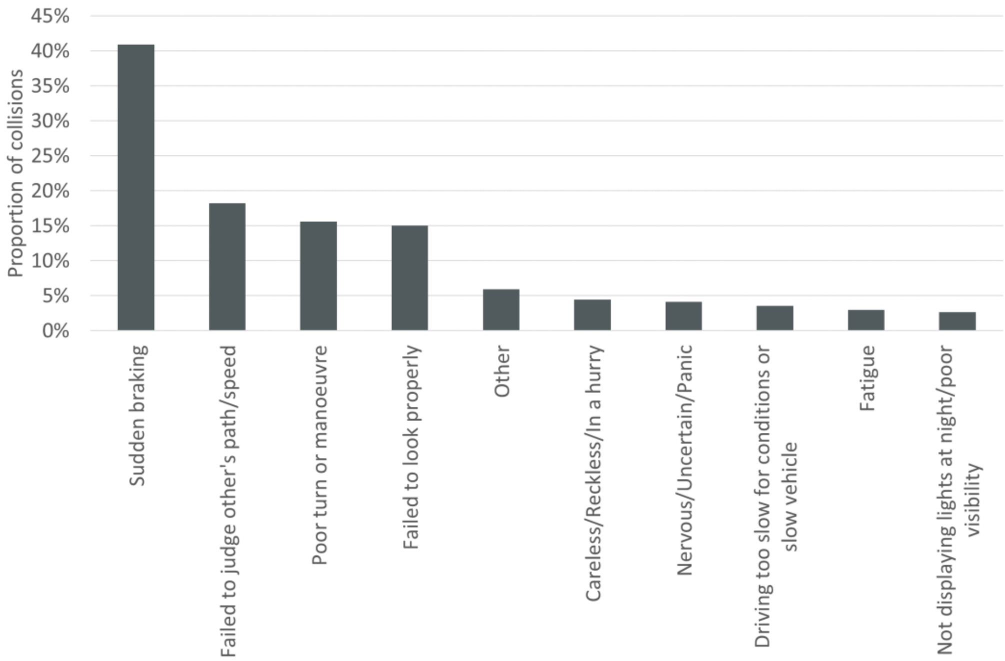


Figure 3-28: Top 10 contributory factors for shunted vehicles in two-vehicle LGV/HGV frontal shunts (proportion of collisions with police attendance and at least one contributory factor recorded for the shunted vehicle presented, n = 340), SRN 2016-2018

As is to be expected, 'Failed to judge other's path or speed' and 'Failed to look properly' were commonly recorded: for 18% and 15% of shunted vehicles respectively. However, the most commonly-recorded factor for shunted vehicles was 'Sudden braking' which was recorded in 41% of relevant collisions. 'Poor turn or manoeuvre' was also commonly recorded (16% of collisions). This suggests that LGV/HGV frontal shunt collisions are happening when a vehicle in front of an LGV/HGV brakes or slows suddenly (possibly in order to turn) and the LGV or HGV does not react accordingly.

Table 3.7 shows which factors LGV/HGV and other vehicle factors were commonly recorded together. The ten most recorded combinations are shown, together with the proportion of collisions where the combination in question was recorded.

Table 3.7: Top 10 HGV/LGV and other vehicle contributory factor pairs, SRN 2016-2018

HGV/LGV factor	Other vehicle factor	Proportion of collisions*
Following too close	Sudden braking	31%
Failed to judge other's path/speed	Sudden braking	23%
Failed to look properly	Sudden braking	18%
Failed to judge other's path/speed	Failed to judge other's path/speed	7%
Sudden braking	Sudden braking	5%
Failed to look properly	Failed to look properly	5%
Failed to judge other's path/speed	Poor turn or manoeuvre	5%
Failed to judge other's path/speed	Driving too slow for conditions or slow vehicle	3%
Slippery road (due to weather)	Sudden braking	3%
Failed to look properly	Poor turn or manoeuvre	3%

*Proportion of two-vehicle frontal shunt collisions with police attendance and where the HGV/LGV and shunted vehicle both had at least one contributory factor recorded.

The most common combination was ‘Following too close’ recorded by the goods vehicle and ‘Sudden braking’ recorded by the shunted vehicle. This supports the conclusions drawn from Figure 3-28 above that LGV/HGV frontal shunts are happening when vehicles slow suddenly. It also suggests that goods vehicles are following vehicles too closely and this would then mean they had less time to react when the vehicle in front brakes suddenly.

The analysis in this section so far has focused on the actions of the drivers involved in frontal shunt collisions. However, it is also important to consider external factors to fully understand the circumstances surrounding these collisions, even though these are less commonly recorded. Three contributory factor groups have been considered here as external factors: ‘road environment contributed’, ‘vision affected by’ and ‘vehicle defects’. The ten most commonly-recorded factors from these groups are shown in Figure 3-29. The proportions have been calculated using the total number of frontal shunt collisions with police attendance and at least one contributory factor recorded.

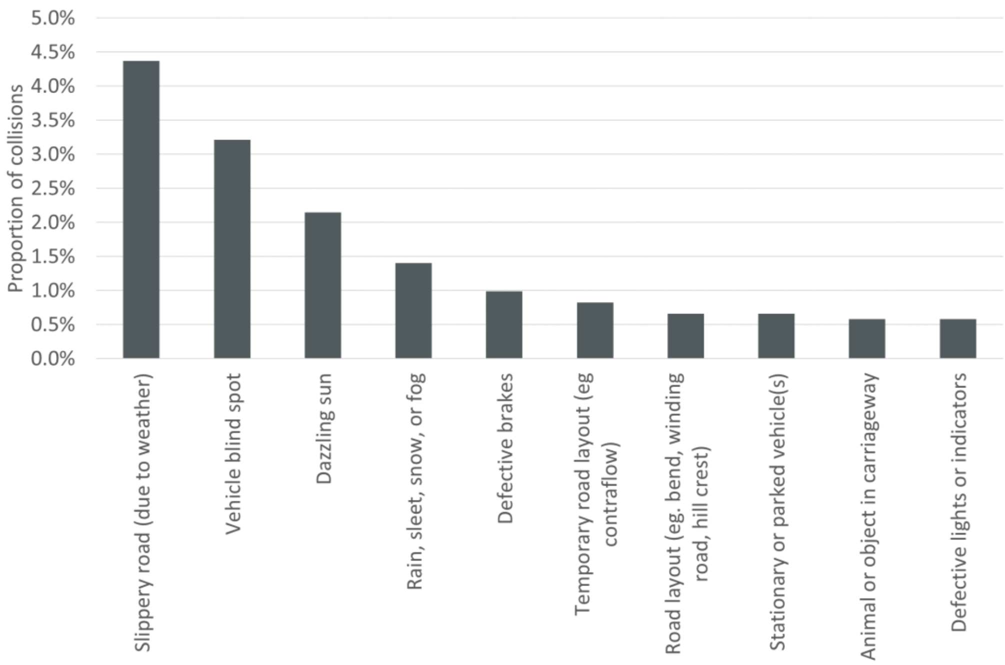


Figure 3-29: Top 10 contributory factors recorded in two-vehicle LGV/HGV frontal shunt collisions from the groups 'road environment contributed', 'vision affected by' and 'vehicle defects' (proportion of collisions with police attendance and at least one contributory factor recorded, n = 1,214), SRN 2016-2018

Figure 3-29 shows that factors from the three groups considered are not very commonly recorded; the most common factor 'Slippery road (due to weather)' was only recorded in just over 4% of collisions.

However, despite the small numbers, weather-related factors are recorded more commonly in HGV/LGV frontal shunts than road layout factors; both the road layout factors in the top ten were recorded in less than 1% of collisions. Figure 3-5 in Section 3.2 showed that the majority of frontal shunt collisions took place in dry weather but the data in Figure 3-29 above suggests that, when bad weather is present, it is a contributing factor to the collision. Additionally, 'Dazzling sun' was recorded for just over 2% of collisions which suggests that good weather can contribute to shunt collisions as well. These findings reflect those from the literature review (Section 2.2.1.3) that demonstrate that both good and poor weather can be contributing factors to these collisions.

Mechanical vehicle defects (defective brakes and defective lights or indicators) were relatively uncommon (less than 1% of collisions each). This suggests that Highways England does need to focus on safe vehicles as part of the wider safe system approach, but the issues which need resolving are wider than just 'fixing' the vehicle. The approach taken must consider all aspects, including the road user's behaviour which has been shown to be much more common within the contributory factors identified in this section.

To further understand any road element layouts which are contributing to frontal shunt collisions, cluster analysis was used to identify any 'hotspots' of collisions with factors from the 'road environment contributed' and 'vision affected by' groups. However, no clusters were found. This is likely to be because the number of collisions was too small.

Key findings

- 'Failed to look properly', 'Failed to judge other's path/speed' and 'Following too close' were the most commonly-recorded contributory factors for LGVs and HGVs in frontal shunt collisions.
- 'Sudden braking' was most the most common factor recorded for shunted vehicles.
- The most common pair of factors for the shunting and shunted vehicle was 'Following too close' recorded for the HGV or LGV and 'Sudden braking' for the shunted vehicle.
- Three of the top five non-driver contributory factors were related to the weather at the time of the collision.

3.6 Multi-vehicle frontal shunt collisions

This section explores the characteristics of HGV/LGV frontal shunt collisions involving three or more vehicles. As discussed previously, Stats19 does not record in which order vehicles hit each other in a collision and this limits the analysis that can be done. However, common characteristics of these collisions have been investigated and cluster analysis has been used to identify hotspots for these types of collisions on the SRN.

3.6.1 Collision characteristics

There were 1,291 HGV/LGV frontal shunt collisions involving three or more vehicles on the SRN between 2016 and 2018. Figure 3-30 shows how many collisions there were involving each number of vehicles.

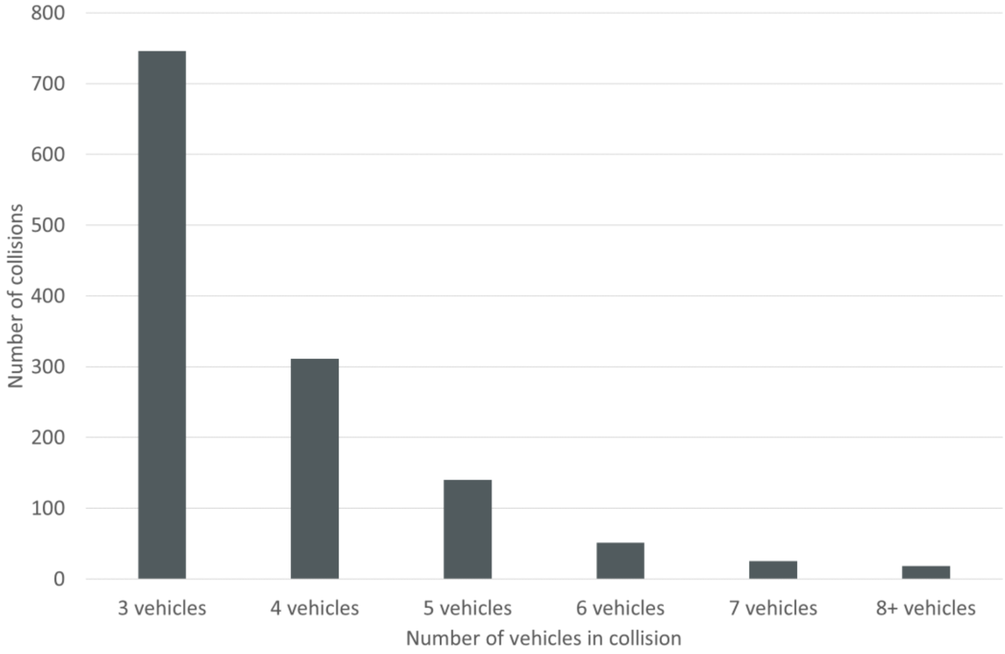


Figure 3-30: Number of multi-vehicle LGV/HGV frontal shunt collisions by number of vehicles involved, SRN 2016-2018[8]

The data presented in Figure 3-30 show that 58% of collisions with more than two vehicles involved three vehicles; 24% involved four vehicles. The largest number of vehicles involved in a single LGV/HGV frontal shunt collision was 16 but this was only the case for one collision.

Figure 3-31 shows the number of multi-vehicle frontal shunt collision on the different road types: motorway, dual carriageway A road, and single carriageway A road. The data in this chart are not split by whether the collision was an HGV shunt or an LGV shunt. This is because it is possible that multi-vehicle shunts may involve an HGV and an LGV, both with first point of impact recorded as front. However, analysis showed that this was the case for only 3% of multi-vehicle frontal shunts (33 collisions).

[8] Note that the data in this chart do not match those in Figure 3-1 in Section 3.1 because the definition of LGV does not include car-derived vans here.

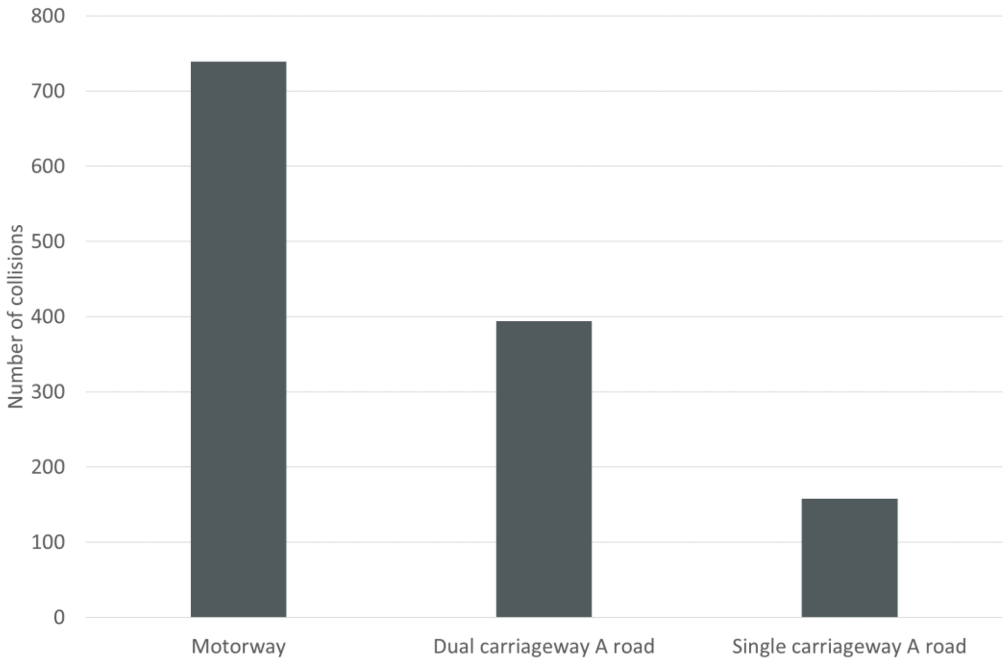


Figure 3-31: Number of multi-vehicle LGV/HGV frontal shunt collisions by road type, SRN 2016-2018

The results in Figure 3-31 are similar to those for two-vehicle frontal shunts shown in Figure 3-9. Most collisions happen on motorways (58%) and relatively few happen on single carriageway A roads.

To further understand what is happening in multi-vehicle frontal shunts, the vehicle direction fields in Stats19 were analysed. These fields provide information about the direction a vehicle is travelling from and to and this enables the direction of the vehicle to be calculated. For each road type, Figure 3-32 shows the proportion of collisions where all vehicles involved were travelling in the same direction.

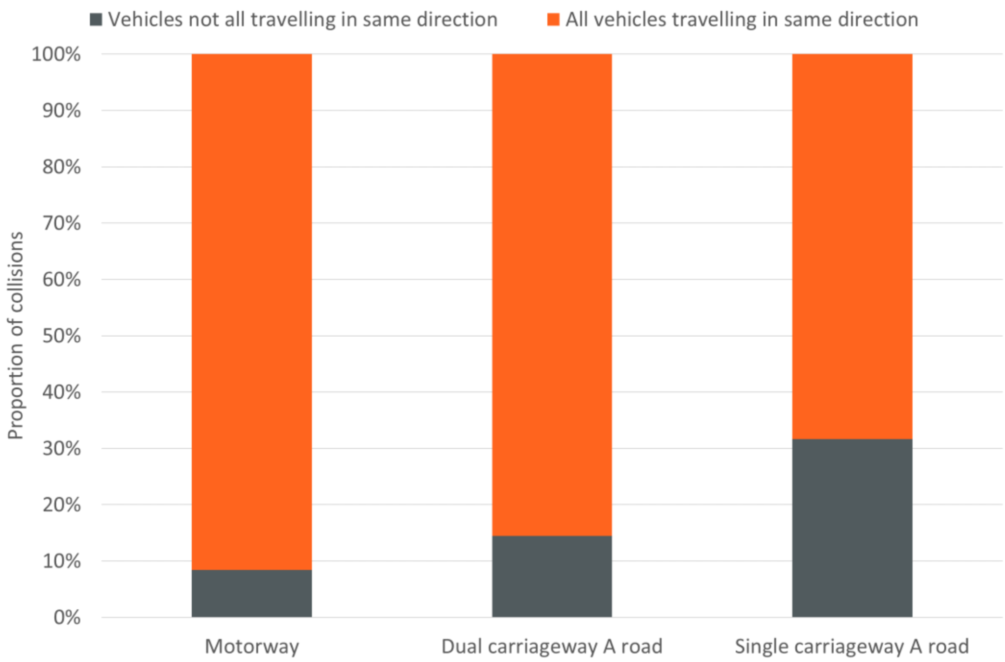


Figure 3-32: Proportion of multi-vehicle HGV/LGV frontal shunt collisions by road type and whether all vehicles involved in the collision had the same direction of travel recorded, SRN 2016-2018

Figure 3-32 shows that most multi-vehicle frontal shunt collisions involved vehicles which were all travelling in the same direction. This suggests that many multi-vehicle shunts could be queue-tail or in-queue collisions. Motorways and dual carriageway A roads have higher proportions of collisions with vehicles travelling in the same direction (92% and 86% respectively) than single carriageway A roads (68%) suggesting that, if these collisions are queueing collisions, they are more of a problem on motorways and dual carriageways.

Analysing the manoeuvres of the vehicles involved in multi-vehicle shunts gives further insight into whether these collisions are likely to be happening in queues. Figure 3-33 shows the manoeuvres of vehicles involved in multi-vehicle frontal shunts where all vehicles are travelling in the same direction. The vehicles have been split by vehicle type to allow information for shunting HGVs and LGVs and shunted vehicles to be seen separately.

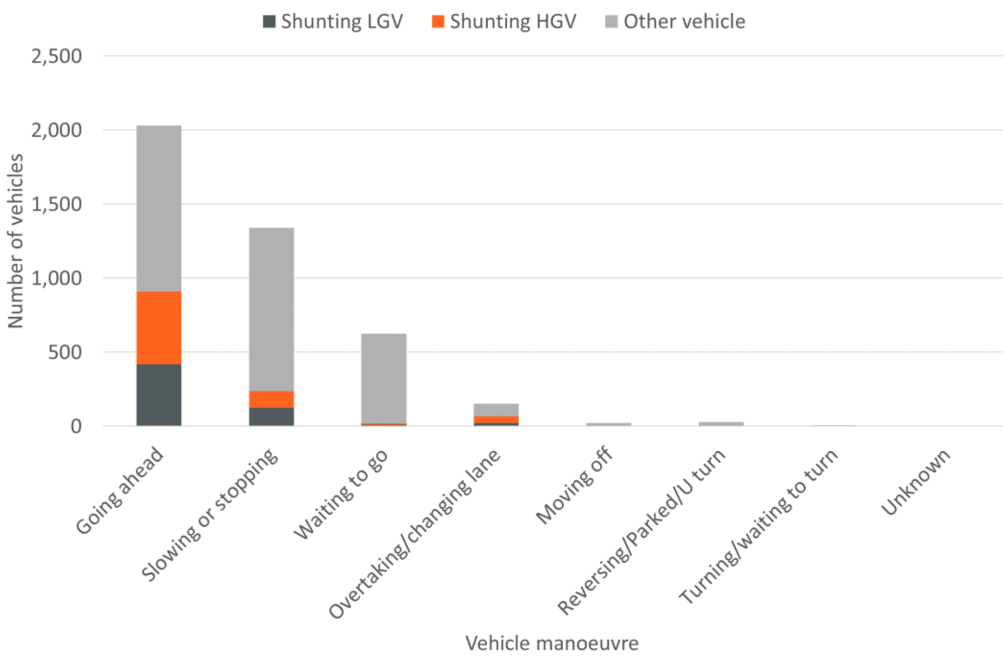


Figure 3-33: Number of vehicles in multi-vehicle LGV/HGV frontal shunts where all the vehicles were travelling in the same direction by vehicle manoeuvre, SRN 2016-2018

The data shown in Figure 3-33 support the conclusion that many multi-vehicle LGV/HGV frontal shunt collisions are queueing collisions. Forty-eight percent of vehicles involved in frontal shunts where all the vehicles were travelling in the same direction had vehicle manoeuvre recorded as 'going ahead', 32% were 'slowing or stopping' and 15% were 'waiting to go'. 'Slowing or stopping' and 'waiting to go' are manoeuvres frequently recorded for vehicles in queues and the high-proportion of vehicles 'going ahead' indicates that vehicles in these collisions were unlikely to be performing turns or lane-changing manoeuvres when the shunt happened.

Shunted vehicles account for a much larger proportion of 'slowing or stopping' and 'waiting to go' vehicles than shunting LGVs and HGVs. This suggests that multi-vehicle HGV/LGV frontal shunts often involve a vehicle which is slowing, stopping or stationary and an HGV/LGV which is going ahead and not slowing and therefore impacts the vehicle in front.

Key findings

- Most multi-vehicle shunts happen on motorways and in over 90% of these collisions all the vehicles involved are travelling in the same direction. This proportion is only 68% on single carriageways.
- In collisions where all vehicles are travelling in the same direction, the most common manoeuvres are 'Going ahead', 'Slowing or stopping' and 'Waiting to go', suggesting that these are queue-tail or in-queue collisions.

3.6.2 Cluster analysis

This section presents the results of cluster analysis of HGV/LGV frontal shunts collisions involving three or more vehicles. The method used was the same as described in Section 3.3.4 and the resulting clusters are shown in Figure 3-34.

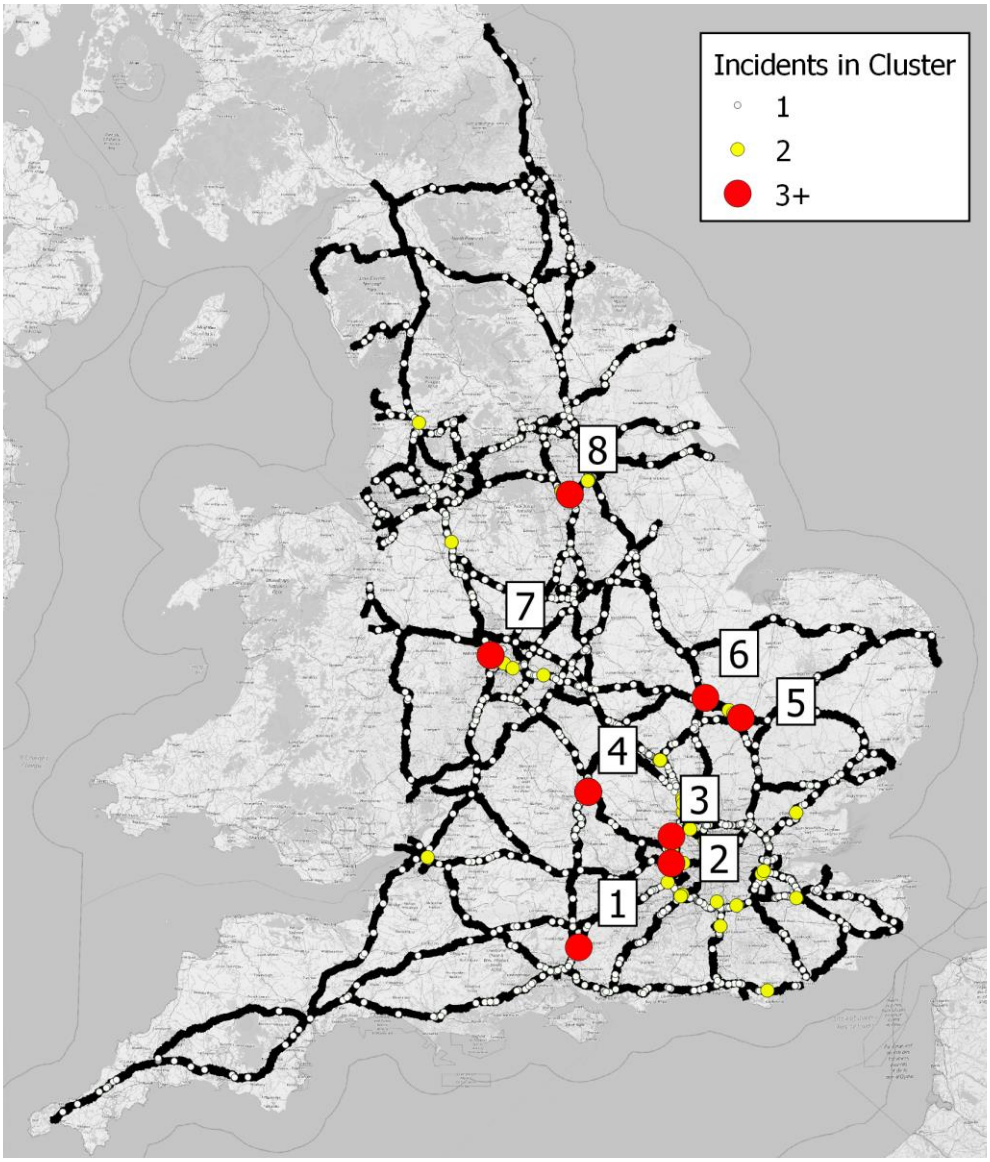


Figure 3-34: 50m clusters of multi-vehicle HGV/LGV frontal shunts, SRN 2016-2018

Figure 3-34 shows there were eight clusters containing three or more collisions. In a similar way to the two-vehicle shunt clusters in Section 3.3.4, the clusters were examined to exclude those where collisions within the cluster were on different carriageways. The remaining five clusters (Clusters 1, 2, 4, 5 and 8) are shown in Figure 3-35. Collisions are represented by red dots and the black lines indicate which roads are part of the SRN. For Cluster 2, the collisions in the cluster are shown by the red box.

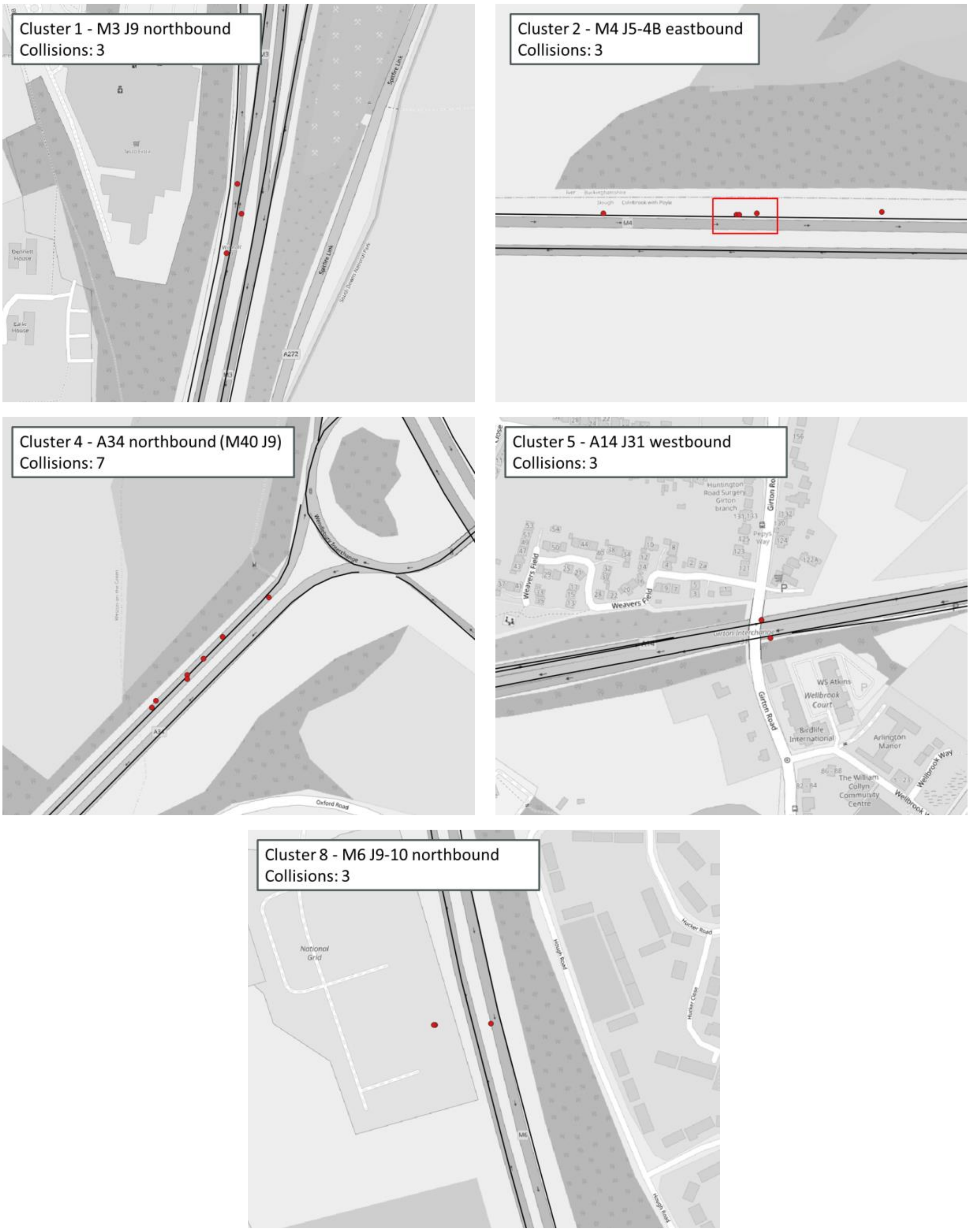


Figure 3-35: Clusters containing three of more multi-vehicle HGV/LGV frontal shunts, SRN 2016-18[9]

[9] Collision coordinates in Stats19 can be slightly inaccurate so collisions may not display exactly where they occurred.

Three of the clusters were on motorways and two were on dual carriageway A-roads. Unlike the two-vehicle shunt clusters, none of the multi-vehicle shunt clusters are on roundabouts, there are all on the main carriageway, although three of them are near junctions.

The cluster with the most collisions is Cluster 4, with seven collisions, which is located on the A34 as it approaches the junction with the M40. Clusters 1 and 5 are also near junctions; both are near diverges where slip roads leave the main carriageway. Junction approaches and diverges could be likely to have queuing traffic so clusters of multi-vehicle shunts at these locations support the findings in Section 3.6.1 that multi-vehicle HGV/LGV shunts are likely to be happening in queues.

4 HE Fatals analysis

The HE Fatals database captures in-depth collision data on the events of fatal collisions on the SRN from 2014 to 2020, including an in-depth assessment of the root cause and potential countermeasures for every collision. At the time of this analysis, the database covered collisions over the period from 2014-2018. Police forensic collision investigation reports are used as the source material for the independent safety-focused investigations that are coded into the database to form an analysable evidence source to inform Highways England's road safety policy. Some cases are supplemented by further information, such as witness statements, toxicology reports and tachograph analysis, which can aide in identifying the true nature of the collision's causation in much greater detail than other collision statistics (e.g. Stats19).

This section presents the results of detailed analysis of fatal collision data from 2014-2018 to understand the circumstances and causes of HGV/LGV frontal shunt collisions on the SRN. Within the HE Fatals data, collisions were initially identified as being relevant to this research in the following categories:

1. Rear end collisions
2. Collisions with an obstruction

HGV/LGV frontal shunts were then identified as collisions where the bullet vehicle[10] is classified as a Light or Heavy goods vehicle. In line with the approach taken for the Stats19 analysis (see Section 3.1), car-derived vans were also excluded from this analysis.

Section 4.1 presents the overall landscape of the shunt collisions from these data and the subsequent section focuses only on the collisions of interest involving HGVs/LGVs as the bullet vehicle (Section 4.2). The causes of HGV and LGV shunts are investigated in Section 4.3 and finally, the contributory factors were analysed (Section 4.4) and compared with the results from the Stats19 analysis (see earlier section 3.5).

4.1 Overall landscape of shunt collisions

At the time of this analysis, the HE Fatals database contained 550 cases[11], of which 143 were identified as rear end collisions or collisions with an obstruction (i.e. the shunt collisions). Within these cases, there were 376, directly involved[12] vehicles, and 470 recorded occupants[13] (including pedestrians and cyclists).

These collisions can be further broken down into collision type subcategories (Figure 4-1).

[10] In shunt collisions, there is the bullet vehicle which impacts the target vehicle during the initial impact.

[11] The HE Fatals database is a live database, therefore the number of collisions will increase over time. Numbers were correct at the time of data extraction in mid-August 2020.

[12] All vehicles in the HE Fatals database are directly involved in the collision, however in a small number of cases, some vehicles and occupants which have minimal interaction in the collision are not captured, therefore these numbers are a minimum.

[13] Within the HE Fatals database, in most cases, all occupants are captured regardless of injury severity. They are not referred to as casualties as some occupants are uninjured.

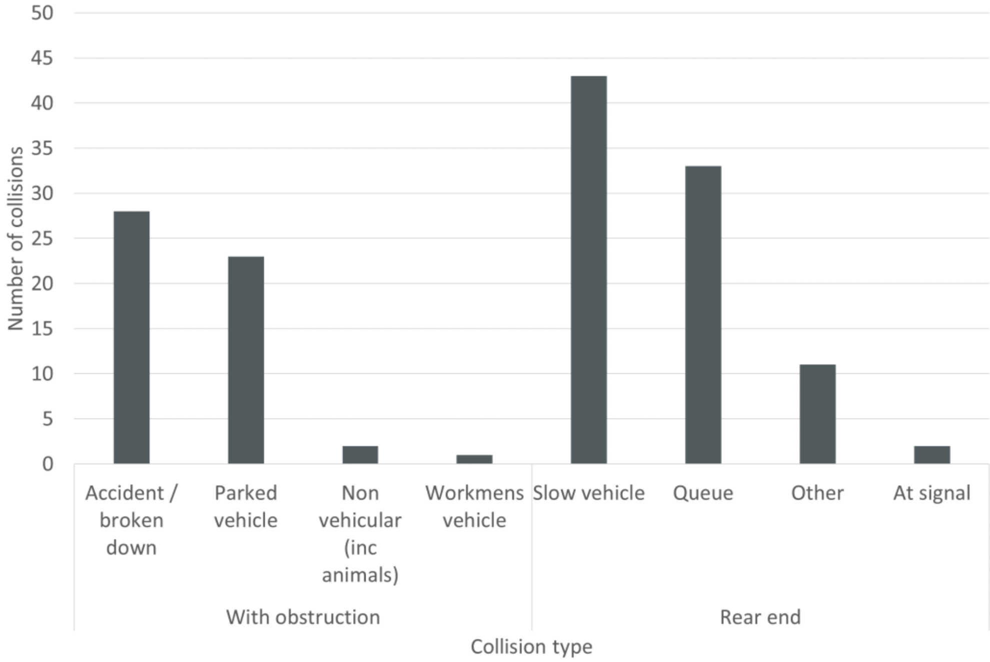


Figure 4-1: Distribution of shunt collisions between collision types and their associated subcategories

Collisions with slow moving vehicles were the most common collision type, followed by queuing traffic, prior accident/broken down vehicles and parked vehicles.

The type of vehicles involved in these collisions is shown in Figure 4-2.

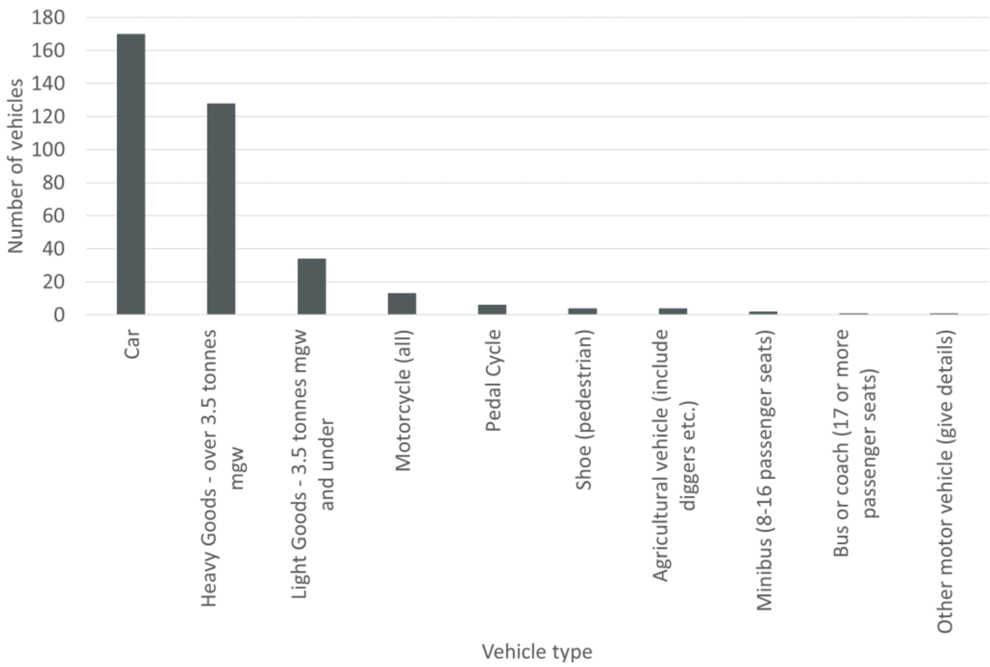


Figure 4-2: Vehicles involved in shunt collisions within the HE Fatals Database

The distribution of vehicles in these collisions reflects the distribution of traffic on the SRN, with the majority of these vehicles being cars followed by HGVs and LGVs. There were relatively few vulnerable road users (e.g. motorcycles and pedal cycles) and other vehicle types (e.g. agricultural vehicles).

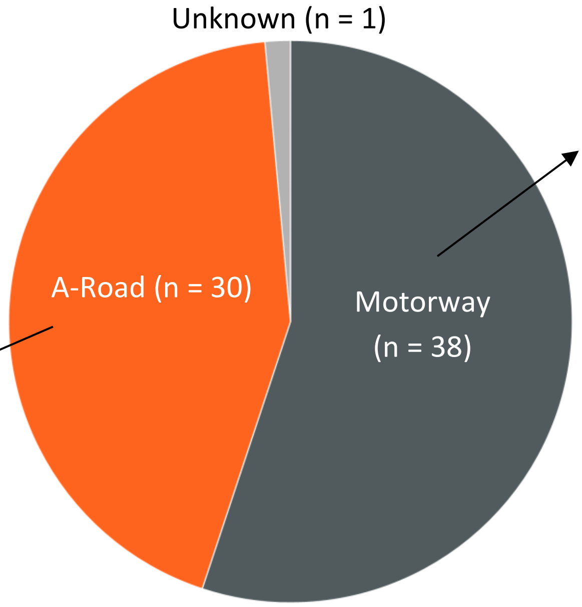
Of the 143 cases registered as rear end collisions or collisions with an obstruction, 69 involved an HGV or LGV (excluding car-derived vans) as the initial bullet vehicle. These were defined as the 'collisions of interest' for the purposes of this study and the analysis in the subsequent sections summarises the circumstances and causes of these collisions. Within these cases, there were 200 directly involved vehicles and 246 recorded occupants (including pedestrians and cyclists).

Key findings

- There are 69 'collisions of interest' which involved an HGV or LGV (excluding car-derived vans) as the initial bullet vehicle.

4.2 Collisions where HGV/LGV was the bullet vehicle

All collisions within the HE Fatals Database took place on the SRN. The location by road type and carriageways class of these collisions is shown in Figure 4-3.



Motorway	Total
Dual carriageway	36
Roundabout	1
Unknown	1

A-Road	Total
Dual carriageway	26
Single carriageway	4

Figure 4-3: Location of HGV/LGV shunt collisions by road type and carriageway class

Most of the collisions occurred on motorways, and they were more common on dual carriageways than single carriageways, reflecting the distribution of road types on the SRN network.

The distribution of HGV/LGV shunts between the collision types and associated subcategories is shown in Figure 4-4. Comparison of this figure with Figure 4-1 shows how shunt collisions involving these large vehicles differ from all shunt collisions.

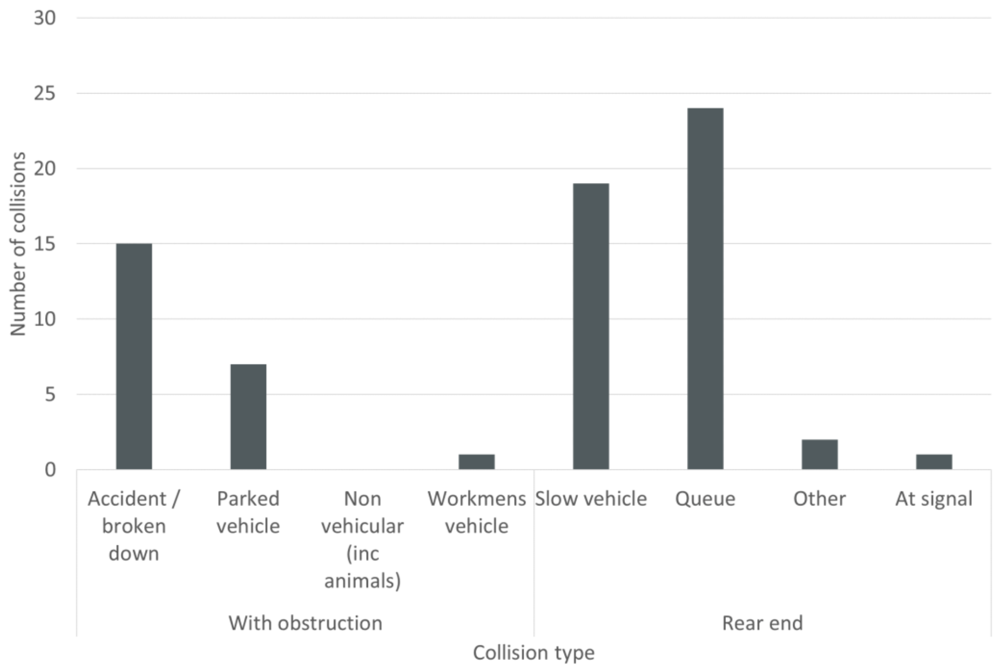


Figure 4-4: Distribution of HGV/LGV shunt collisions between collision types and associated subcategories

In comparison with all rear end collisions (Figure 4-1), there were proportionately fewer HGVs and LGVs impacting slow moving vehicles (41% compared with 48%), probably as the HGVs/LGVs often travel more slowly than other vehicles on the road. Collisions with obstructions are similarly distributed across the two samples.

When comparing HGVs with LGVs, a greater proportion of LGV collisions (57%) were 'Rear end – Slow vehicle' collisions than was the case for HGVs (20%). This disparity may be due to the fact that LGVs typically travel faster than HGVs and therefore are more likely to encounter a vehicle moving slowly relative to their speed. This also demonstrates that LGVs have a far lower percentage of fatal collisions with queues and obstructions. It is unclear if this is because fewer collisions of this type occur, or because LGVs are significantly lighter than HGVs and when collisions occur, the impact is less likely to cause fatal injuries.

4.2.1 Vehicles involved

Shunt collisions typically involve two vehicles; however, they can include many more than this, especially when a queue of traffic is involved (e.g. large vehicles colliding with the rear of a queue can cause a shockwave down the queue and many subsequent impacts). Table 4.1 shows the number of vehicles and occupants recorded within the investigated HGV/LGV shunt collisions.

Table 4.1: Number of vehicles and associated occupants

Number of vehicles involved	Number of collisions	Number of Occupants
2	44	104*
3	8	39
4	9	45
5	4	31
6	1	6
7	2	14
8	0	0
9	1	7
Total	**69**	**246**

**Three involved a pedestrian that alighted from their vehicle prior to impact.*

Just under two thirds (63%) of these collisions involved just two vehicles. The highest number of vehicles in a single collision was nine.

Within the collisions of interest, the bullet vehicle will always be an HGV or LGV; however, the target vehicle varies. Table 4.2 shows the frequency of different collision combinations, and the location of the fatalities within these collisions.

Table 4.2: Frequency of HGV/LGV shunt collisions by vehicle combination

Bullet vehicle	Target (first vehicle impacted by bullet) vehicle	Number of fatal collisions investigated	Fatality by vehicle orientation (V1 bullet, V2 target (first impacted), V3 second impacted…)
LGV	Pedal cycle	1	V2 (1)
	Car	5	V1 (1), V2 (4)
	HGV	8	V1 (8)
HGV	Motorcycle	1	V2 (1)
	Pedal cycle	3	V2 (3)
	Agricultural	1	V1 (1)
	Car*	28	V1 (1), V2 (24), V3 (2), V4 (2)
	LGV*	7	V1 (1), V2 (3), V3 (1), V4 (2)
	HGV*	15	V1 (14), V3 (1)
Total		**69**	

** In one case for each category, the driver had alighted their vehicle.*

The majority of these collisions involved an HGV as the impacting vehicle (80%). The largest number of collisions were HGVs impacting cars, followed by HGVs impacting HGVs and LGVs impacting HGVs. There were relatively few collisions with motorcycles, pedal cycles, agricultural vehicles and pedestrians, mostly likely due to the comparatively low number of these vehicles using the SRN.

In most cases, the fatality occurred in the smaller of the two initial impacting vehicles, regardless of if they were the bullet or the target vehicle. However, there were three exceptions to this:

- In two collisions, the initial impact was with a smaller vehicle, yet the bullet vehicle continued moving and had a secondary impact with a larger vehicle, resulting in fatalities in the bullet vehicle.
- In one collision, the target vehicle was a large heavy car which caused a fatality in the bullet LGV.

4.2.2 Occupant severity

In most cases, the HE Fatals database records all occupants involved in the collision, and their injury severity, so this can be investigated in relation to the vehicle type (Figure 4-5).

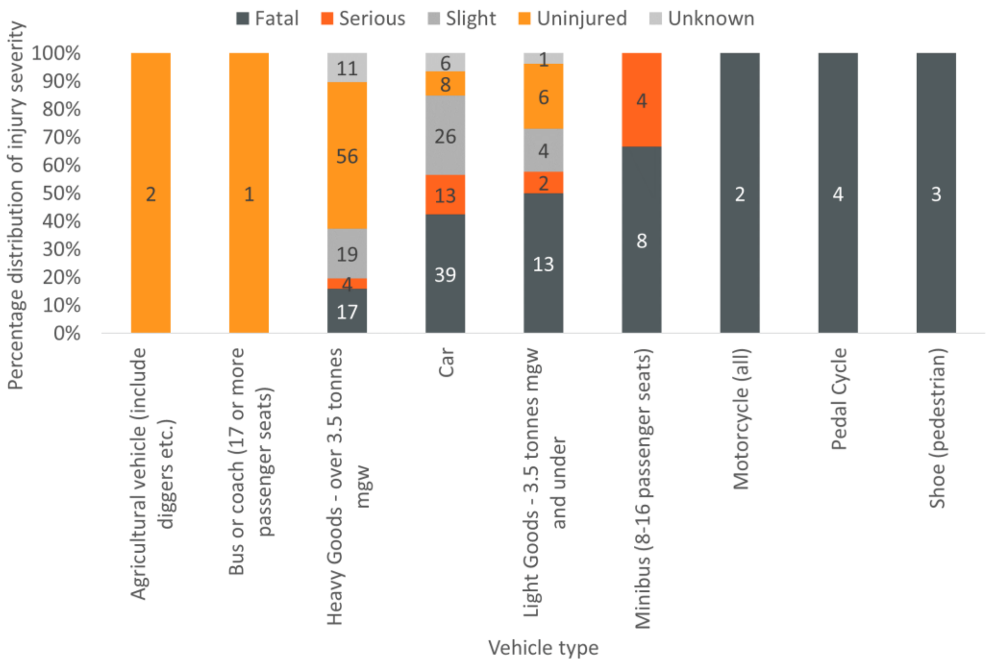


Figure 4-5: Occupant severity in relation to vehicle type within HGV/LGV shunt collisions

Within the collisions of interest, occupants of larger vehicles were less likely to have serious or fatal injuries compared with occupants of smaller vehicles. However, cars had a slightly reduced likelihood of fatal/serious injury when compared with LGVs and a minibus (which is unexpected when considering that LGVs and minibuses are bigger); however, this is likely due to a high percentage of cars being involved in second and third impacts in the queue of traffic. Energy is dissipated with each collision, reducing the risk of injury for each subsequent collision. It should also be noted there is only a small sample of cases within some vehicle groups, and therefore some caution should be taken when interpreting these trends.

Key findings

- When comparing HGVs with LGVs, a greater proportion of LGV collisions were ‘slow vehicle’ collisions. LGVs are typically travelling faster than HGVs and therefore more likely to encounter a vehicle moving slowly relative to them.
- Just under two thirds (63%) of these collisions involved just two vehicles. Collisions in queues typically involved more vehicles.
- In 80% of these collisions an HGV was the impacting vehicle.
- The largest number of collisions were HGVs impacting cars, followed by HGVs impacting HGVs and LGVs impacting HGVs.
- Occupants of larger vehicles were less likely to have serious or fatal injuries compared with occupants of smaller vehicles.

4.3 Identifying the causation factors

Several approaches have been used to examine the causation factors in these collisions:

1. Within the HE Fatals database, each collision contains a brief summary of events surrounding the case. A qualitative analysis of these summaries was carried out to identify key factors.
2. The recorded circumstances of the collisions (e.g. weather, lighting, the target vehicle position and the traffic conditions) were noted.
3. The frequencies of several causation variables recorded in the data were summarised. The most common groups of causes were then investigated in more detail to identify, for example, the collision type and whether there were differences between LGVs and HGVs.

Causation factors have been identified as associated with the environment, vehicles or behaviour (people). The Venn diagram in Figure 4-6 shows the distribution of fatal HGV/LGV shunt collisions by the presence and combination of causation factors identified.

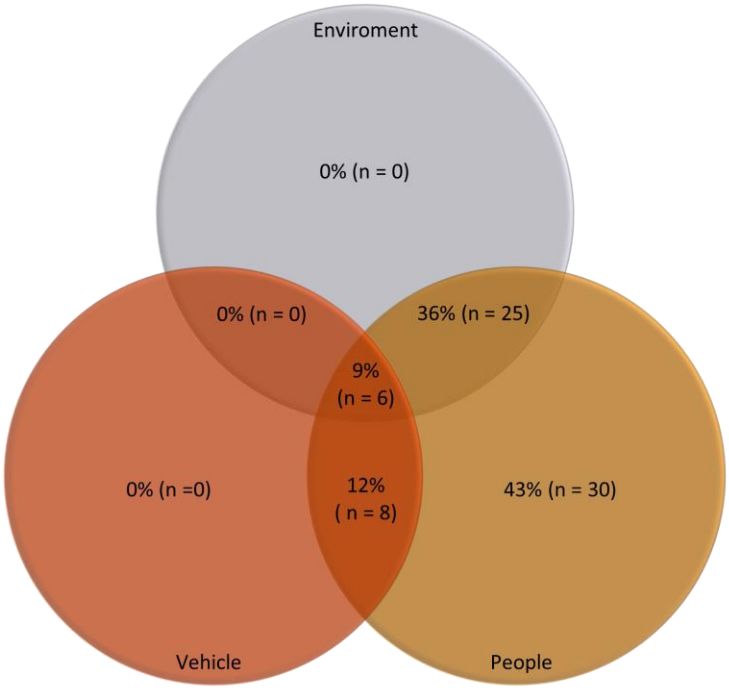


Figure 4-6 Venn diagram of causation factors for each of the 69 investigated collisions

All 69 collisions have a people associated causation factor, whereas 31 had an environmental factor and 14 had a vehicle factor with 6 of these collisions having all three.

The results from the causation factor analysis using the three methods are summarised in the following sections.

4.3.1 Environment

An overview of the recorded weather (Table 4.3) and lighting conditions (Table 4.4) are presented here.

Table 4.3: Weather conditions at the time of the collision

Weather	Number of collisions
Fine without high winds	56
Fog or mist – if hazard	1
Raining with high winds	1
Raining without high winds	7
Snowing without high winds	1
Unknown	3
Total	**69**

Table 4.4: Lighting conditions at the time of the collision

Lighting	Number of collisions
Darkness - no streetlighting	23
Darkness - streetlighting	8
Daylight	38
Total	**69**

The majority of collisions occurred when the weather was 'fine without high winds'. However, in nine of these cases other environmental factors were also noted during the qualitative review of the incident summary: two involving glare from the sun, two with steep hills, two with animals on the road and three with poor sightlines (two due to sharp bends and one due to fences or vegetation), demonstrating the importance of looking beyond just the immediate weather conditions at the time of the collision.

Ten collisions had adverse weather conditions recorded:

- Eight in the rain (one with high winds)
  - On two occasions rain possibly obscured the view of a cyclist and on one of these occasions high winds were claimed to have caused the LGV to impact a cyclist while overtaking.
  - Rain may have also obscured the view of a layby to the nearside in one instance, suggesting that peripheral vision may be more likely to be adversely impacted by rain.
  - In the five other collisions involving rain, the weather or road conditions were not noted to have any effect on the collision likelihood or severity.
- One in the snow which caused the surface to become slippery which lead to the target vehicle losing control before being impacted.
- One with fog where visibility was noted to be poor during the foggy conditions.

In the latter two instances the driver not driving to the conditions (target vehicle in the snow, bullet vehicle in the fog) was likely to have contributed to the collision occurrence.

Just under half (45%) of the collisions occurred in darkness, and one third (33%) in darkness with no streetlighting present. As there is typically considerably less traffic during the night, this may suggest that darkness has a negative effect on the occurrence of fatal collisions which is further exacerbated by the absence of streetlighting.

2016 work by TRL for Highways England considering night-time KSIs on the SRN (Lloyd et al., 2016) suggested that darkness collisions with no road lighting are higher severity than those with road lighting. However, when flow is considered and the collision rate is calculated, this is highest on roads with road lighting and lowest on those without. This is probably because those links which have high darkness flow or high darkness collision rate having been selected for road lighting installation (this finding was also highlighted in the literature review – see section 2.2.1.2). Hence, without knowing the HGV/LGV night-time traffic flows on roads with street lighting and without, it is not possible to confirm whether the presence or absence of streetlighting is influencing the number of frontal shunt collisions involving these vehicles. That said, of the 23 which occurred during darkness with no streetlights, the collision investigator noted that the absence of lighting would have had a substantial impact on the collision in seven cases:

- Three where a prior collision had occurred and hazard warning lights were not illuminated (one had forgotten, the two others were unable to turn them on due to damage).
- There were also three cyclists and one motorcycle with low conspicuity who were either travelling slowly or stationary at the time of the collisions.

Figure 4-7 summarises the frequency of each of the environmental causation factors coded in the dataset. Note that each collision can have multiple causation factors associated with it and so the figures in this chart cannot be summed.

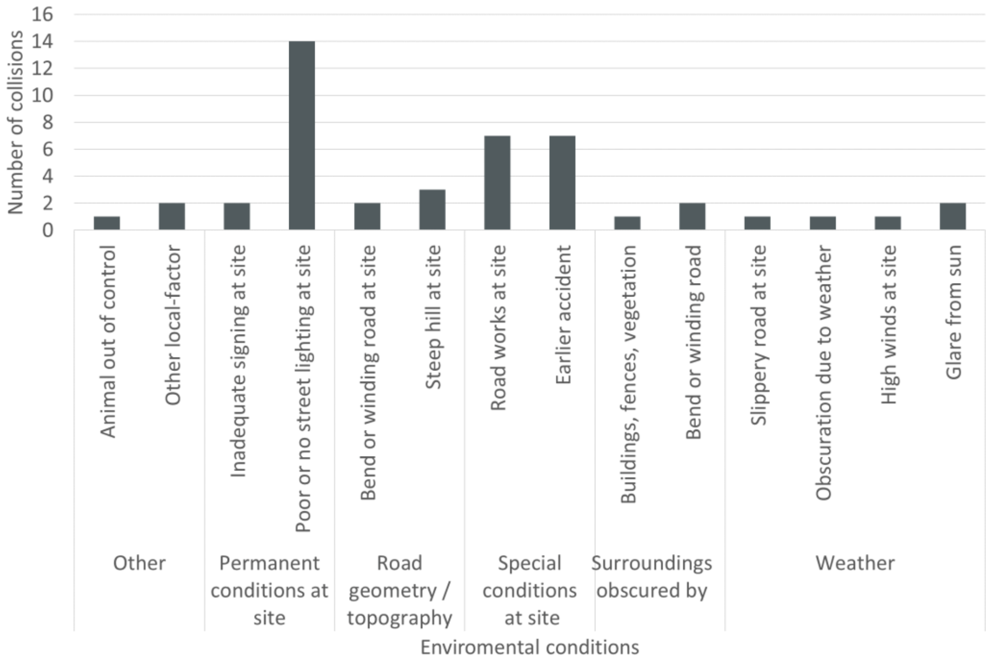


Figure 4-7 The number of collisions where environmental causation factors were present

The two most common groups of causation factors were special conditions at site and permeant conditions at site. Special conditions were noted in 13 of the investigated collisions and permeant conditions at 16; there were five collisions where both a special condition and a permanent condition at the site were considered to be causation factors.

The 24 collisions from these two categorises were investigated in more detail:

- As outlined in section 4.2.1, 80% of the collisions of interest had an HGV as the impacting vehicle compared with just 20% for LGVs. Within this subcategory of 24 collisions, the impacting vehicle was an HGV in 20 (83%) cases, suggesting that the conditions at the site are not affecting either HGVs or LGVs disproportionally.

- In the full sample of 69 collisions, ‘obstruction’ collisions accounted for around a third of cases. This proportion was slightly higher in the 24 collisions detailed here; half of these were ‘obstruction’ type collisions (nine where the obstruction was an accident or broken-down vehicle, two where the obstruction was a parked vehicle, and one where the obstruction was a works vehicle); this finding reflects the prevalence of the ‘earlier accident’ causation factor as this is a type of obstruction.
- All the 24 collisions had at least one behavioural causation factor associated suggesting that environmental factors were not the sole cause of the collision.

4.3.2 Vehicle

Both the bullet and target vehicles can have mechanical defects recorded which are either contributory or non-contributory to the collision. All known vehicle defects within the 69 investigated collisions are displayed in Figure 4-8.

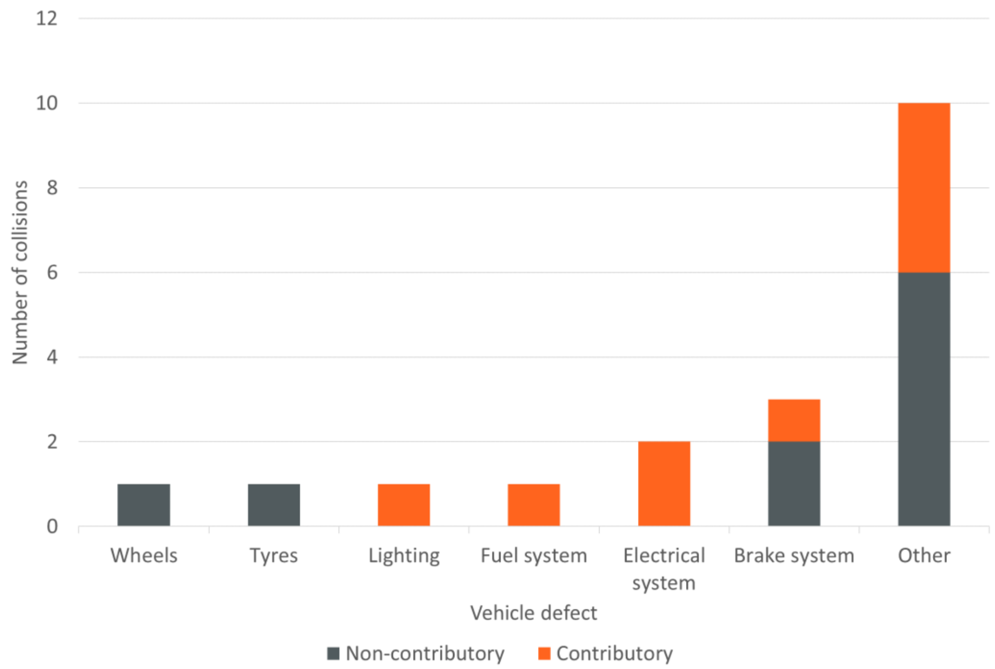


Figure 4-8 Number of collisions with mechanical defects and whether they were contributory or non-contributory to the collision

Of the 69 collisions 14 had a least one mechanical defect within the vehicles involved. The most common was ‘other’ defects which included:

- HGV was overloaded, had a brake efficiency less than minimum requirements and the ABS warning light was on
- Front of the bonnet became detached, flipping up blocking the drivers view

- Broken timing belt
- Lack of engine coolant
- Punctured radiator hose
- After market air horn fitted effecting brakes efficiency and reliability
- Three had mechanical engine failure – not further specified

Of these 14 vehicles with mechanical defects, eight of these defects were thought to contribute to the collision:

- On seven occasions the defect caused the target vehicle to slow or stop in a live lane, and in two of these instances, without the option of displaying any lights.
- On one occasion an HGV's defective brakes contributed to the secondary impacts (did not contribute to the primary impacts and did not brake until after this point).

All collisions with a vehicle defect had at least one behavioural causation factor associated with the collision, most commonly this was a 'driver error' factor.

4.3.2.1 Bullet vehicle factors

In addition to the review of the vehicle defect causation factors, the qualitative review of the case summaries identified several instances where specific safety features within the bullet vehicle did not work as intended or had other undesired consequences.

For example, in one collision it was noted that the bullet HGV was fitted with Automatic Emergency Braking (AEB) but that the circumstances of the collision mean that it was outside its operational ability. Post collision investigation of the case noted the following: under normal operation in daylight, the RADAR works in conjunction with a video camera to automatically brake if a slower moving or stationary vehicle is detected in its path. However, at night or in low light conditions the RADAR works as normal, but the camera is less effective. In this collision it was night-time and only partially lit, as well as snowing, placing the AEB system at the extremity of its operational capabilities. It was concluded that as a result, the emergency braking feature was unlikely to function.

In another case, two of the bullet vehicles were known to be actively using cruise control at the time of the collision. When using cruise control less input is required from the driver, which means they may be more likely to become distracted or fatigued and not notice the target vehicle ahead in time to avoid the collision. Both drivers were known to have 'lack of attention' and 'failed to judge other persons path or speed', with one of the drivers also known to be on their phone.

4.3.2.2 Target vehicle factors

The target vehicle circumstances may also contribute to these collisions. As part of the initial qualitative review of case summaries, information about the target vehicle's position or movement was noted (Table 4.5).

Table 4.5: Factors as to why the target vehicle was causing an obstruction

Circumstance	Number of collisions	Notes
Queuing traffic	30	6 prior collision/breakdown 4 roadworks 1 pedestrian in carriageway 19 congestion/high traffic volume
Broken down	15	3 on hard shoulder 12 not on a hard shoulder 9 of which had no hard shoulder (2 due to roadworks and 2 due to the hard shoulder being used as a live lane. 5 were on roads not designed with hard shoulders) 3 occurred in live lanes
Slow vehicle	12	4 Pedal cycle 2 agricultural 2 HGV up hill 1 HGV out of layby 1 traffic management vehicle 1 HGV 1 lost car
Prior collision	7	Cause of prior collision was: 4 due to loss of control (1 slow vehicle, 1 snow, 1 fatigue, 1 unknown), 2 due to animals 1 unknown with someone stopped to help
Unknown stop/slow	4	1 driving erratically with alcohol recorded 3 unknowns
In lay-by	1	1 parked in lay-by
Total	**69**	

Queuing traffic was the most common reason identified for the target vehicle to be causing an obstruction, most commonly due to a prior breakdown or collision.

Fifteen vehicles were broken down, three of which were on the hard shoulder when impacted by the HGV/LGV. In these cases, the bullet vehicle had drifted into the hard shoulder for unknown reasons.

Out of the 15 vehicles that had broken down, eight had recorded causes of the breakdown:

- Three had run out of fuel
- Three were due to faulty maintenance
- Two were due to neglect

On three occasions it was noted that vehicles were stationary in a live lane for a prolonged period with other traffic safely navigating the scene before they were impacted. Durations for the stationary vehicles before the impact were reported as 60, 20 and 12 minutes:

- The vehicle stationary for 60 minutes had run out of fuel and there was no hard shoulder for refuge, conditions were daylight, fine and dry on a 70mph A-road.
- The vehicle stationary for 20 minutes had also broken down with no hard shoulder on an A-road just before dawn.
- The vehicle stationary for 12 minutes was on an unlit motorway at night. The driver was drunk and stopped in lane 1, despite a hard shoulder been present.

In three cases, it was noted that vehicles that should have had lights or hazards on, which were mechanically able to do so, did not have them illuminated. However, in other cases, the qualitative analysis highlighted that there were issues with their illumination. For example, during one collision, a car initially broke down with hazards on. The car was then impacted by an HGV in the first collision which caused the lights on the car to fail. A second HGV then impacted the car, two minutes after the initial collision, due to the lack of lighting.

Since the HE Fatals data does not routinely record if any of the collisions had external warning mechanises present or working (e.g. VMS signs notifying approach driver of vehicles in the lanes ahead or queueing traffic), where possible for each of the cases, we sought to obtain traffic and signal data to understand the circumstances immediately preceding the collision. For example, this analysis enables confirmation of whether the shunt was a result of prior congestion in the area. It also enables an understanding of the impact of the collision on the surrounding area for a period following the collision; for example, to see if the shunt itself caused subsequent queues or carriageway closures.

This analysis relies on accurate collision location information being available and is restricted to collisions on motorways (where the MIDAS detectors which measure the traffic speeds are located) in the last three years (this is the timeframe for which the database covers). Of the 69 collisions of interest, 38 were on motorways (Figure 4-3) and only seven of these had data available for this analysis. The full analysis and associated Motorway Traffic Viewer (MTV) plots are in Appendix B, but a summary of the conclusions for each case are presented here:

- Case 48: The HE Fatals data recorded the collision as happening at 01:55; however, based on the analysis of the traffic data, it is most likely that the collision occurred at 09:55.
- Case 59: The traffic was starting to queue in lane 1 for the slip road for junction 9 (J9) about 10 minutes before the collision. Post-collision, traffic continued slowly passed the scene for a few minutes until most was diverted off at J10. Queues reached back to J13.
- Case 61: No sign of queueing before the collision. Post-collision the carriageway was closed for about 4.5 hours, open for half an hour then close again for another 3.5 hours.
- Case 63: Queue protection algorithms set a 40mph speed limit around the time of the collision and a lane closure was set soon after. The carriageway was closed for approximately 10 hours post-collision.
- Case 64: Collision not quite visible on the plot, although no sign of queue before the collision. Traffic was reduced for approximately 9.5 hours post-collision.

- Case 65: The dynamic hard shoulder was open at the time of incident and the carriageway was busy in all lanes with traffic was travelling around the 60mph speed limit. Post-collision lanes 1,2 and 3 were closed and traffic continued slowly in lane 4.
- Case 69: From a few minutes before the incident, traffic in lane 1 is queuing for the diverge. There was a large speed differential between the lanes with averages of 14mph, 57mph and 68mph recorded in lanes 1,2 and 3. Post-collision the whole carriageway was closed for approximately 5.5 hours.

4.3.3 Behaviour

In addition to the environmental and vehicle causation factors, the behaviour of any person involved in the collisions is investigated and, if causative to the collision, recorded. In all 69 cases the driver of the bullet vehicle had at least one behaviour causation factor recorded. The frequency of each behavioural causation factor for occupants of both bullet and target vehicles is presented in Figure 4-9.

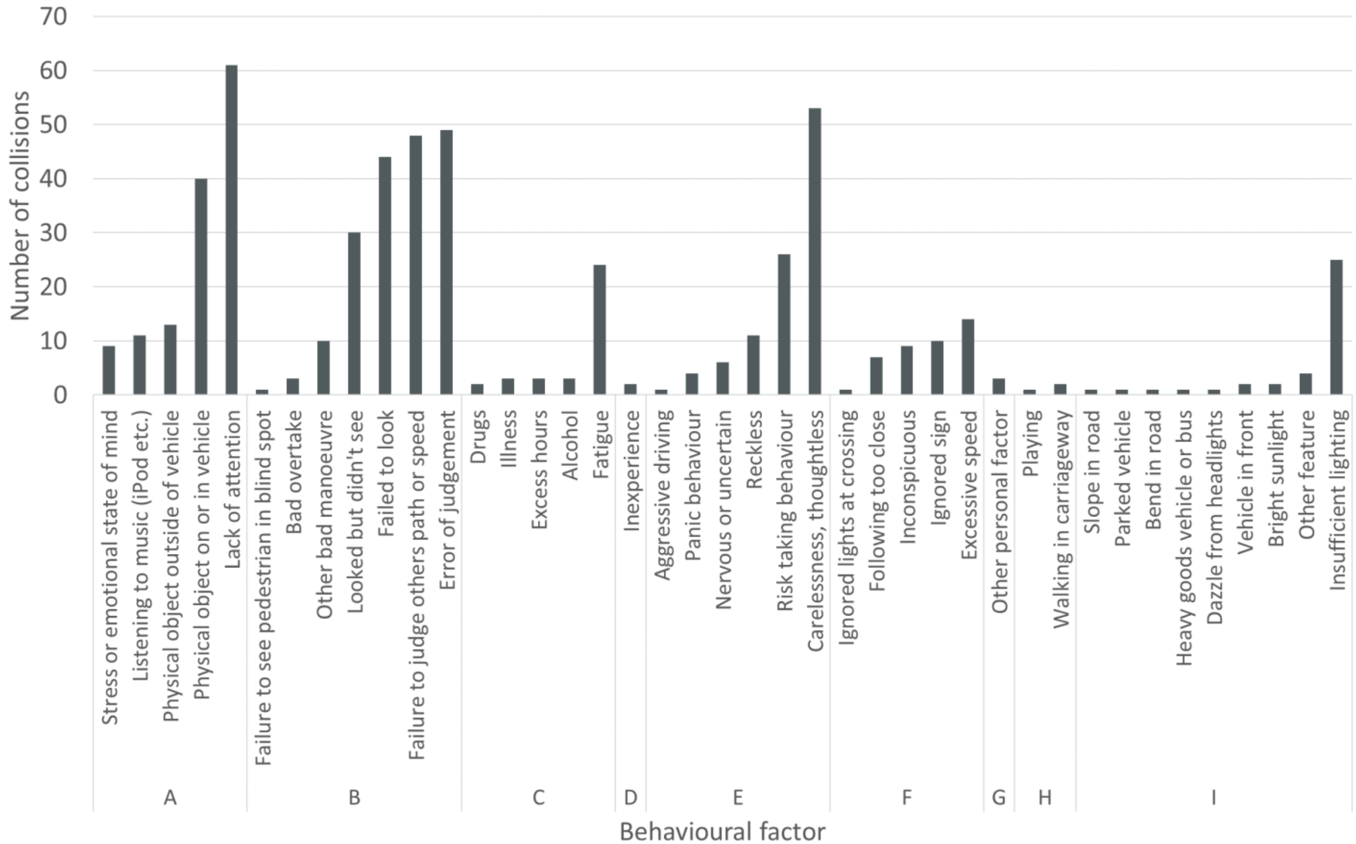


Figure 4-9 Number of collisions where a behaviour causation factor was identified

A - Distraction/Attention

B - Driver error

C - Driver impairment

D - Driver inexperience

E - Driving style

F - Injudicious action

G - Other

H - Pedestrian

I - Vision obscured by

The most common groups of causation factors were 'driver error', 'driving style', 'distraction/attention', 'driver impairment' and 'injudicious action'.

There was little observable difference in the distribution of these causation factors between LGV and HGV collisions.

When assessing these behavioural factors, they can either be 'known' or 'suspected' to be a causation factor within the case. Table 4.6 summarises the number of known and suspected cases in the top 5 categories.

Table 4.6 The number of known and suspected behavioural factors for the top five categories

Causation group	Known	Suspected	Total	% known
Driver error (category B)	36	30	**66**	55%
Distraction/Attention (category A)	29	33	**62**	47%
Driving style (category E)	21	31	**52**	40%
Injudicious action (category F)	22	8	**30**	73%
Driver impairment (category C)	11	15	**26**	42%

Injudicious action was the behavioural factor which if recorded, was most likely to be recorded as 'known to have taken place'; this was followed by driver error.

The qualitative review of the case summaries provides further supplementary information related to the behavioural causes; this is summarised in the sections below.

4.3.3.1 Distraction/Attention (category A)

Twelve cases were identified where a known source of distraction was noted. Active mobile phone use was confirmed in nine cases (with a further 18 having a phone in the cab at the time of the collision, but not confirmed as a source of distraction); active use of navigation systems were identified in two cases (a further five had these systems in the vehicle at the time of the collision) and distraction by a vehicle parked on the hard shoulder contributed to another collision. Some of these physical causes of distraction are easier for a collision investigator to identify than mental causes of distraction, as they can be confirmed by physical investigation. However, mobile phone usage can still be difficult to prove as only phone call and messages, as opposed to social media use, can be confirmed. Furthermore, mobiles can be lost or removed from the vehicle; this may explain why 'lack of attention' is noted more commonly than 'physical object in vehicle' as the former is easier to record without concrete evidence.

4.3.3.2 Driver error (category B)

The most common driver errors recorded include 'error of judgement', 'failed to judge other's path or speed', 'failed to look' and 'looked but didn't see'. These are high-level factors that don't require a large burden of proof, and reflect the common contributory factors recorded by police officers at the scene of collisions.

Other driver errors 'bad overtake' or 'bad manoeuvre' were much less common but included cases such as the following:

- One case where the LGV driver entered lay-by without reducing speed. This may have been an error of judgement, if the driver mistook the layby for a slip road for example, or may have been a deliberate suicide.
- One case where the LGV driver misjudged an overtake of a cyclist, assuming they were traveling faster than they were, and collided with the back of the cyclist before they could move far enough to the right to initiate the overtake.
- One where the LGV driver saw the vehicle ahead starting to slow and misjudged the likely rate of deceleration, meaning the vehicle slowed quicker the expected while the LGV driver was looking in their rear-view mirror to initiate an overtake. As a result, the LGV gained on the vehicle ahead more quickly than expected and collided with the rear of the vehicle ahead.

4.3.3.3 Driver impairment (category C)

Some driver impairments including the physical presence of drugs and alcohol are relatively easy to identify from toxicology reports post-collision or breath tests at the roadside; however, other factors such as fatigue and illnesses may be harder to identify as they often rely on the statements of drivers or witnesses, which are less likely to provide definitive conformation of a cause. Despite this, 'fatigue' was the most common cause identified in this category (Figure 4-9).

The qualitative review of the case studies identified:

- Six cases where fatigue of the bullet vehicle driver was likely to have contributed:
  - Two due to drivers' hours infringements
  - One due to the use of prescription drugs which caused fatigue
  - Three due to lack of sleep
- One case of illness where the HGV driver of the bullet vehicle had Ischaemic heart disease and had been acting abnormally prior to journey

Driver impairment causation factors were slightly more common in 'obstruction' collisions than in 'read end' collisions (which includes queue and slow vehicle collisions): 14 of the 23 (48%) obstruction collisions of the had at least one driver impairment factor compared with 15 of the 46 (33%) of rear end collisions.

4.3.3.4 Driving style (category E)

The most common driving style factors were 'carelessness, thoughtlessness', 'risk taking behaviour' and 'reckless'. Some of these behaviours were further explained within the summaries:

- Bullet vehicle:
    - Driving while using prescription drugs known to cause drowsiness
    - Continuing to drive despite feeling tried and driving past service stations
    - Using a mobile phone
    - Speeding
- Target vehicle:
    - Remaining in the vehicle once broken down instead of moving a safe distance from the carriageway
    - Not wearing high visibility clothing

In addition, a few of the target vehicle drivers were recorded as driving aggressively, or particularly nervously.

- Driving aggressively, losing control of the vehicle, becoming an obstruction
- Acting nervously after losing control of the vehicle, forgetting to put the vehicle's hazard lights on and attempting to go back to the vehicle to do so while it was still causing an obstruction
- Slowing erratically due to feeling lost after possibly missing their exit while in fog
- Exiting and attempting to work on a vehicle which has broken down in a live lane
- Taking off their seatbelt whilst their car is stopping in a live lane, with no immediate intent to exit the vehicle.

Driving style causation factors were slightly more common in 'obstruction' collisions than 'read end' collisions (which includes queue and slow vehicle collisions): 19 of the 23 (82%) obstruction collisions of the had at least one driving style factor compared with 33 of the 46 (72%) of rear end collisions.

4.3.3.5 Injudicious action (category F)

'Excessive speed' was the most common causation factor in this category. The qualitative analysis identified one case where the LGV driver of a bullet vehicle was driving at 70mph, 10mph above posted speed limit of 60mph for that vehicle. 'Excessive speed' can also be considered a factor by a collision investigator if a vehicle is traveling 'too fast for the conditions' (for example due to adverse weather or traffic) even if they are still under the road's posted speed limit.

'Ignored signs', 'inconspicuous' and 'following too close' were also common in this category, with eight collisions identified in the qualitative case review as being a result of an inconspicuous target vehicle; these were four pedal cycles/motorcycles, three after a prior accident (two of which were unable to turn their hazard lights on) and one due to an unknown stop.

Key findings

- All 69 HGV/LGV shunt collisions in the HE Fatals database had a people-associated causation factor; 31 had an environmental factor and 14 had a vehicle factor.
- Not driving to the conditions in both poor and good weather were shown to be causes of some collisions. Poor weather sometimes resulted in obscuration and slippery surfaces; good weather sometimes resulted in glare from the sun.
- The absence of street lighting was said to have had a substantial impact on the collision in seven cases; the conspiciuity of vulnerable road users and the absence of hazard warning lights were identified as particular issues.
- The two most common groups of environmental causation factors were special conditions at site (roadworks and prior accident) and permanent conditions at site (mostly related to poor or no streetlighting).
- 14 collisions involved a least one mechanical defect, eight of which contributed to the collision (defects with the target vehicle to slow or stop in a live lane and defective brakes on HGV which contributed to secondary impacts).
- Sometimes safety features on the bullet vehicle (AEB and cruise control) did not work as intended or had other undesired consequences.
- Queuing traffic was the most common reason identified for the target vehicle to be causing an obstruction.
- Analysis of the traffic data shows that shunt collisions into queues were common. Post-collision, some of these cases caused substantial queues or carriageway closures, often for long periods of time.
- The most common groups of behaviour causation factors were ‘driver error’, ‘driving style’, ‘distraction/attention’, ‘driver impairment’ and ‘injudicious action’.
- Twelve cases were identified where a known source of distraction was noted. Active mobile phone use was confirmed in nine cases.
- ‘Fatigue’ was the most common cause identified in the ‘driver impairment’ category. Fatigue was noted due to driver’s hours infringements, lack of sleep, use of prescription drugs and illness.
- The most common ‘driving style’ factors included ‘risk taking behaviour’ and ‘reckless’. Bullet vehicle drivers were reported as driving whilst tired, using a mobile and speeding. Target vehicle drivers remained in the vehicle once broken down and were reported to not be wearing high visibility clothing.
- Some of the target vehicle drivers were recorded as driving aggressively or nervously.

4.4 Analysis of Stats19 contributory factors for Fatals cases

In addition to the causation variables analysed in the Section 4.3, the collision investigator coding the case into the HE Fatals database assigns contributory factors following the same guidance which police officers use to assign these to a collision in the Stats19 data. However, the collision investigator does not have the same time constraints or external pressures as the police (because this is being done retrospectively) and may also have other information (e.g. from coroners or witness reports) on which to base their conclusions. As this coding is independent of the police coding and therefore may include some, all or none of those recorded in the Stats19 data. Further to this, all contributory factors that are known or likely to apply for each case are assigned, meaning there are typically more per case than in Stats19. Only the contributory factors in the HE Fatals dataset are considered here.

Of the 69 HGV/LGV shunt collisions of interest, 67 had at least one Stats19 contributory factor recorded for the bullet vehicle but only 26 had one recorded for the target vehicle. Each factor was assigned also have a confidence level recorded to indicate whether the researcher thought that factor was 'very likely' to have contributed to the collision or only 'possible'.

The ten most contributory factors recorded as 'very likely' for the bullet vehicle in HGV/LGV shunts in the HE Fatals dataset are shown in Figure 4-10. For each factor, the proportion of collisions this factor was recorded in is presented because collisions can have multiple factors recorded. The data are also split by the likelihood with which the factor was recorded.

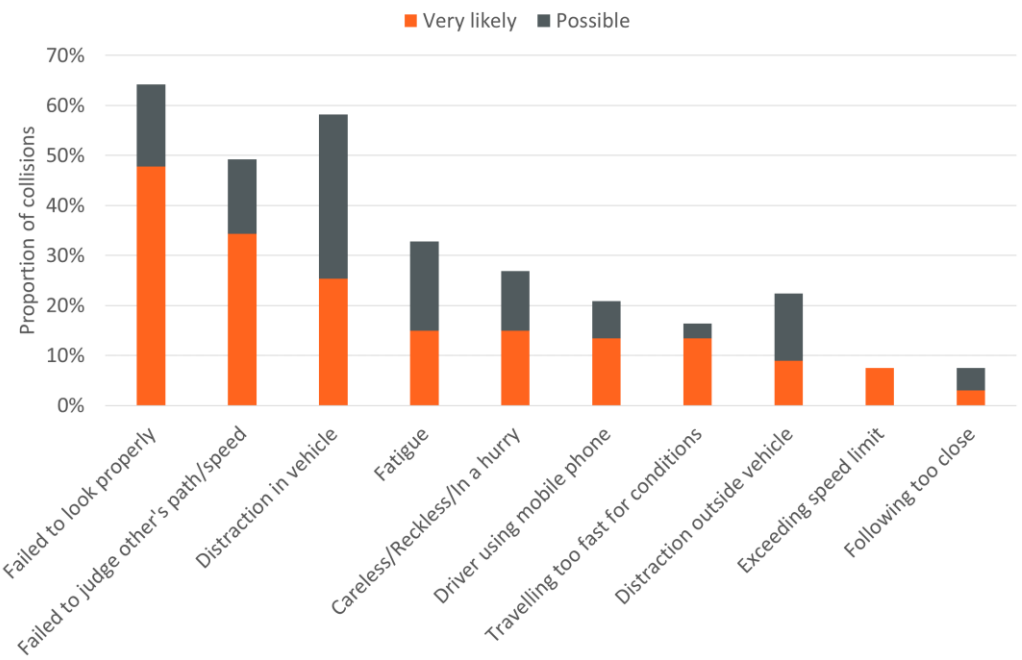


Figure 4-10: Top 10 most common Stats19 contributory factors recorded as 'very likely' for the bullet vehicle in HGV/LGV frontal shunts in the HE Fatals dataset by factor likelihood (n = 67)

Figure 4-10 shows that the most common contributory factors recorded as 'very likely' for the bullet vehicle are 'Failed to look properly' and 'Failed to judge other's path/speed'. These two factors were also most common in the analysis of contributory factor data from Stats19, discussed in Section 3.5. However, the analysis of Stats19 data showed that 'Following too close' was common for HGV/LGVs in frontal shunt collisions but this factor is only recorded for the bullet vehicle in five collisions in the HE Fatals dataset (7%). This could be because 'Following too close' may be more likely to be recorded in collisions which take place in queuing traffic and these are less likely to be fatal because the vehicles involved are travelling more slowly.

'Distraction in vehicle' is another commonly recorded factor and, when collisions where the factor was recorded as 'possible' are included, it appears in 58% of the HE Fatals cases. This is another contrast between the contributory factors in the HE Fatals data and the Stats19 data (where 'Distraction in vehicle' was recorded in less than 10% of collisions), suggesting there may be some differences in how the police officers and collision investigators are assessing this factor. 'Distraction in vehicle' is recorded as 'very likely' in less than half of the HE Fatals cases where it is assigned. However, even when only considering the 'very likely' assignments of this contributory factor, the level is higher than seen in Stats19.

'Fatigue' is also recorded as 'possible' in more collisions than it is recorded 'very likely'. In contrast, 'Failed to look properly' and 'Failed to judge other's path/speed' are recorded as 'very likely' in the majority of cases in which they appear, probably reflecting the ease at which information on these factors can be gained (fatigue and distraction may require witness statements or driver self-reporting to be identified with certainty).

For each of the three most commonly recorded factors ('Failed to look properly', 'Failed to judge other's path/speed' and 'Distraction in vehicle'), the factors which are commonly assigned alongside these three have been explored to gain insight into what may be distracting drivers. Figure 4-11 shows the top five factors recorded as 'very likely' alongside each of 'Failed to look properly', 'Failed to judge other's path/speed' and 'Distraction in vehicle' (recorded with either likelihood). Interpretation of these findings is presented below the chart, although some caution should be applied due to the relatively small number of collisions represented (43, 33 and 39 in the three analyses respectively)

In a similar way to the contributory factor combinations from Stats19 presented in Figure 3-27, the proportions have been calculated within each of the main three factors; for example, 60% (26) of the 43 collisions where 'Failed to look properly' was recorded for the bullet vehicle also had 'Distraction in vehicle' recorded for the same vehicle.

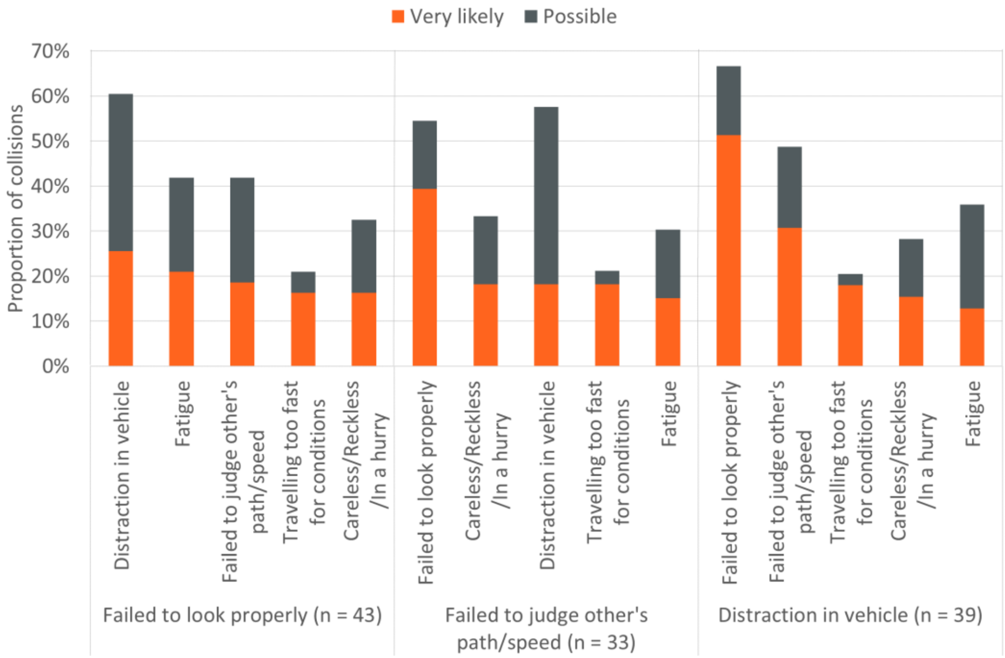


Figure 4-11: Top five factors recorded with each of 'Failed to look properly', 'Failed to judge other's path/speed' and 'Distraction in vehicle' for the bullet vehicle (proportions presented within each of these three main factors)

Figure 4-11 shows that 'Failed to look properly', 'Failed to judge other's path/speed' and 'Distraction in vehicle' are commonly recorded alongside each other. 'Careless/Reckless/In a hurry', 'Travelling too fast for conditions' and 'Fatigue' are also commonly recorded alongside all three of these factors.

'Travelling too fast for conditions' is recorded in around 20% of collisions with each of 'Failed to look properly', 'Failed to judge other's path/speed' and 'Distraction in vehicle' and in most cases is recorded as 'very likely'. This could suggest that fatal frontal shunt collisions are happening when a vehicle is travelling too fast and so the driver does not have enough time to see and react to the road users around them or recover if they are distracted.

'Fatigue' is also commonly recorded alongside 'Failed to look properly', 'Failed to judge other's path/speed' and 'Distraction in vehicle', although it is recorded as only 'possible' in approximately half of cases. If a driver is fatigued, they may be less able to concentrate on the road and react to other road users' behaviour.

The Stats19 analysis did not find 'Fatigue' and 'Travelling too fast for conditions' to be commonly recorded alongside 'Failed to look properly' and 'Failed to judge other's path/speed', suggesting that these factors could be more common in fatal frontal shunt collisions. However, the difference could also be because it may be more difficult for police officers attending a scene to establish whether a driver was fatigued or travelling too fast whereas a researcher after the event may be able to assign these factors with more confidence.

There were not enough collisions in the HE Fatals dataset where the target vehicle had a Stats19 contributory factor assigned, for full analysis to be possible. However, exploration of the data showed that only two collisions (out of the 26 where a target vehicle factor was recorded) had 'Sudden braking' recorded and in both cases it was recorded as 'possible' rather than 'very likely'. This contrasts with the results of the Stats19 analysis where 40% of collisions had 'Sudden braking' recorded for the target vehicle. The top three factors recorded for the target vehicle in the HE Fatals dataset were 'Other', 'Not displaying lights at night or in poor visibility' and 'Cyclist wearing dark clothing at night' (recorded in seven, five and four collisions respectively).

Key findings

- Contributory factors were more commonly assigned to the bullet vehicle than the target vehicle.
- The three most recorded factors were 'Failed to look properly', 'Failed to judge other's path/speed' and 'Distraction in vehicle'.
- Compared with the Stats19 data 'Distraction in vehicle' is much more common in the HE Fatals data, suggesting there may be some differences in how the police officers and collision investigators are assessing these factors. However, this is often only recorded as 'possible'.
- 'Careless/Reckless/In a hurry', 'Travelling too fast for conditions' and 'Fatigue' were commonly recorded alongside the three most common factors.
- 'Sudden braking' was much more common for the target vehicle in the Stats19 data compared with the HE Fatals data.

5 Driver engagement

To gain further insight into the causes of frontal shunt collisions and to identify further relevant countermeasures, 20 drivers and managers from a range of organisations were interviewed. Interviewees belonged to one of the following categories:

a) Commercial HGV or LGV drivers who had experienced frontal shunt collisions or near misses

b) Managers of commercial HGV or LGV drivers who had experienced frontal shunt collisions or near misses.

5.1 Method

Individual interviews were carried out with each participant, with the aim of eliciting information about the personal and occupational contexts, circumstances, and potential contributory factors in frontal shunt collisions or near misses. This open and exploratory approach provided an opportunity to uncover potential causes or contributory factors that were not identifiable through analysing Stats19 and the Highways England Fatals data.

5.1.1 Participant recruitment

A recruitment survey was used to allow potential participants to register their interest in the study. This survey provided information about the purpose and context of the study, and asked for the necessary consent to take part in the research. A series of questions was used to determine whether potential participants met the inclusion criteria (outlined in Table 5.1).

Table 5.1: Participant inclusion criteria

Participant group	Inclusion criteria	Rationale for inclusion criteria
Commercial HGV or LGV drivers	1. The participant had struck (or feels they almost struck) another vehicle from behind while driving an HGV or LGV in the last six months 2. The collision or near miss resulted in no more than a slight injury to any party 3. The participant is not currently experiencing post-traumatic symptoms	Criterion 1 ensured the experience of the participant was relevant and recent, as the aim was to recruit drivers who could provide accurate details of the events in the interview. Criteria 2, 3 and 4 were included to minimise the risk of re-traumatising drivers who had been involved in a collision or near miss. Participants who did not meet these criteria were provided with details on how to access various mental health support services.

Participant group	Inclusion criteria	Rationale for inclusion criteria
	related to the incident (measured by the IES-R[14]) 4. The participant does not indicate that the interview may be too stressful for them	
Managers of HGV or LGV drivers	1. The participant has at least two years' experience managing HGV or LGV drivers 2. One of the participant's managees struck (or almost struck) another vehicle from behind while driving an HGV or LGV in the last 12 months 3. The participant does not indicate that the interview may be too stressful for them	Criteria 1 and 2 ensured the experience of the participant was relevant and recent, as the aim was to recruit managers who could recall the relevant events well. The cut-off period was more relaxed for managers as they were not required to recall as many details of a specific event. Criterion 3 minimised the risk of causing unnecessary psychological harm to participants. Participants who did not meet this inclusion criterion were provided with details on how to access various mental health support services.

Roots Research, an experienced recruitment agency, assisted with recruitment. In addition, recruitment was boosted by social media advertising, through contact with members of TRL's large participant database and snowball sampling. Compensation of £40 was paid to participants.

Participants were from a range of organisations, including haulage and emergency services, all based in England. The final sample of participants consisted of 12 commercial drivers (nine HGV and three LGV) and eight managers.

Most of the participants were male (10 of the 12 drivers and 7 of the 8 managers), which is broadly representative of the demographics in the industries sampled.

5.1.2 Facilitating the interviews

Interviews were conducted via telephone by one member of the research team, typically lasting between 30 and 45 minutes each. Audio recordings of the interviews were taken with participants' permission for later transcription.

Topic guides were used to ensure a consistent facilitation approach across the interviews with the two different groups (drivers and managers). The researchers were required to become familiar with the topic guides prior to conducting any interviews. The topic guides were

[14] **Weiss DS and Marmar CR (1997).** The impact of event scale – revised. In: Wilson JP and Keane TM (eds). *Assessing psychological trauma and PTSD*. New York, NY: Guilford Press, 399-411.

separated into several sections, including a preamble and debrief. Questions focused on drawing out information surrounding specific frontal shunt collisions that the individual had either personally experienced or dealt with from a managerial position. This included the driving and organisational context, what happened post-incident, and perceived contributory and preventative factors.

Due to the interview requiring participants to recall potentially traumatising incidents, a welfare check was included to form a brief agreement with the participant on how to manage any anxiety and emotional arousal that may result from the interview. Additional risk mitigation measures were put in place if any participant was to show signs of distress or if a researcher was particularly considered about an individual's wellbeing; no incidents occurred which required these measures.

Upon completion of the interviews, participants were sent a debrief letter with information on the project and how their data will be used, as well as information on contacting mental health support services, should they require them.

All audio recordings were transcribed by an external transcription service. The interview transcripts were then analysed using a thematic analysis approach.

5.1.3 Analytical approach

Thematic content analysis was chosen as the approach to analyse the 20 interview transcripts. This approach allowed for the key messages to be drawn from the collected data, by identifying the common points being raised by the sample. The researchers who conducted the interviews engaged in an initial discussion to share their thoughts and what each felt the key findings were. This lay the foundation for a consistent and reliable thematic framework to be developed, which captured important message in the transcripts.

The thematic framework was developed in a spreadsheet using Microsoft Excel. Each individual transcript was represented in a column, while the various themes were represented in rows. Transcript columns were grouped by HGV drivers and fleet managers. Relevant quotes from each transcript which demonstrated a theme were collected in the appropriate cell of the spreadsheet. This approach allowed for data to be roughly interpreted 'at a glance' by seeing which themes had the most and least content, as well as showing differences between the two groups.

One researcher carried out the analysis on each transcript, populating the thematic framework with relevant data. Upon completion of this task, a second researcher validated the collected data. Key findings were then drawn out from the collected data. These are detailed and discussed in the following section. Relevant quotes taken directly from the transcripts are used to evidence and support the discussion. Where a quote is used, details are included in parentheses showing the participant number, gender and age (where available) of the participant, whether they are a driver or manager, and line number(s) of the quote (e.g. P1, M, 44, Driver, L151-155).

Key points are summarised at the end of each section. Potential countermeasures are presented in orange text to distinguish them from causes (which are presented in black text).

5.2 Findings

5.2.1 Drivers

When providing details on the cause of the incidents they experienced, drivers typically attributed blame to other road users. Most incidents were found to involve another vehicle cutting across the driver's forward path, resulting in a near-miss. For example:

> *"… I'd left a gap, a vehicle has decided it wanted to be in my space, we're traveling up to a set of traffic lights and it's decided it's in the wrong lane it wants to make the left turn in front of me and decides to cut me up."* (P16, M, Driver, L225-228)
>
> *"[A car has] come from the other lane and just cut straight in front of me because he doesn't want to wait behind me, and then we're at the queue of traffic and he's just slammed his brakes on, and I just about stopped."* (P1, M, 44, Driver, L220-223)

Only one of the twelve drivers that were interviewed placed the cause of an incident on themselves. They admitted to being tired and inattentive at the time, stating:

> *"If I was to be honest, the most contributing factor is probably tiredness, because that's what leads to then not paying attention as much"* (P20, M, 28, Driver, L374-379)

Where drivers blamed other road users as the cause of the incident, they attributed it to them *"not paying attention"* (P18, F, 36, L288), *"speeding"* (P6, M, Driver, L226) and/or generally showing a lack of understanding of appropriate driver behaviour around HGVs. As a result, interviewees often suggested a potential solution to this problem would be to improve driver education:

> *"Education on drivers, on car drivers. Certainly, in my circumstances it's realising that HGVs don't stop as quick, they do leave gaps for their own safety as well as other drivers around them. It's not just down to our safety, it's down to their safety."* (P16, M, Driver, L355-358)
>
> *"I think one of the things I would, I personally would say, is that car drivers, when they're doing their test, need to know what could happen, and be aware of the size of a HGV vehicle."* (P8, M, 61, Driver, L456-458)

Emergency vehicle drivers expressed a desire for the public to be better educated on what to do when they are approaching with blue lights, as their near misses tended to occur when people panic and don't know how to respond.

When asked what factors they felt prevented a worse outcome in their incidents, drivers typically felt that it was because of their own driving expertise. Specifically, they stated being more alert than other road users and were generally anticipatory of other drivers' behaviour.

> *"My response to slam the brakes on, my reactions to that car. I think having done the job for five years, I'm obviously a bit more savvy with driving and I mean I'm 52 anyway, so I've driven normal vehicles for a long time anyway. But you can sort of see when someone isn't behaving as they should, so it just gives you that little more awareness, to be wary of what they may do or may not do and trying to anticipate that a little bit"* (P12, F, 52, Driver, L334-341)

An additional comment that was made by drivers related to the use of on-board camera systems. Some noted that having such camera systems was a good thing as it allowed for readily-available evidence to absolve them of any blame in any incident caused by other road users.

> *"The [camera] facing the road is good, you know, because it covers you in any situation, obviously, if it wasn't there it doesn't cover you and you don't have evidence."* (P17, M, 42, Driver, L412-414)

This pattern of comments was generally observed across the interviews with drivers, as well as across different occupations, including haulage, deliveries and emergency services.

Key findings

- Drivers tended to attribute blame to other drivers rather than to themselves.
- Other vehicles 'cutting in' was the most frequently cited cause.
- Interviewees suggested improvements to driver education, specifically improving road users' awareness of HGV stopping distances, to address this issue.
- Drivers tended to attribute the limited severity of their incident to their own alertness and anticipation of other drivers' behaviour.
- Drivers often had (and were in favour of) outward facing camera systems that often exonerated them in the event of an incident.

5.2.2 Managers

While HGV drivers typically attributed blame to other road users, the fleet managers that were interviewed seemed to assign more blame to the drivers they manage.

> *"Nine times out of ten it's the driver's fault"* (P5, M, Manager, L336-337)
>
> *"A fault accident can only be caused by one thing, and that's the person behind the wheel unfortunately, unless it's a cause-collision crash where it's crash for cash. That's the only other reason, but the major contribution is due care and attention by the driver. Every accident has a cause, and there's only one cause and it's the nut behind the wheel."* (P9, M, 54, Manager, L419-423)

Factors such as *"impatience"* (P5, M, Manager, L242), *"lack of forethought"* (P4, M, Manager, L78) and *"rushing"* (P13, M, Manager, L205) were given as reasons for why drivers have accidents. This is particularly interesting, as it is not reflected in the comments made by drivers themselves. It would be expected that managers, who are able to observe driver behaviour directly (e.g. via telematics) or indirectly (e.g. through reports and interactions) across a fleet of vehicles, have a greater insight into the causes of frontal shunt collisions. Drivers, however, are more likely to only bear witness to their own driving behaviours. With drivers appearing to consider their experience and professional driving ability as the reason accidents don't have worse outcomes (as noted in the previous section), this might explain why the drivers in this sample were more prone to attributing the cause of an incident to other road users.

Further to the comments about drivers being impatient, some fleet managers noted trends with driver attitudes contributing to a harsher driving style and consequently a greater risk of being involved in incidents. For instance:

> *"If moods changed within themselves like you tend to notice it, in their driving as well. It's coming to work in a bad mood, you get quite a lot more of the harsher braking, the faster acceleration and stuff like that."* (P2, M, 31, Manager, L676-679)

This individual explained that he was able to make these observations through the on-board tracking system. Similarly, another manager stated:

> *"I think there is a pattern. I can't nail it on the head but I think there is what I call the drivers with a blasé attitude are the ones that normally come unstuck and have the accidents. It's not necessarily a driver with an aggressive attitude"* (P4, M, Manager, L675-678)

Regarding potential means to address the issue of frontal shunt collisions, fleet managers typically favoured vehicle safety technologies. Autonomous/Advanced Emergency Braking systems (AEBS), lane assist systems, and on-board cameras were all stated. For example:

> *"Interventions I'd be looking at moving forward is having autonomous braking and a front camera just to make sure that decent braking distances are kept and everything else, and if they're on a motorway and they get too close to the car in front again it reduces their speed and keeps a safe distance in front of them."* (P9, M, 54, Manager, L428-433)
>
> *"The system where the vehicles read the space in front, so it starts braking before – […] but what happens in a lot of the cars is, they already know that's happened, and they'll put the brake on for you. That's a fantastic system, and I think in vans, that should be a part of the build of that vehicle. […] So, I think that that would be a very important thing, to put that in as a standard in all vans."* (P3, F, 54, Manager, L309-320)
>
> *"I mean these new technologies that maybe have it so it's compulsory for vehicles to have, from a certain age, have these sensors retrofitted. […] my car goes off if you go over the line slightly or if you're heading off, you know, lane correction or something like that. I think it does some sort of warning that came up and the vehicle took over and slowed you down. Much like some of the new technology that is out there, perhaps have that in place."* (P13, M, Manager, L439-448)

Managers tended to hold more faith in technology preventing an accident than changing driver behaviour through education or training. This idea is supported within comments that were made on the topic of driver training. Though some fleet managers did support improving driver education (e.g. *"More driver training, which is always, you can never have enough training"* (P8, M, 61, Manager, L359-360)), others saw little benefit in it.

> *"I wouldn't say looking at driver training because I don't believe in driver training; it's just a case of chucking good money at bad half the time."* (P9, M, 54, Manager, L365-367)
>
> *"Apart from that, then the only you can do is another form of driver education, which I just don't think it really works really. Because they can play the tick box exercise in the classroom and say "yes sir, no sir," and then next day they're out on the road and*

> *they've forgot everything you just taught them in the classroom."* (P9, M, 54, Manager, L435-439)

Key findings

- Fleet managers tended to attribute blame to HGV drivers rather than on other road users. Factors including impatience, lack or forethought and rushing were listed as reasons for these collisions.
- Some managers noted a relationship between HGV drivers' attitude and likelihood to be involved in incidents; specifically, those who are uncaring or in a bad mood demonstrated a harsher driving style and greater likelihood to have an accident.
- Managers typically favoured vehicle safety technologies (namely AEBS) to address the issue of frontal shunt collisions, generally considering improved driver training to be ineffective.

5.2.3 Driving context/environment

Drivers mentioned driving in a wide variety of road environments, including motorways, A-roads, B-roads, quiet country roads and urban centres. Most of the incidents discussed occurred on the approach to an intersection, roundabout or merge, and usually involved another vehicle (as described by drivers) "cutting in" and "slamming on their brakes". The emergency services vehicles were more likely to have experienced a crash or near miss away from junctions, and mentioned drivers panicking and braking suddenly as a common cause.

When asked whether there were any interventions that could reduce frontal shunt collisions some drivers suggested changes to road signs might help:

> *"Well, if it's them, I guess maybe they could do an ad campaign or a road sign – they're quite good with different road signs, warning people, like Think Bike signs, things like that. It would only take a little bit for people to change. Or yeah, like they do the ads on TV – they've done a few motorbike ones that were quite good."* (P1, M, 44, Driver, L320-324)
>
> *"Better signs, like, again, you get the random signs, Tiredness Can Kill Pull Over and Take A Rest, that's all well and good for normal car drivers and such. But, sometimes general hauliers in general don't have that luxury of saying, oh, I'm going to take my time … they don't have a great deal of opportunity to rest if they're feeling tired, there is no luxury"* (P15, M, 39, Driver, L474-488)

Road layout/changes to the road markings were also suggested:

> *"When you're not local, the Sat Navs, they're not always very clear on what lane to be in and they might put you in the wrong lane. And some of the road layouts for people that are not local can be actually, can be quite confusing about which lane to be in and such"* (P15, M, 39, Driver, L666-672)
>
> *"I guess they could put chevrons on the – I've been on a couple of roads where there's chevrons, and they're saying keep two chevrons ahead of the car in front. That would*

> *be great, but I'm thinking on every road, or maybe major roads"* (P3, F, 54, Manager, L349-352)

Improved speed limits and more enforcement of these were also mentioned:

> *"Highways England I think should look at, are these variable speed limits actually necessary, or are they just switching them on … all they're doing is making totally variable speed limits on a motorway and is then causing harsh braking as people reduce their speeds down to 50 or down to 40 where it's not required."* (P9, M, 54, Manager, L471-476)
>
> *"see more speed traps and cameras, because that will stop a lot of people speeding. Because, a lot of time it is people speeding and not realising it, people having to slam on because they're not checking ahead and that lot."* (P14, M, 24, Driver, L299-302)
>
> *"I think more police on the roads. More police who take drivers and some drivers are intoxicated as well."* (L238-239) *"I think drug testing. Drug testing on the highways and especially at night, … especially young drivers."* (L322-326) (P6, M, Driver)

Key findings

- Most of the incidents occurred on the approach to an intersection, roundabout or merge, and usually involved another vehicle "cutting in" and "slamming on their brakes".
- The emergency services vehicles were more likely to have experienced a crash or near miss away from junctions.
- Changes to road signage, road layouts/markings and speed limits were all suggested as potential ways to reduce frontal shunt collisions.
- Increased police presence/enforcement was also suggested.

5.2.4 Vehicles

Most of the vehicles mentioned by drivers and managers were heavy goods vehicles (HGV class 1, HGV class 2, including truck derivatives such as a fire engine or a petrol tanker). LGVs were generally 3.5 tonnes or larger (e.g. a Mercedes Sprinter) and included ambulances.

When asked about safety features, advanced driver assistance technologies (ADAS) such as autonomous emergency braking (AEB) were mentioned commonly, along with in-vehicle monitoring systems (IVMS, i.e. 'telematics'). More than half of drivers and managers mentioned having a variant of obstacle detection and/or autonomous emergency braking (AEB). Most found this helpful, for example:

> *"I can adjust distance … from the front car. It's really helpful."* (P6, M, Driver, L73-76)

One driver of an HGV with a trailer felt that AEB was dangerous:

> *"They're more dangerous than anything, because when you slam on your [brakes the] trailer kicks out… I've had it on a motorway when there has been nothing near me*

> *and … on the other side of the motorway a car has been coming towards me and my brakes have slammed on"* (P14, M, 24, Driver, L211-217)

One agency HGV driver who frequently drove different vehicles noted that it could be confusing because they didn't know whether the vehicle would have active AEB, passive forward collision warning, or nothing at all.

Some drivers and managers commented on frustration with devices that frequently gave noisy warnings in busy traffic environments, and expressed a concern that this could affect drivers' focus:

> *"What is annoying, if the device is giving you the warnings are too noisy, this is really bad. So, whenever we have devices warning us of passing bicycles on the side, on the corners of the lorries there are special sensors and they will detect movement or obstacles there, and if it's noisy and, obviously, it catches some bushes when we're manoeuvring, in terms of parking for a load. And, in London when we're passing the lamps or something it's, kind of, buzzing… but the level of noise should really be considered what the maximum noise could be. Because, after the long day it might be such a thing which really lowers the ability of drivers to concentrate."* (P17, M, 42, Driver, L436-445)

Managers generally spoke favourably of IVMS that monitored and provided them with oversight of drivers' speeds and driving style (e.g. recording instances of harsh braking or cornering). One spoke about proactively using the technology to give feedback and coach drivers, but noted that the effect of this was temporary:

> *"you do see a slight change but that can sometimes fade as time goes on and they fall into their old habits."* (P2, M, 31, Manager, L604-605)

Key findings

- Many drivers and managers mentioned that their vehicles were fitted with advanced driver assistance technologies (ADAS) such as autonomous emergency braking (AEB), front and side obstacle detection and lane keep assist.
- Drivers had some issues (e.g. drivers who switched between vehicle types were not always sure whether they had active AEB or a warning system and this could cause some confusion)
- Some vehicle alerts were perceived to be distracting/fatiguing as they were triggered too frequently in busy traffic/narrow roads etc. when there was no real danger of the driver hitting something.
- In-vehicle safety monitoring systems (i.e. telematics) were relatively common, especially in trucks, and often included cameras. There was no direct evidence that these systems prevented crashes, but it is used by some organisations to give feedback/coach drivers.

5.2.5 Organisational factors

The sample covered a range of industries and organisations and thus the typical working day/ shift patterns differed across participants. Some participants drove for relatively short periods and then got out of the vehicle to do other work:

> *"They'll drive to the store, so depending how long, could be about, say, 40 minutes to the store, then they would stay there for a couple of hours, and drive to the next one... So, there's not a lot of driving going on, really, when you look at it."* (P3, F, 55, Manager, L144-148)

Others reported driving for longer periods or having long shifts:

> *"I can be doing 13 plus hours a day, which when I do 13 plus hours a day there will be up to five hours driving, so long days"* (P20, M, 28, Driver, L401-403)
>
> *"I do a nine hour shift, I would say between five and six hours I will be driving."* (P19, M, 28, Driver, L50-51)

Overnight working and contracted hours of 40-50 hours a week were not uncommon:

> *"He was starting at 2:00 in the morning. They would do their nine-hour driving."* (P4, M, Manager, L53-56)
>
> *"All shifts start usually from midnight to six in the morning and they vary between nine and 13 hour days"* (P8, M, 61, Manager, L24-26)
>
> *"It'll be four 12-hour shifts, maybe. Well, ideally it's 48-hour working week on 4 shifts, so anywhere from 48 to 50, 51, 52, depending on scheduling and hours and traffic conditions."* (P5, M, Manager, L75-77)

As outlined in the literature review (Section 2.2.2.3), the amount of sleep and when it takes place are important factors in fatigue, as is the amount of time-on-task. Unsocial hours (typically defined as night (or evening) shifts, early morning shifts or rotating shifts) have been shown to effect sleep and thus drivers working these periods may be more effected by fatigue; some participants highlighted that fatigue may sometimes play its part in shunt collisions/near misses:

> *"They don't mean to go out there to have an accident, sometimes it's probably carelessness, it could be a bit of fatigue, depending on the drops he's been doing that particular day."* (P7, M, 32, Manager, L427-429)

Despite the unsocial hours and long shifts, most drivers felt that they got adequate breaks and were not rushed (this was especially true for the HGV drivers interviewed), and managers reported careful monitoring of breaks to ensure they met with the working time directives. One driver commented that they didn't believe the same was true for van drivers and made observations that they 'watched out' for van drivers and taxi/uber drivers who they perceived as more likely to make erratic manoeuvres.

> *"They just don't look … they just weave in and out of traffic to get themselves forward, because they're usually delivery guys and such."* (L375-377) *"They're just always in a rush trying to get forward a few cars."* (L684-685) (P11, M, 48, Driver)

The nature of work for emergency services drivers meant that they were not necessarily able to take rest breaks.

> *"We get breaks when we're not busy, basically. If we have a really busy day then we don't get any breaks. That can be day or night shifts."* (P10, M, 40, Driver L141-143)

When asked about interventions to prevent shunt collisions, many participants thought rest/fatigue needed to be better managed and made some suggestions for how to do this:

> *"People realising when they are fatigued, obviously, that's a big one, and, I wouldn't say more safety features, in that situation there is not much you can do, it's more personal"* (P14, M, 24, Driver, L239-242)
>
> *"I would feel, especially on the night shift, … having you know, something every couple of hours maybe, even if it was only 5 minutes, just to, you know, have a drink and just close your eyes, you know, just to reboot yourself before you carry on even further."* (P12, F, 52, Driver, L159-163)
>
> *"maybe the planning of the routes, because some days you have a route where, let's say, it's a Monday and I started late so I finish late, and then on a Tuesday I'm on a route where I need to get into work early, then although I'm still meeting legal requirements I'm getting less sleep than I'm used to."* (P20, M, 28, Driver, L403-407)

The current regulations were questioned by several drivers and managers:

> *"I think the law could actually do with a change and make it so that it's an hour a day, rather than three quarters of an hour, depending on the working time directive and the driving hours… But, I think maybe if the law was changed and there was less time allowed to drive until you have to have your first break that would be an ideal situation to help improve safety across the industry, not just the work I do but across the driving industry"* (P16, M, Driver L182-188)
>
> *"I do get adequate rest and I have all the legal requirements for rest, it's just the nature of the job, you're always going to be tired unless, well yes, I mean, you're always going to be tired. OK, if I had a driver's mate and my day was shorter and I didn't have to do all the heavy lifting myself, maybe, but that's not going to happen."* (P20, M, 28, Driver, L391-395)
>
> *"I don't agree with the law as it stands at the moment, where your maximum daily rest has got to be 11 hours and your minimum nine hours. Now, say some of my drivers are getting back to the depot at six o'clock at night, half an hour to get home and asking him to come back at three, four o'clock in the morning, that I don't agree with."* (P7, M, 32, Manager, L712-717)
>
> *"And in terms of daily rest, I personally don't believe nine hours is sufficient for a HGV driver to have off, but I understand that the industry is so tight with margins and things like that, that often it does demand it"* (P13, M, Manager, L144-154)

Some drivers reported that training and education about safety and policies tended to happen at induction and less so after:

> *"They don't give me any messages, they show me on video, induction video and that's it and I watched this video and after that I fill out some questions and that's it. It takes one or two days"* (P6, M, Driver, L94-96)

Others reported much more training and on-going feedback:

> *"If you're a new driver you have to complete 40 hours of training, and you have to have training in every different type of vehicle we have. And also, we have safe operating procedures, and there's one for every job or everything we do in the transport. Plus, you're assessed, as well, you're assessed every six months"* (P1, M, 44, Driver, L163-167)
>
> *"All training is done in house, we have driver trainers that I employ, so when we get a new spec of vehicle... And also, so they have about two to three hours per driver on the vehicle before they take it out."* (P7, M, 32, Manager, L100-104)
>
> *"For the first six months you probably have people coming out with you and sitting down and talking about your weaknesses and what you need to work on"* (P20, M, 28, Driver, L189-191)

One agency driver noted that he was inducted and received training at every new customer site.

The approach to safety management also varied across organisations:

> *"They company's quite – really quite safety orientated, so we have a lot of toolbox talks. We've just had a big safety rollout – I think it cost 6 million, and that was four whole days where we completed classroom projects on safety."* (P1, M, 44, Driver, L171-174)
>
> *"We were quite strict in terms of safety. We employed a company called Peninsular that looked after our health and safety and HR, we also had a mental health team that were available 24/7 for a driver to access via an app or a telephone number which offered them 24/7 support regardless, and it actually extended to their families as well... I also got sent away to become IOSH trained, so I did a lot of the health and safety side of things."* (P13, M, Manager, L74-86)
>
> *"Our motto for safety is, "safety starts with me." So, it's very much focused on the individual taking responsibility for their own safety. Obviously, the company and the business has their policies, but what we're trying to do is put an emphasis on the individual to look after their own health and safety"* (P5, M, Manager, L128-132)

Sometimes drivers were incentivised to drive safely:

> *"We have a performance enhancement which allows us to … it's like a payment every quarter which shows whether we've been efficient in our economy driving, our normal driving circumstances, any incidents, of course, and any problems that we may have had. So, you want to try and make sure that you're always earning that quarterly bonus, so there is always an incentive there to make sure that you're meeting a certain target, which the target is, obviously, based on safety."* (P1, M, 44, Driver, L153-159)

Most participants mentioned daily walk-around/pre-driving checks and regular maintenance inspections (sometimes doing these more frequently than was required by the licence conditions). One participant also reported random drink, alcohol and drug tests for drivers.

The literature review found that payment systems can have an influence on driving hours and fatigued driving, with drivers paid per trip or per kilometre or per shown to be more likely to drive while fatigued and take other risks (see Section 2.2.3.2). Although this was investigated further within the interviews, all drivers interviewed were paid on a per hour or salary basis and no effect of these payment systems were noted.

Key findings

- Most HGV drivers reported that despite working unsocial hours and having long shifts, they felt they got adequate breaks and were not rushed.
- Managers reported careful monitoring of breaks to ensure they met with the working time directives.
- However, rest/fatigue was still reported to need better management. In particular for emergency services drivers whose work meant that they were not necessarily able to take rest breaks.
- Some changes were suggested to the working time regulations to enable drivers to increase the amount of rest they get.
- Provision for training and education about safety and policies varied across organisations, with some drivers reporting this tended to happen at induction and less so after.
- Other participants reported training and feedback on their driving was ongoing.
- The approach to safety management varied, with some drivers incentivised to drive safely.
- Daily walk-around/pre-driving checks and regular maintenance inspections were common.

5.2.6 Incident reporting

Drivers reported that there was no requirement to report near misses, sometimes these might be flagged by IVMS (telematics) devices but unless their manager questioned them on it, they wouldn't mention it. It was acknowledged that this was a regular occurrence:

> *"I would only have raised it if it was raised with me, because that's – well, honestly, it's like a normal occurrence that's going to happen to you on a daily basis, probably"* (P1, M, 44, Driver, L272-274)
>
> *"It's just one of those things, that's part of the job"* (P12, F, 52, Driver, L394-395)

If a collision were to occur, most participants were clear on their responsibilities for dealing with it and reporting. This sometimes included gathering photos or videos at the scene to support later investigation. Managers would usually have some form of communication with their drivers whilst at the roadside to check everyone was ok and some reported they engaged with the drivers after the event:

> *"Look into it deeper to see how it could have been avoided or if there is a way indeed it could have been avoided full stop at all."* (P9, M, 54, Manager, L317-318)
>
> *"If we have a reported accident, what we do tend to do is look at it and then we'll probably put the driver out with a driver trainer, just to see how he's driving style is, whether it's related to the accident."* (P8, M, 61, Manager, L190-193)

Key findings

- There is no requirement from most organisations to report near misses.
- Reporting and evidence gathering is required for collisions involving injury.
- At some organisations, evidence (e.g. photos, video, telematics data) was reviewed after the event and guidance/training given to the driver on how to avoid similar collisions in the future.

5.2.7 Limitations

When considering the findings that have been detailed in this section, it is important to bear in mind some limitations with the approach. In particular, the limitations associated with the participant sample used as this is likely to have had an impact on the findings that have been drawn out.

Firstly, the sample is very small. Only 12 drivers and eight fleet managers were interviewed. The industries represented also varied (e.g. haulage, delivery, emergency services). It is unlikely that the opinions and comments raised by those that were interviewed fully reflect those of the thousands of individuals who work with LGVs/HGVs across the various industries and across the country. Although the data collected do represent an initial guide to some of the breadth of themes that emerge from a discussion of this topic, it is likely that some key themes were not captured from this sample.

A further criticism could be made of the recruitment method used to recruit drivers. To avoid the risk of drivers who had been involved in a collision experiencing post-traumatic stress due to engaging in the interview, many individuals were excluded based on responses given in the recruitment survey. As a result, all the drivers who were interviewed had only experienced a recent near-miss event. None had been involved in frontal shunt collisions involving an injury. Had there been some drivers that had been involved in a recent collision incident, it is possible that additional findings could have been observed.

6 Conclusions from Phase 1

This section presents a high-level summary of the causes identified in the form of an Ishikawa diagram (Section 6.1) and outlines the planned next steps for Phase 2 (Section 6.2) – identification and prioritisation of countermeasures to address these causes.

6.1 Ishikawa diagrams

The findings from the phase 1 analysis are presented in the form of an Ishikawa diagram (these are sometimes called fishbone diagrams, due to their appearance, or 'cause and effect' diagrams). These are designed to show the possible causes of an event, in this case why HGV/LGV frontal shunts are occurring on the SRN. These diagrams enable common themes and areas where system performance may be weaker to be identified.

Each diagram contained the key causes identified from the analysis of Stats19, HE Fatals and the driver engagement task. The literature review findings were not included automatically since these did not necessarily relate to SRN-specific causes; however, where the findings from the literature review were echoed in the other data sources these are evident within the diagrams.

These causes are grouped under the three safe system pillars of behaviour (for both the HGV/LGV driver and other road users), roads/environment and vehicles. Two additional categories are included: one to reflect the organisational factors identified through the engagement and literature review tasks and another to list factors which increased the collision severity. Where relationships were evident between different causes, these have been indicated by a dotted line.

In addition, the ordering of causes within each of these five groups reflects the strength of evidence for that cause (from strong to weak), based on the prevalence of the cause in the data and whether the same cause was identified across multiple sources. For example, where the Stats19 analysis, HE Fatals analysis and driver engagement tasks all identified the same cause, these have the strongest evidence and where a cause was only identified within a small number of cases by one source, the evidence is weakest.

Figure 6-1 presents the final output. This diagram summarises the causes of HGV and LGV frontal shunts, structured as described above. This structure will make it easier to generate relevant countermeasures at the next stage of the research. The 'Effect' side of the diagram also provides a summary of the circumstances for these collisions, information which might be useful in designing and implementing countermeasures.

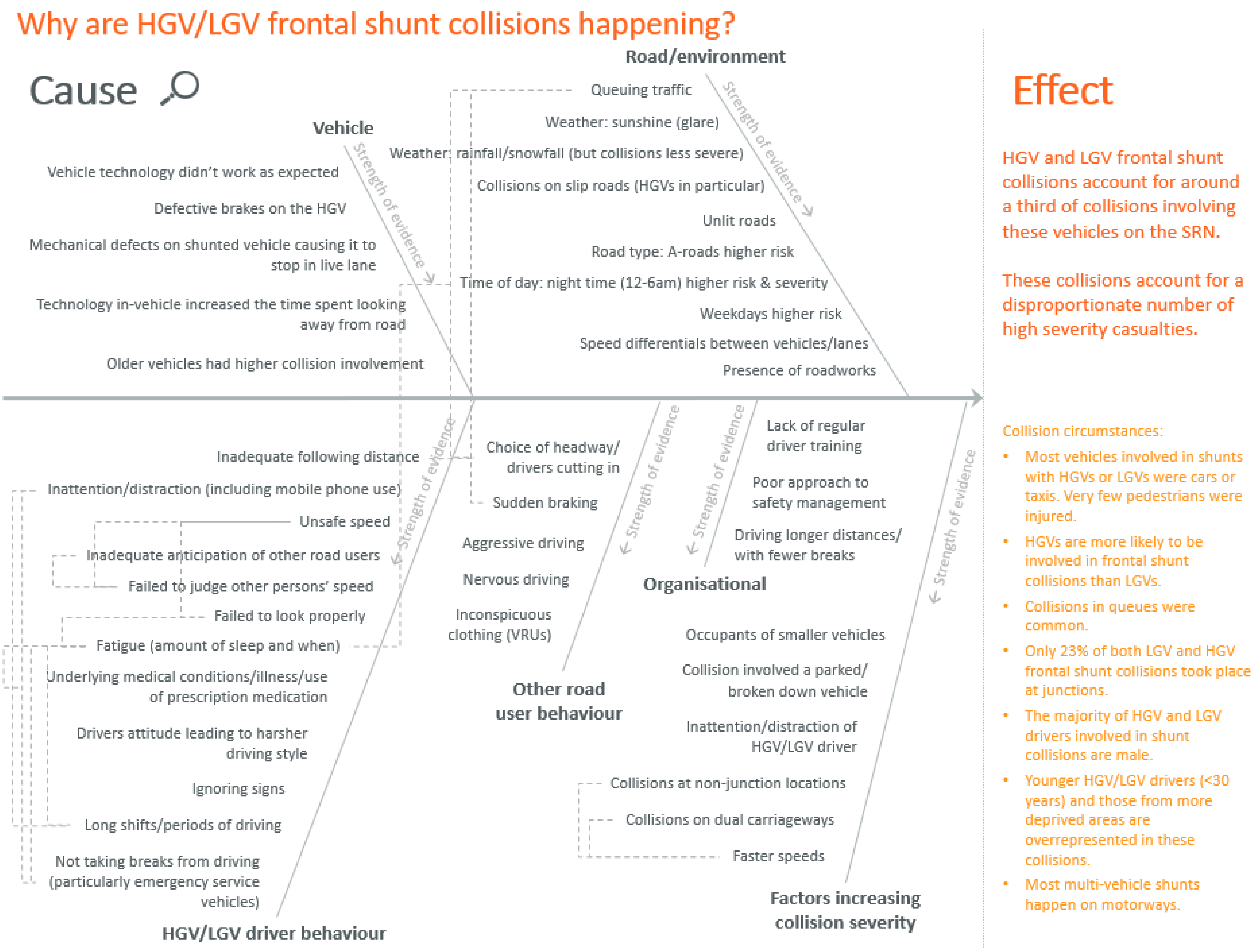


Figure 6-1: Ishikawa diagram for causes and effects relating to shunt collisions on the SRN

The value of these diagrams is that they not only demonstrate the key causes but can also show whether a particular dimension generates a disproportionately large number of causes. In this case the Ishikawa diagram illustrates that a large proportion of the causes seem to relate to the HGV/LGV drivers' behaviour[15], and a lot of these causes were shown to be inter-related (e.g. fatigue being potentially a result of the use of prescription medication, and/or long periods of driving). This is important when considering what countermeasures might be appropriate to prevent these collisions; in the fatigue example it would not be enough to look at the length of driving shifts since this is not the only cause of fatigue.

Road/environmental factors were also relatively common in these collisions, with queuing traffic being the biggest cause identified for frontal shunts. This linked to behavioural factors for other vehicle drivers including "cutting in" and "sudden braking". This suggests that if the behavioural elements can be addressed, the reductions in frontal shunt collisions might be expected.

Issues with vehicle technology featured within the causes on the vehicle stream. Firstly, this technology not working as expected (e.g. AEB not operating during poor light conditions) or issues with identifying which vehicles had active AEB or a warning system, which caused some confusion about how the vehicle might perform in an emergency. The technology was also reported to sometimes have unintended consequences (e.g. increased glances away from the road). Since 2015 it has been mandatory for all new goods vehicles weighing more than 3.5 tonnes in Europe to be equipped with AEBS – when vehicle fleets are mixed ages this could explain driver's confusion, and may also explain why older vehicles were shown to have a higher collision involvement than younger vehicles.

Due to the nature of the datasets, the organisational factors could only really be investigated through the driver engagement task, although the causes identified were backed up by the findings from the literature.

6.2 Next steps in Phase 2

The aim of Phase 2 will be to develop a list of recommended countermeasures to address the identified causes. This will be carried out through three tasks:

- A rapid evidence review of countermeasures to address the causes (building on those identified in the literature review in Section 2).
- A workshop to bring together road safety experts to discuss potential countermeasures to address the causes identified in the Ishikawa diagrams. Throughout the workshop the feasibility of implementing these solutions on the SRN will be the focus, and the potential timescales for implementation/effect on the casualty numbers (i.e. short, medium or long term) highlighted. This is important as some interventions, for example changes to vehicle safety regulations, may take longer to implement, resulting in a longer time period before which casualty

[15] It should be remembered that the Ishikawa diagrams present a list of all the causes identified from the data analysis and attributed to each road user in the collisions; they should not be used to draw conclusions on the relative levels of blameworthiness for these collisions.

reductions would be observed. The level and manner of influence from Highways England will also be different for different countermeasures, for example Highways England do not set vehicle safety regulations, so this will be considered in this evaluation.

- The final task is a stakeholder workshop which will determine the final prioritisation of the recommended countermeasures. Highways England will agree the stakeholders in discussion with TRL, who will lead the recruitment and facilitation of the workshop.

The final report will summarise the results of these tasks and will make recommendations for next steps.

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Appendix A Search terms for literature review

Level 1		Level 2
HGV		Accident
Commercial goods vehicle		Collision
Truck		Incident
Goods vehicle		Crash
Lorr*		Casualt*
Cargo vehicle		Kill*
LGV	**AND**	KSI
Commercial vehicle		Fatal*
Delivery vehicle		Injur*
Van		Shunt
Large vehicle		Rear end
Heavy vehicle		In-depth investigation
Freight		Naturalistic
		Simulat*

Appendix B Traffic analysis

This appendix presents the analysis of the MIDAS traffic data for each of the seven cases for which this was available. For each case, a summary of the vehicles involved (bullet vehicle and initial target vehicle), the collision type and a short case summary are presented from the HE Fatals data. From the MIDAS data, an MTV plot showing the vehicle speeds over the course of the day in question is presented, along with interpretation of the findings from this.

MTV plots show the speed of vehicles travelling on the network. Areas of black represent usual traffic speeds; areas of grey/white show slower speeds and dark blue represents missing data (either because the MIDAS loops broken or there is no flow. Other colours indicate signals switched on/off as per the key. The yellow circles highlight the time at which the collision was recorded to have occurred.

Case number 48

Bullet vehicle: HGV

Initial target vehicle: car

Collision type: Obstruction - Accident or Broken down

Case summary: V2 (car) is travelling along a 70mph motorway. V2 runs out of fuel and pulls up to the side of the carriageway partially in lane 1 as no hard shoulder present, with it hazards on. The driver of V2 exits the vehicle. V1 (HGV) is travelling a short distance behind V2. V1 has over 300 m of visibility however fails to notice V1 strikes the rear offside of the car. V2 spins in to the offside VRS and is redirected in to the semi-trailer of V1. V2 comes to a rest in lane 1 and pointing in a perpendicular direction to the flow of traffic. The impact has caused the cars lighting to fail. V3 (HGV) is travelling 2 minutes behind the others. The driver of V3 fails to notice the unlit car and strikes the rear of V2. A passanger of V2 is fatally injured.

Summary from MTV plot (Figure 7-1): The collision was recorded as happening at 01:55 on the M25 clockwise between Junction 26 and 27. However, the MTV plot for lane 2 shows no sign of the incident on either carriageway at the reported time. Anticlockwise there is an overnight lane closure with some signals to protect the coning. Based on the data in the MTV plot, it is most likely that the collision occurred clockwise at 09:55 (red circle).

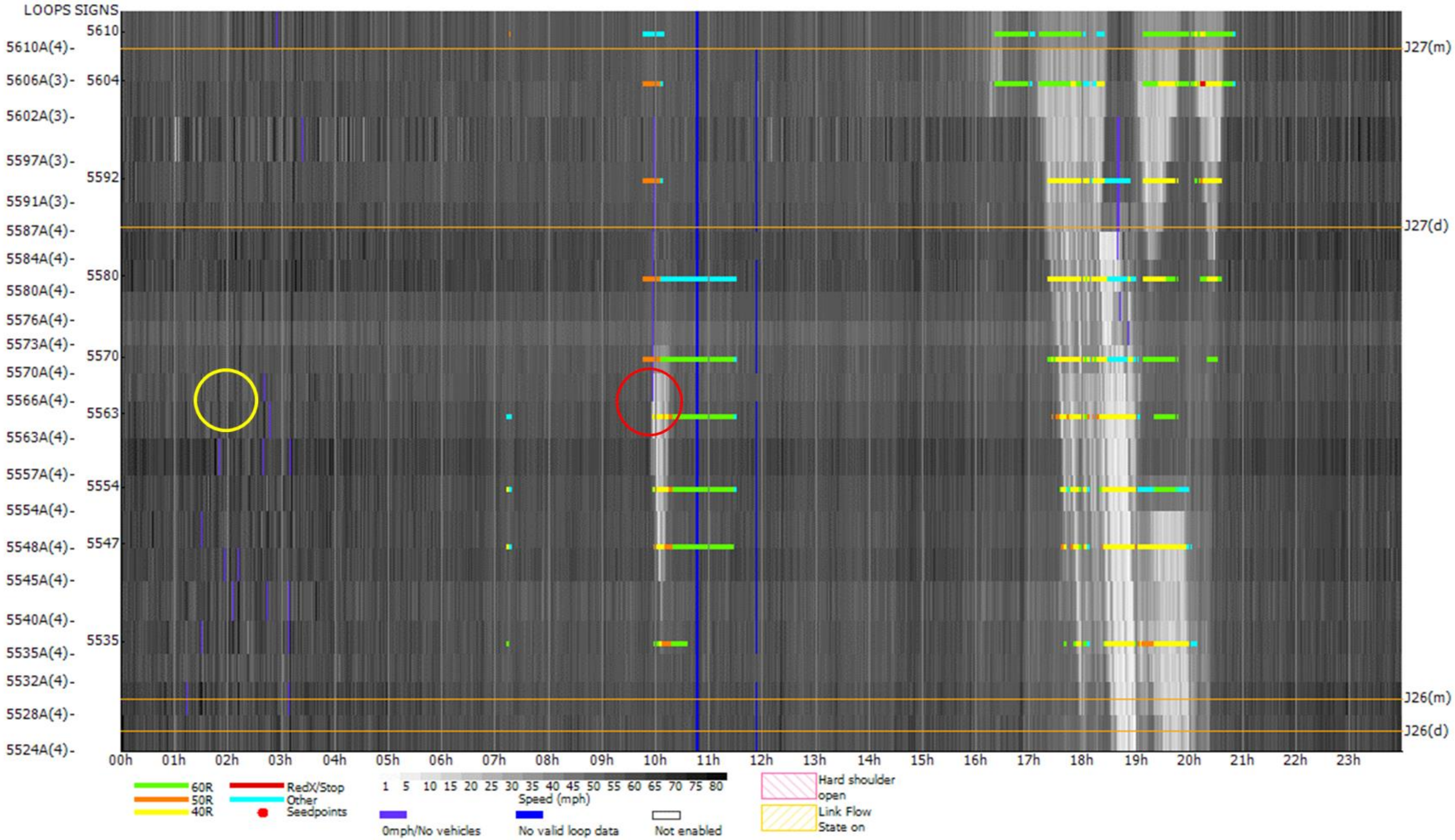

Figure 7-1: MTV plot for case 48 - M25 clockwise carriageway, Lane 1

Case number 59

Bullet vehicle: HGV

Initial target vehicle: car

Collision type: Rear end – Queue

Case summary: V1 (HGV) is travelling at 52mph with cruise control in lane 1 on the northbound motorway carriageway. The driver of V1 had, 5 minutes earlier, been using a blue tooth headset, and had driven past two matrix signs warning of a queue. V2 (car) is behind V3 (HGV) and V4 (HGV) in the queue. All three of the vehicles reduce their speed gradually to ~10mph. V1 fails to react to the upcoming queue. V1 strikes the rear of V2, V2 underruns V3 and both occupants of V2 suffer fatal injuries. V3 impacts the back of V4. V1 could have stopped in 90/200 m available.

Summary from MTV plot (Figure 7-2): The collision was recorded as happening at 10:20 on the M3 northbound between Junction 9 and 10. The traffic was starting to queue in lane 1 for the J9 diverge at 2039/B at about 10:10. The accident occurred about 10 minutes later. Some traffic continued slowly passed the scene for a few minutes until most was diverted off at J10. Queues reached as far back as J13.

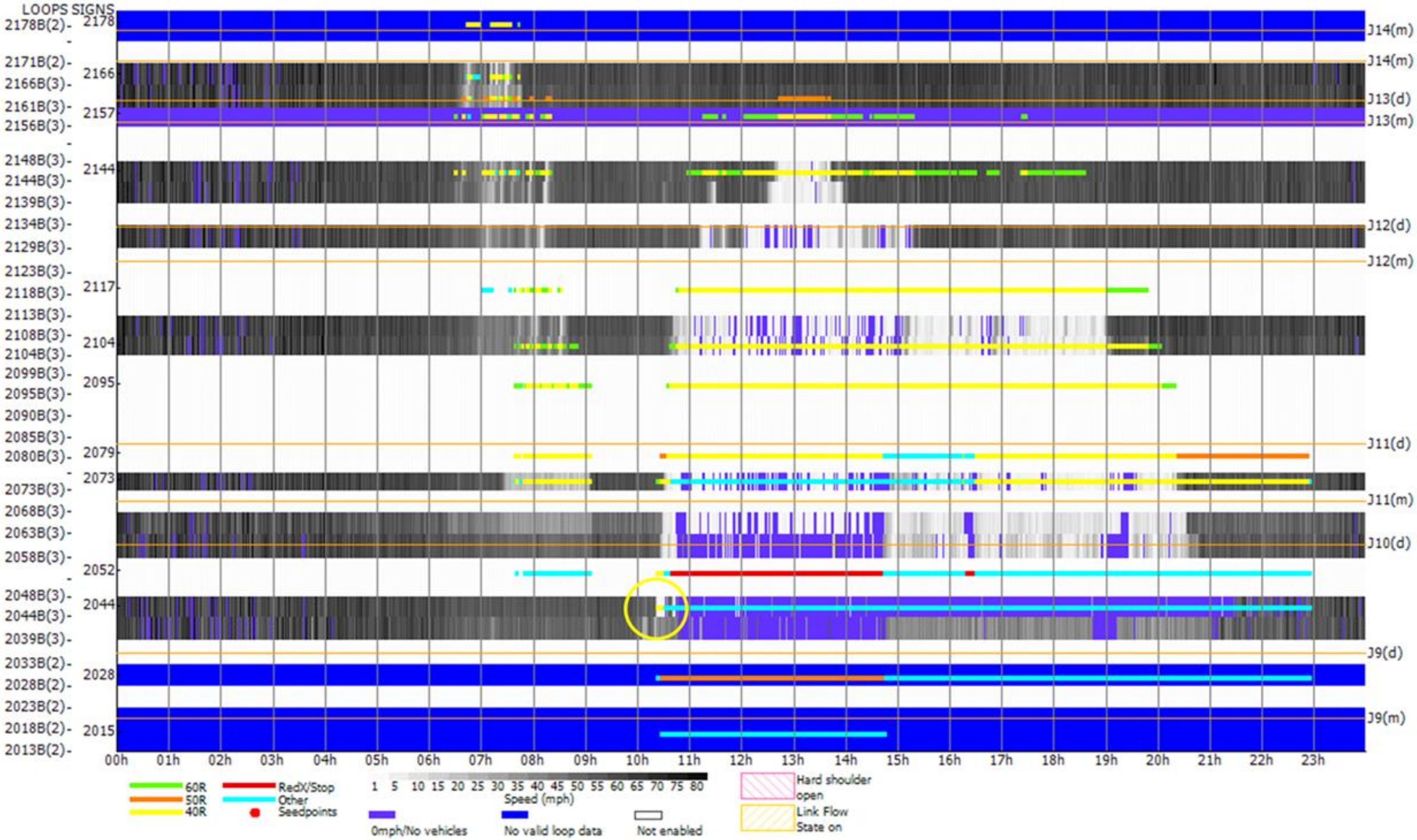

Figure 7-2: MTV plot for case 59 – M3 northbound carriageway

Case number 61

Bullet vehicle: HGV

Initial target vehicle: HGV

Collision type: Rear end - Queue

Case summary: V1 (HGV) is travelling at 55mph in lane 1 of the northbound motorway carriageway. There are three VMS with a 40mph advisory speed limit, and several smaller static signs on the grass verges, indicating a two lane closure ahead. The driver of V1 was on the phone for the last 339 minutes. V1 notice late that V2 (HGV) has slowed to 9mph ahead due to a build-up in traffic despite V2 having his hazard lights switched on. V1 veers to the nearside before striking the rear of V2. V1 canters on to its two nearside wheels, rotates slightly in a clockwise direction before re-entering lane 1. V2 is shunted 43 m forward and comes to rest in-between lane 1. The driver of V1 was wearing a seat belt and was fatally injured.

Summary from MTV plot (Figure 7-3): The collision was recorded as happening at 05:03 on the A1(M) northbound between Junction 48 and 49. From the MTV plot it looks like the accident occurred slightly earlier than reported: around 04:55 between detector 7923 and 7939. There was no sign of queuing before the accident. Post-collision, the carriageway was closed until 09:30 (4.5 hours) and then closed again from approximately 10:00 until 13:30 (3.5 hours).

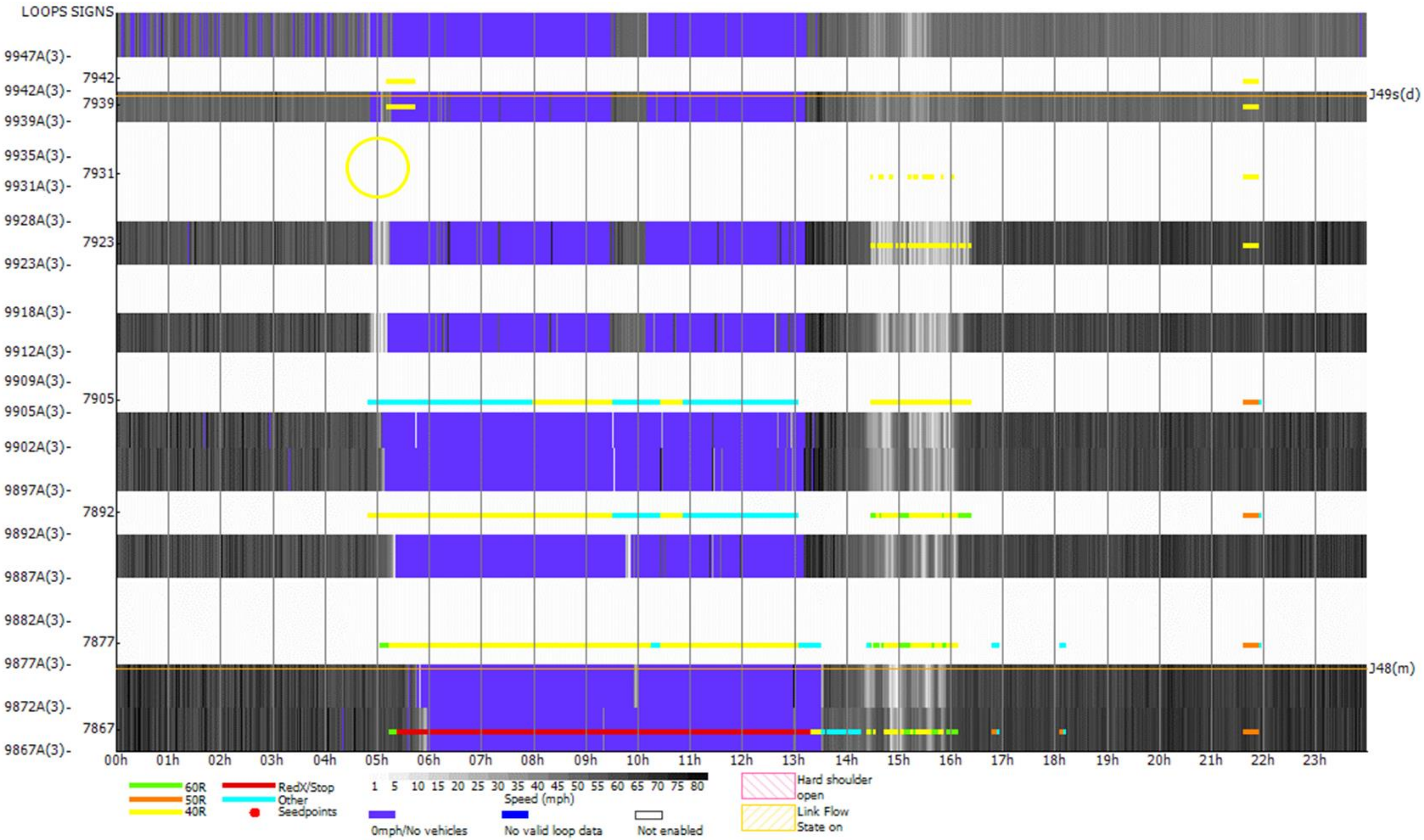

Figure 7-3: MTV plot for case 61 – A1(M) northbound carriageway

Case number 63

Bullet vehicle: HGV

Initial target vehicle: LGV

Collision type: Obstruction - Parked vehicle

Collision summary: On 3-lane motorway during moderate traffic, just beyond slip road off. Driver of V3 (HGV) under the influence of alcohol and having been driving erratically, brought the vehicle to rest in lane 1 and stayed in that position for 12 minutes displaying rear lights but not hazards. V2 (LGV) approaching from behind was unable to overtake due to passing lorries so came to rest ~25m behind V1 displaying hazard & brake lights. V1 (HGV) driver approaching from behind using hands free phone failed to act on HGVs moving into the adjacent lane on approach nor to presence of clearly visible stationary V3 & V2, colliding with rear of V2 at 56mph, shunting V2 forward into the rear of V3. V2 underran V3, coming to rest on the grass divider between the main c/way and slip road. V1 also ran into rear of V3 and came to rest across L1 and hard shoulder. V3 was pushed to rest across L1 & hard shoulder having jack-knifed. The driver and 7 passengers in V2 suffered fatal injuries.

Summary from MTV plot (Figure 7-4): The collision was recorded as happening at 03:10 on the M1 southbound between Junction 14 and 15 (within the services junction). The plot shows that MIDAS queue protection automatically set a 40mph limit at about 02:55 but this went off again about 03:00. The accident was reported at 03:10 and a lane closure set manually at 03:15. The carriageway was closed from Junction 15 until about 13:00 (~10 hours).

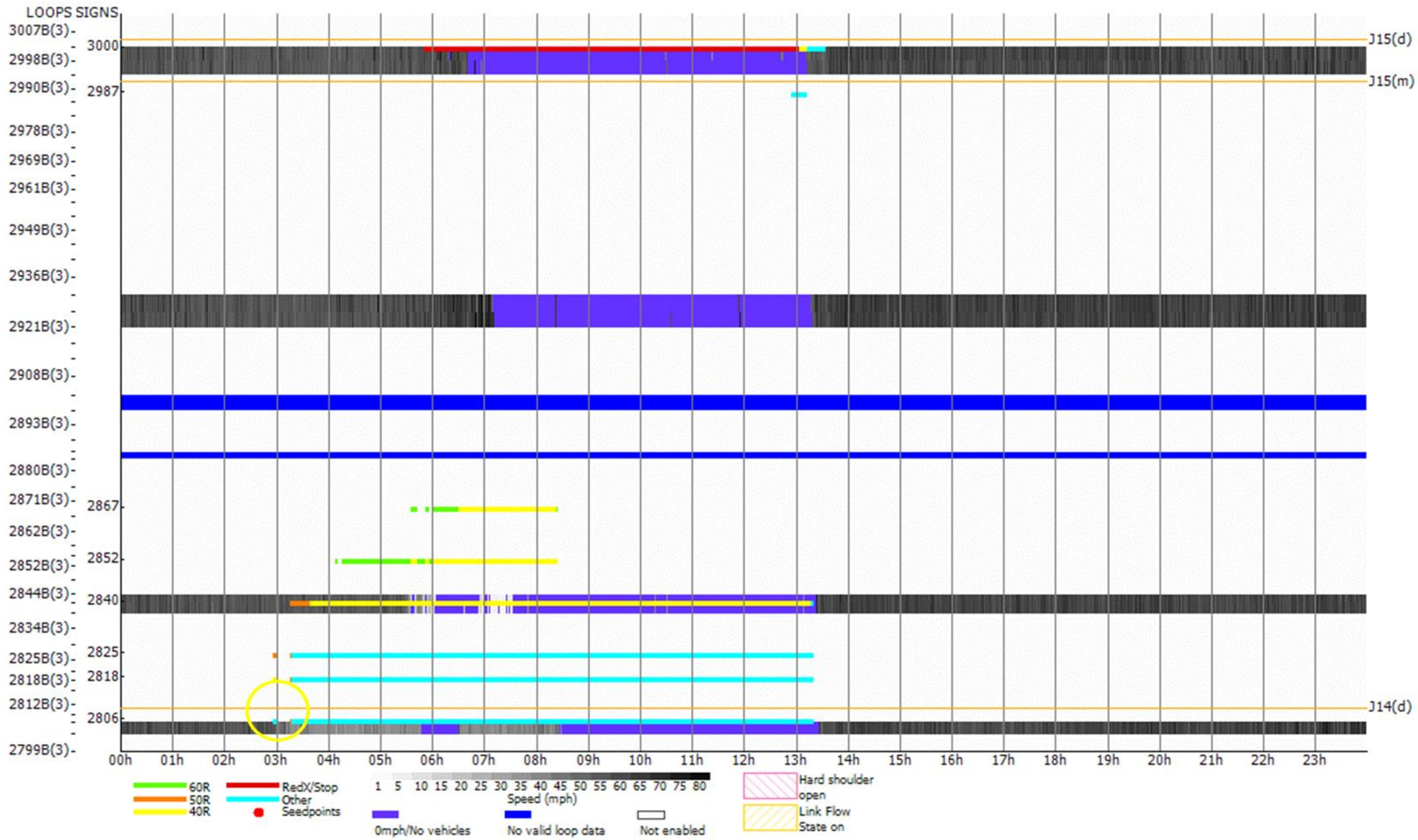

Figure 7-4: MTV plot for case 63 – M1 southbound carriageway

Case number 64

Bullet vehicle: HGV

Initial target vehicle: car

Collision type: Rear end - Slow vehicle

Collision summary: On a 4 lane single carriageway bridge. V1 (HGV) was travelling in Lane 1 of 4. The driver had accessed his mobile telephone internet browser and a TV show soundtrack was playing. As the bridge began to end a decent commenced. Ahead of V1, also in Lane 1 was V2 (car). For reasons unknown V2 began to slow at an undetermined rate. V1 driver was looking down as V2 began to slow. V1 driver failed to react, colliding with the rear of V2. V1 came to rest in Lane 1. V2 came to rest in Lane 3. The driver of V2 sustained fatal injuries.

Summary from MTV plot (Figure 7-5): The collision was recorded as happening at 04:08 on the M25 clockwise approaching Junction 1A. The collision is not visible on the plot as it occurred just upstream. There was no sign of a queue before the collision. Traffic flow appears reduced until about 13:30 (9.5 hours).

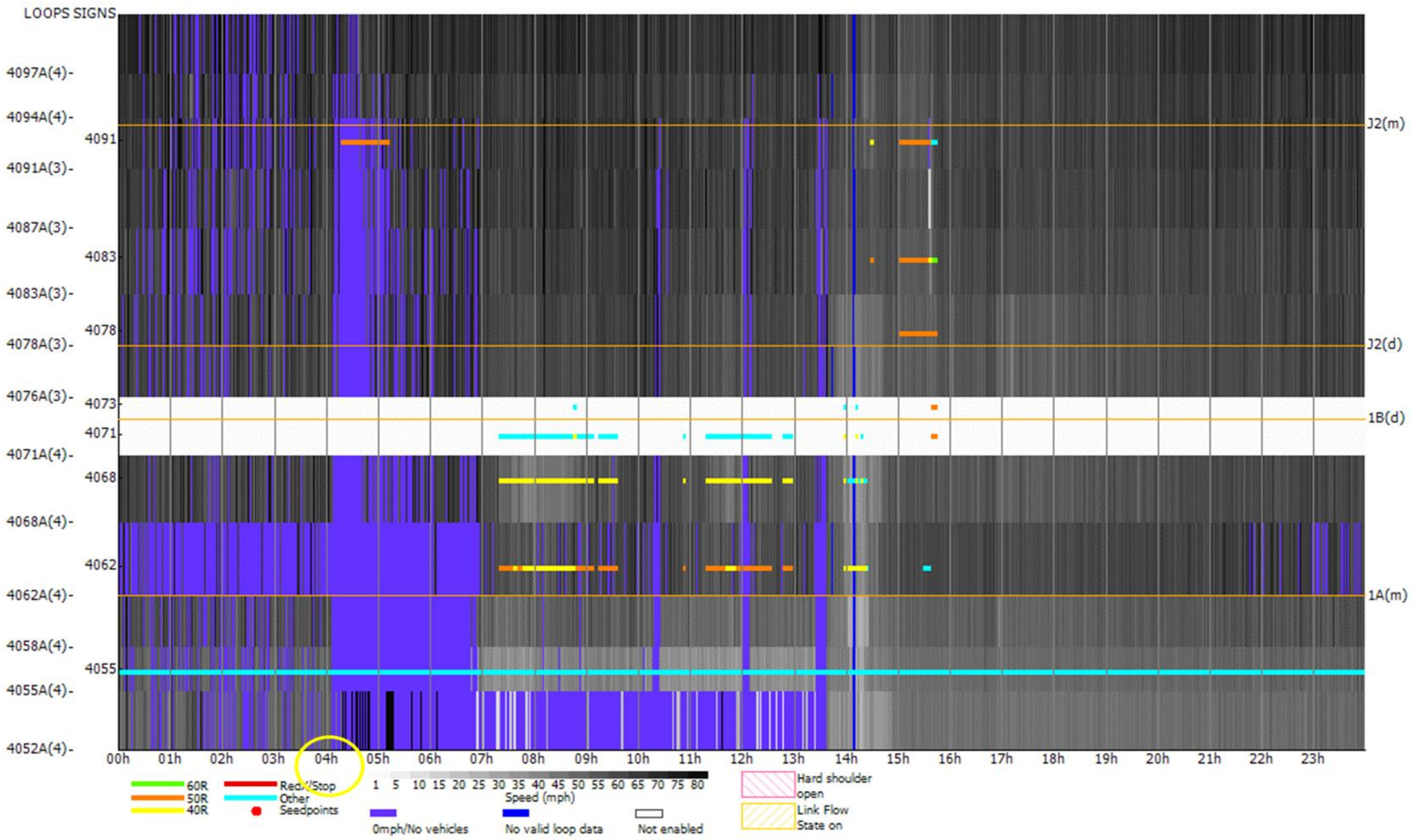

Figure 7-5: MTV plot for case 64 – M25 clockwise carriageway

Case number 65

Bullet vehicle: HGV

Initial target vehicle: LGV

Collision type: Rear end - Other

Collision summary: Raised managed motorway network bordered by concrete bridge parapets with a metal barrier on top. Each direction of travel had 4 lanes including a part time hard shoulder. While the motorway was in "All Lanes Running" V2 (LGV) broke down and stopped in what is referred to as Lane Below Signal (LBS) 1 - this would normally be the hard shoulder. The driver alighted V2 and went to the front of the vehicle. V1 (HGV) also travelling in LBS 1 failed to notice stationary V2 with sufficient stopping time and commenced emergency braking and steering to the offside. V1's front nearside collided with the rear offside of V2. V2 was shunted forward impacting V2's driver causing fatal injuries. V2 came to rest further down LBS 1. V1 came to rest approximate 130 meters down the carriageway in LBS 1.

Summary from MTV plot (Figure 7-6): The collision was recorded as happening at 09:13 on the M6 southbound between Junction 5 and 6. The plot shows that the dynamic hard shoulder was open at the time of incident. The carriageway was busy in all lanes and traffic was travelling around the 60mph speed limit. Post-collision lanes 1,2 and 3 were closed and traffic continued slowly in lane 4.

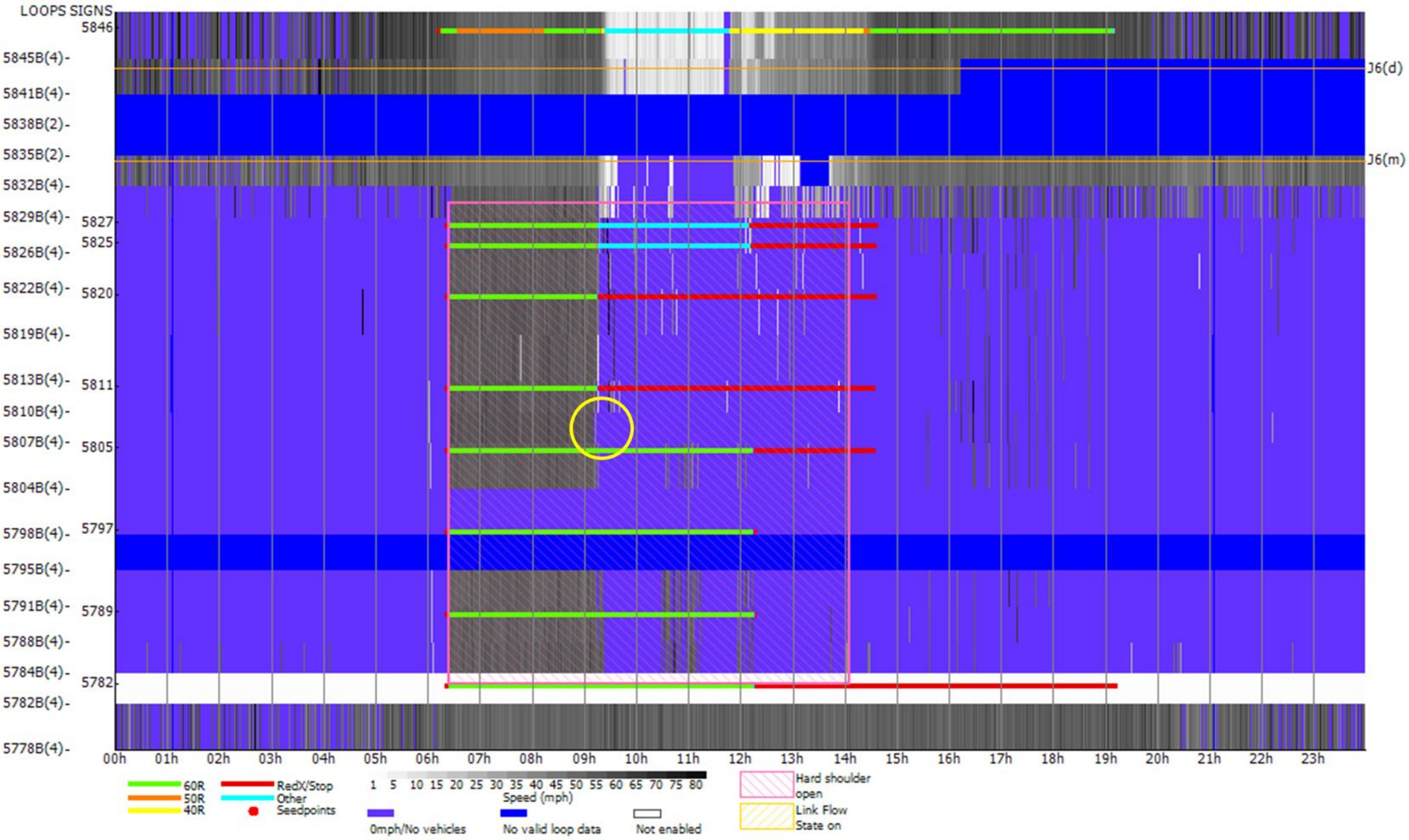

Figure 7-6: MTV plot for case 65 – M6 southbound carriageway

Case number 69

Bullet vehicle: HGV

Initial target vehicle: car

Collision type: Rear end - Queue

Collision summary: On straight section of rural 70mph 3-lane motorway. V1 (HGV) travelling in lane 1 approaching slow moving or stop/start queuing traffic for slip road off at 48mph. Driver failed to react to presence of numerous warning signs and reduced speed advisory signs saying he had not seen any of them. When 14m from rear of V2 (car), V1 applied emergency braking. V1 collided with the rear of V2. V2 was shunted forward into the rear of V3 (car). V2 & V3 whilst stuck together were shunted into the rear of V4 (car) before V2 & V3 entered the hard shoulder; V3 came to rest against the NS barrier. V4 was then struck again by front of V1 to its NS as it rotated ACW. The rear of V5 (car) appears to have been struck by the front of V1 shunted into the rear of V6 (car), V6 was shunted into the rear of V7 (car) at low speed. V1 came to rest astride L1 & L2. V4 came to rest astride L2 & L3. V6 & V7 came to rest in L1. Vision ahead obscured from point of view of V1 by internal objects; multiple braking faults present on V1 which may have contributed to secondary impacts but not initial cause of accident. The driver of V3 and the FSP of V2 were fatally injured.

Summary from MTV plot (Figure 7-7): The collision was recorded as happening at 08:27 on the M5 southbound between Junction 25 and 26. From about 08:15 (a few minutes before the accident) traffic in lane 1 was queuing, probably for the diverge. There was a large speed differential between the lanes with averages of 14mph, 57mph and 68mph recorded in lanes 1,2 and 3 at 08:18 at 9056/A. The plot shows that the lane (and in fact whole carriageway) was closed following the incident for approximately 5.5 hours and signals set (the turquoise line is the ‘end’ signal downstream of collision).

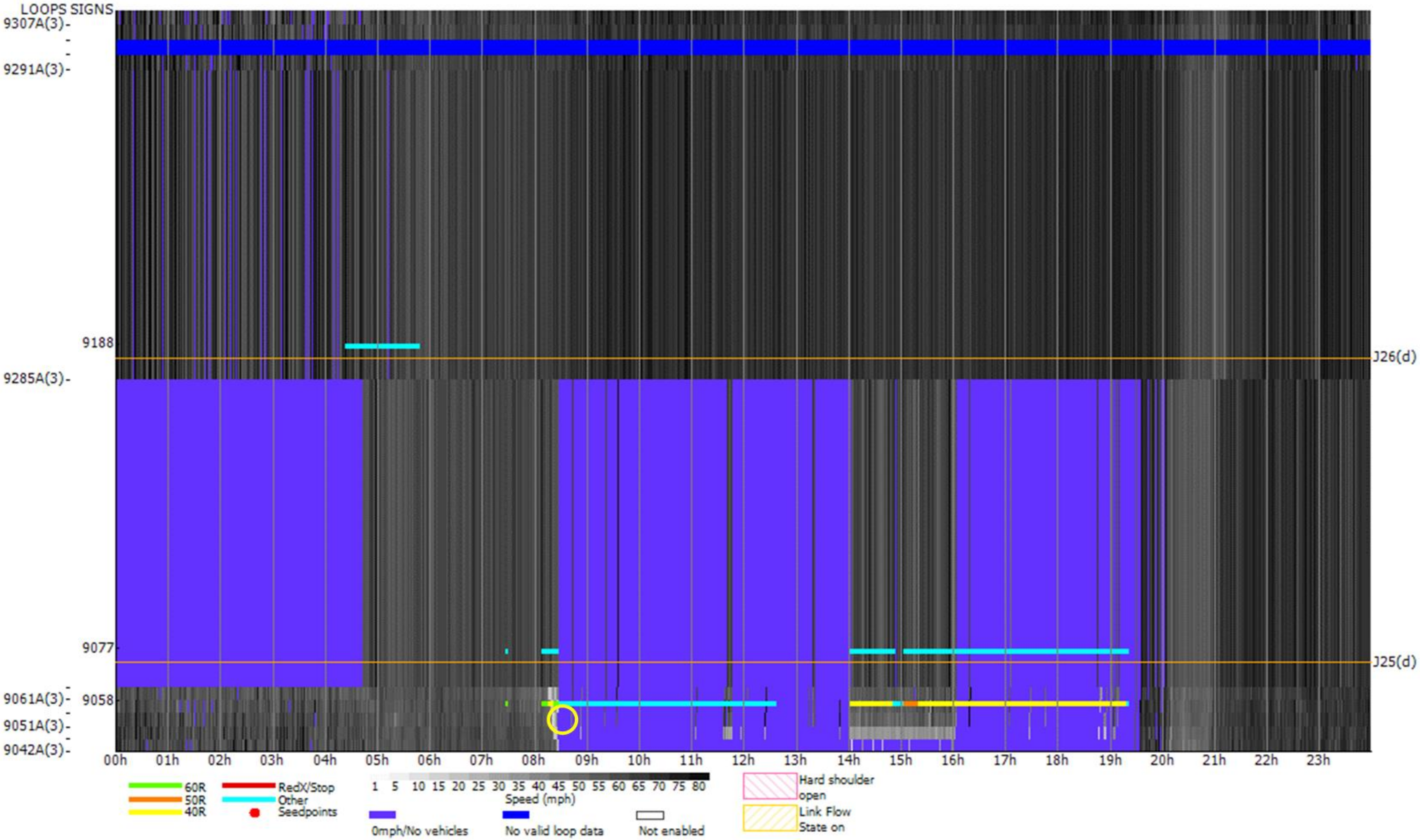

Figure 7-7: MTV plot for case 69 – M5 southbound carriageway

HGV and LGV frontal shunts on the Strategic Road Network

One of the most common collision types identified for commercial vehicles on the Strategic Road Network (SRN) is frontal shunt collisions, where the front of the HGV or LGV impacts the rear of another vehicle. This project aims to understand the root causes of these collisions (Phase 1 – this report) and identify countermeasures or interventions which could help to prevent them in the future (Phase 2). The causes identified span a number of categories: a large proportion of the causes relate to the behaviour of the HGV/LGV drivers, but other factors including the vehicles, other road users, the road/environment and organisational factors also play their part.

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