# ANALYSIS OF ACCIDENTS INVOLVING LIGHT COMMERCIAL VEHICLES IN THE UK

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## ABSTRACT

In 2002, light commercial vehicles (LCV) with a gross vehicle weight (GVW) less than 3500kg accounted for 11.3% of motorised road traffic (in terms of billion vehicle kilometres travelled) in the UK, a steady increase from 10.0% in 1992.

The UK Department for Transport (DfT) commissioned TRL to carry out the Heavy Vehicle Crash Injury Study (HVCIS), which is a multi-disciplinary study into heavy vehicle safety. One part of this project is research into fatal accidents involving LCVs, in order to determine the causes of LCV accidents and to begin to identify cost-effective countermeasures that could improve safety for accidents involving this type of vehicle.

Between 1995 and 1998, there were a total of 1,221 fatal accidents involving LCVs recorded in the UK. TRL obtained and analysed the police accident reports for 43% of these fatal accidents. Data taken from the police reports for analysis included loading details, load movement, vehicle condition, journey purpose and accident causation. Impact details were also coded, using a modified form of the SAE Collision Deformation Classification system.

The report presents the analysis of the data from the completed LCV part of the Heavy Vehicle Crash Injury Study and investigates the types of accident involving these classes of vehicle and the road users at most risk of injury. Factors such as vehicle defects and driver behaviour are also reviewed. Suggestions are made where changes in vehicle design could have the potential to reduce the number and/or severity of LCV accidents and associated injury risk, including both primary and secondary aspects.

## INTRODUCTION

There is anecdotal evidence to suggest that there has been an increase in the use of LCVs possibly because of increased home delivery and internet shopping. National transport statistics show that in 1993, LCVs accounted for 10.1% of the road traffic in the UK. By 2003, this had steadily increased to 11.8% [1]. LCV traffic increased by 39% in comparison with a 19% increase in all traffic [1].

The aim of this paper is to analyse the involvement of LCVs in accidents and identify possible cost effective countermeasures that can be implemented to reduce the number of casualties resulting from LCV accidents. The trends for accidents involving LCVs are introduced and an analysis of fatal accidents is described. Potential countermeasures to avoid and reduce the severity of accidents are discussed.

It should be noted that the views expressed in this paper are the views of the authors and not necessarily those of the UK Department for Transport.

## ACCIDENT TRENDS 1993-2003

Data from the UK national road accident database (STATS19) has been obtained and analysed for accidents that occurred between 1993 and 2003 inclusive. The analysis considered accidents that involved at least one LCV. The accident sample contained data relating to 196,128 accidents involving 419,879 vehicles and 275,829 casualties.

Figure 1 shows how the accident rate for all vehicles and LCVs has changed during the ten year period 1993 to 2003.

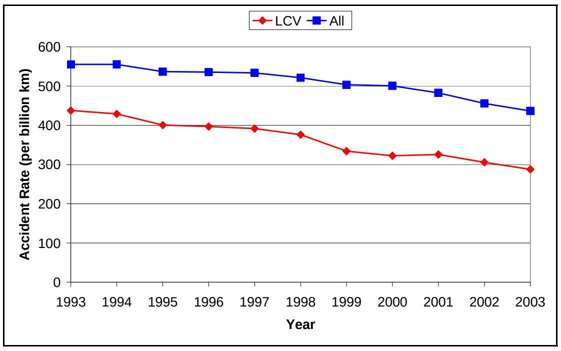


**Figure 1**. **Trend in accident rate for all accidents and those involving LCVs, 1993-2003 (STATS19)**.

Figure 1 shows that there has been approximately a 43% reduction in the accident rate for accidents involving LCVs between 1993 and 2003. Over the same period, the accident rate for all vehicles has reduced by 21%.

Figure 2 shows the trends in casualty rates for fatal and killed or seriously injured (KSI) road users for accidents involving LCVs. The data for all road casualties are shown for comparison.

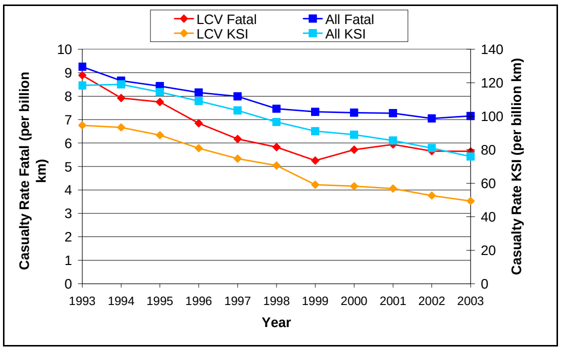


**Figure 2. Fatal and KSI casualty rates for all road users and those injured in accidents with LCVs, 1993-2003 (STATS19)**

Figure 2 shows that the casualty rates have reduced for both fatal and KSI casualties in all accidents by 23% and 36% respectively. For casualties caused in accidents involving LCVs, the casualty rates have also reduced. The fatality rate reduced by 37% and the KSI rate reduced by 48% over the 10 year period. However, since 1999 the fatality rate for accidents involving LCVs has risen or stayed constant contrary to other trends.

During the period 1993 to 2003, LCVs were involved in an average of 7.7% of all accidents. However, an average of 9% of all fatalities resulted from accidents involving an LCV. This data shows that although the LCV accident rate has decreased more than for accidents involving all vehicle types, LCVs are involved in a higher proportion of fatal accidents than average.

Figure 3 shows the percentage of vehicle types that were involved in accidents of all severities with LCVs.

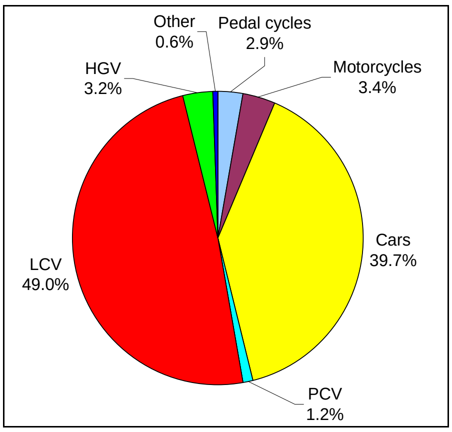


**Figure 3. Percentage of each vehicle type involved in LCV accidents (STATS19)**

The most frequent type of vehicle involved in these accidents are LCVs, 49%. This is to be expected because at least one LCV has to be involved in the accident for it to be considered in the analysis. The LCV involvement is less than 50% because some accidents will involve multiple opponent vehicles. The second most frequent type of vehicle involved in accidents with LCVs are cars, almost 40%. There are significantly more cars involved than other types of vehicle, excluding LCVs. This is probably because cars comprise 80% of the vehicle fleet [1] and therefore the chance of the collision partner being a car is high.

Figure 4 shows the percentage of each vehicle type that are involved in LCV accidents that result in a fatality.

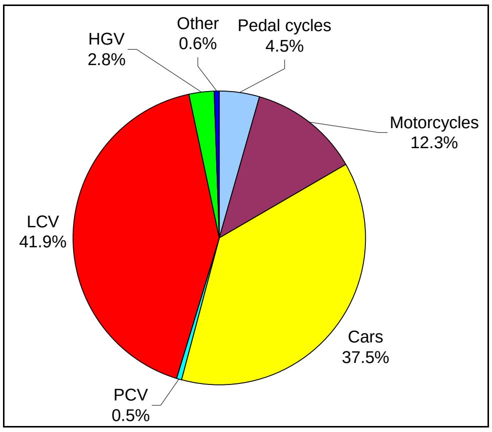


**Figure 4. Percentage of each vehicle type involved in fatal LCV accidents (STATS19)**

The most significant difference between the vehicles involved in accidents of all severities and those involved in fatal accidents is the number of motorcycles involved. When only fatal accidents are considered, motorcycles account for over 12% of the vehicles involved, whereas they account for less than 4% of vehicles involved in accidents of all severities. Motorcycles are over-represented in fatal accidents, which may be because of the vulnerability of the motorcyclists.

There were a total of 275,829 casualties, 3,497 of which were fatal and 34,279 serious. The distribution of road users casualties are shown in Figure 5.

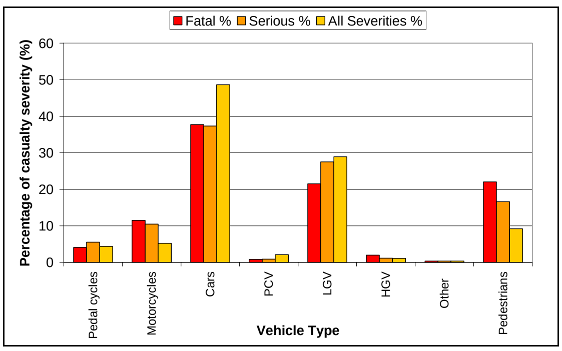


**Figure 5. Distribution of road user casualties by severity**

The most frequently injured road users in accidents involving LCVs are car occupants (49%) followed by LCV occupants (29%) and pedestrians (9%). Car occupants are also the most frequently killed road users, accounting for 38% of the fatalities.

Pedestrians and LCV occupants are the second and third most frequent road user killed, accounting for 22% and 21.5% of the fatalities, respectively. The proportion of motorcyclists, car occupants, HGV occupants and pedestrians that are fatally injured is higher than those that are seriously injured. Vulnerable road users, particularly pedestrians and motorcyclists are at a proportionately greater risk of serious or fatal injury when compared with all severities. This observation relates to their lower level of protection compared with other road users.

## ANALYSIS OF FATAL ACCIDENT DATA

The HVCIS fatals database contains data from accidents involving LCVs, heavy goods vehicles (HGVs), passenger carrying vehicles (PCVs) and vehicles classed as “Other Motor Vehicles” (OMVs).Early population of the database was focused on LCV accidents and contains 27% of the fatalities in STATS19 for that period resulting from LCV accidents. Later releases of the database only include LCVs that are involved in accidents with the other types of vehicle which are of interest (HGVs, PCVs etc.) and so the data for LCVs may be skewed to accidents with larger vehicles. This analysis has been carried out on the first release (phase 1a) of the database to minimise this sampling bias.

### Assessment of countermeasures and emerging technologies

For each accident studied, a judgement was made as to whether any modifications to the design of the LCV might have enabled it to avoid the collision or reduce the severity of injuries to non-fatal. In making this judgement many factors had to be taken into consideration including closing speed, road surface conditions, available space for avoiding action, seatbelt use, as well as the age and health of fatality. The nature of this judgement can be rather subjective, therefore a probability scale was used with each countermeasure being marked as “quite likely”, “probably”, or “maybe” avoiding the accident. To determine an estimate of the benefits of the countermeasures that have been identified non statistical probabilities were assigned to each countermeasure. These were 1.0 to the “quite likelies”, 0.75 to the “probables”, and 0.25 to the “maybes” to produce a subjective best estimate of the likely benefits.

The countermeasures that are assessed include a number of emerging and recently developed technologies that might, if they work, prevent or reduce the severity of some types of accident and subsequently injury. These technologies include collision avoidance, lane following and ABS.

Making the assumption that these new technologies can be made to work reliably, TRL has reviewed the accident cases and attempted to predict the savings that might be achieved by using them. In some cases theoretical systems are considered with specific information about how they work. Examples of when such technologies should be coded are:

- Where an LCV driver suffers a lack of attention or falls asleep and fails to notice slow moving or stationary vehicles ahead. The theoretical collision avoidance system will only avoid the accident if the vehicle ahead was in view long enough for the LCV to brake to a standstill (or to the same speed as the vehicle ahead). The system will not avoid accidents where a vehicle pulls across its path at the last minute or where vehicles travelling in the opposite direction move across to the wrong side of the road and collide head-on, and it will be unable to steer the vehicle in any way. The system considered was not able to detect pedestrians or pedal cyclists.
- Where a vehicle for some reason leaves the lane in which it was travelling and collides with a vehicle in the on-coming lane, the lane following system is coded. This is not appropriate if a sharp steering input causes the vehicle to leave its lane.

### Vehicle involvement

Figure 6 summarises the percentage of each vehicle type involved in LCV accidents in the HVCIS fatal accident database.

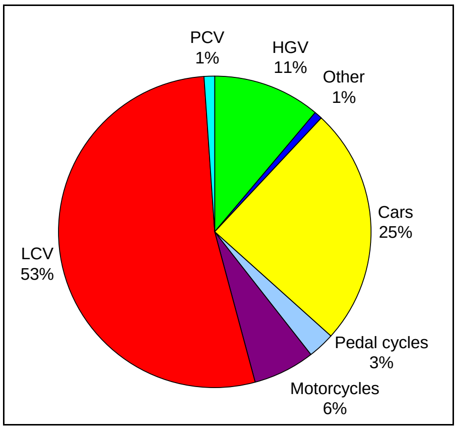


**Figure 6. Vehicles involved in fatal LCV accidents (HVCIS)**

Figure 6 can be compared with Figure 4 to show how representative the HVCIS data is of the national statistics. This comparison shows that LCVs account for a greater percentage of vehicles involved in the accidents. This may indicate that there are cases in HVCIS where more than one LCV is involved and less accidents where there was more than one other vehicle involved. There is also a higher proportion of HGVs and a lower proportion of cars and motorcycles, which may be a function of the cases that were available for analysis. This information should be considered when estimating potential benefits.

**Accident causation factors**

There are a number of factors that can influence the cause of accidents. Two of these include the vehicle drivers and the roadworthiness of the vehicles involved. The following sections describe these factors for the LCVs, drivers and fatalities involved in accidents in the sample.

**Vehicle defects**

It is reasonable to hypothesise that vehicle defects can be related to the age of the vehicle. Figure 7 shows the distribution of LCVs by year of registration.

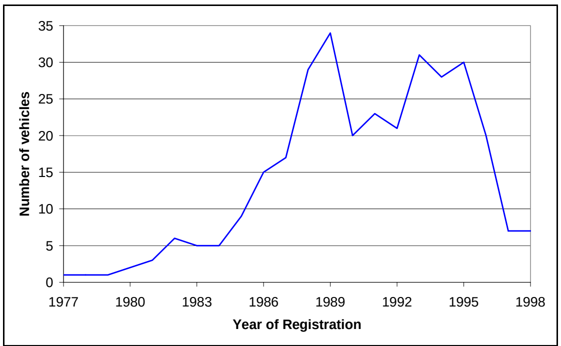


**Figure 7. Year of registration of LCVs involved in fatal accidents (HVCIS)**

The number of LCVs involved in fatal accidents that were registered before 1984 is low. Most of the LCVs involved were registered between 1984 and 1997. The number of vehicles registered in 1998 is very low because this is the upper boundary for the year in which the accident took place.

There were a total of 54 defects on LCVs involved in fatal accidents. Twelve, 22%, of the defected vehicles were considered to have contributed to the accident. There were eight vehicles with contributory tyre defects. These vehicles were registered between 1985 and 1994. Five of the tyre defects were because of lack of maintenance. One defect was because of previous impact damage, one was caused by a structural defect and one by faulty maintenance. There were also three brake defects that contributed to the accidents registered in 1983 and 1985, two through lack of maintenance and one caused by faulty maintenance. There was also one accident where the wing mirror was incorrectly repaired preventing it from springing out of the way if struck. This data tends to suggest that the vehicle defects are not strongly related to the age of the vehicle, with most of the defects arising from negligence with respect to maintenance. For other vehicles involved in these accidents there were a total of 26 defects, 20% of which were contributory to the cause of the accident.

**Driver factors**

The behaviour of 44% of the LCV drivers was considered to have contributed to the accidents. Lack of attention was the most frequent behaviour and was displayed by 24% of the LCV drivers. Almost 11% of the drivers were driving their vehicles at a speed that was considered unsuitable for the conditions. Five percent of the LCV drivers were suffering from fatigue and a further five percent made errors of judgement. Other driver behaviour factors included, but were not limited to, being under the influence of alcohol or drugs, inexperience, contravening a red light and being overloaded. Some drivers displayed a combination of the above factors.

The actions of 51% of the other drivers involved were considered to have contributed to the cause of the accident. Lack of attention was the most frequent behaviour for theses drivers, 23%, followed by excess speed, 18%, and error of judgement, 14%.

**Factors contributed by the fatality**

In some cases the road user that was fatally injured contributed to the cause of the accident. As with the driver factors, each fatality may display more than one of these behaviours. It was thought that the behaviour of 37% of the fatalities did not contribute to the cause of their accidents. The most frequent behavioural factor was lack of attention, 27% of the fatalities.. Eighteen percent of the fatalities did not wear the seatbelt that was provided and 16% were travelling at speeds that were excessive for the conditions. Other factors included but were not limited to, error of judgement, 9%, being under the influence of alcohol, 7%, and fatigue 3%.

**Casualties**

There were a total of 345 fatalities resulting from accidents involving LCVs. The distribution of fatalities by road user type is shown in Table 1.

**Table 1.**

**Number of accidents and fatalities by road user type killed**

| Road user | Number of accidents | Number of fatalities |
|---|---|---|
| HGV | 3 (1.0%) | 3 (0.9%) |
| LCV | 81 (26.2%) | 89 (25.8%) |
| OMV | 1 (0.3%) | 1 (0.3%) |
| Car | 116 (37.5%) | 140 (40.6%) |
| Motorcycle | 36 (11.7%) | 37 (10.7%) |
| Pedal cycle | 16 (5.2%) | 16 (4.6%) |
| Pedestrian | 56 (18.1%) | 59 (17.1%) |
| Total | 309 | 345 |

The most frequently killed road users were car occupants, 40.5%, LCV occupants, 25.8% and pedestrians, 17.1%. The following sections describe the types of accidents in which these road users were fatally injured and describes possible design improvements to vehicles that may avoid the accidents or reduce the severity of the injuries sustained.

**Car occupant casualties**

There were a total of 140 car occupants that were fatally injured in 118 accidents involving LCVs. For one of these fatalities there was no impact between the car and the LCV. The passenger in the car leant out of the window and struck their head on the back of a parked LCV. This accident has been excluded from further analysis.

The proportion of vehicles that were cars in the HVCIS sample was lower than in the national statistics, therefore it can be assumed that car occupant fatalities are likely to be under-represented. It is therefore possible that any potential benefits from countermeasure identified may be greater than estimated in this analysis.

For the remaining 139 car occupant fatalities the most severe impacts were with the objects shown inTable 2. In some cases the car may have had an impact with an LCV and then collided with a bridge. The impact with the bridge resulted in the fatal injuries and is therefore the most severe impact.

**Table 2.**

**Impact object for most severe impact resulting in car occupant fatalities**

| Impact object | Number of fatalities |
|---|---|
| LCV | 118 (84.9%) |
| HGV | 7 (5.0%) |
| PCV | 1 (0.7%) |
| Other vehicle | 9 (6.4%) |
| Wide object | 1 (0.7%) |
| Narrow object | 3 (2.2%) |
| Rollover | 1 (0.7%) |
| Total | 139 |

The objective of the reported research was to consider design changes to LCVs that could reduce the number of people injured in accidents involving LCVs and the severity of injuries. Therefore fatalities caused by impacts with objects that are not LCVs are excluded from further analysis.

The following analysis considers car to LCV accidents where this impact was the most severe for both vehicles. There are 115 of these impacts because three of the most severe impacts for the car were not the most severe impact on the LCV.

Table 3. summarises the impact locations on the LCV and car for the most severe impacts between these types of vehicle.

**Table 3.**

**Impact locations for LCV to car impacts**

| Impact location of car | Impact location on LCV | Number of car occupant fatalities |
|---|---|---|
| Back | Front | 2 (1.7%) |
| Front | Back | 5 (4.3%) |
| Front | Front | 46 (40.0%) |
| Front | Near-side | 6 (5.2%) |
| Front | Off-side | 4 (3.5%) |
| Near-side | Unknown | 2 (1.7%) |
| Near-side | Back | 1 (0.9%) |
| Near-side | Front | 28 (24.3%) |
| Off-side | Front | 18(15.7%) |
| Off-side | Off-side | 3 (2.6%) |
| Total | | 115 |

**Front of LCV to front of car**

The most frequent impact configuration is front of car to front of LCV, which accounts for 40% of the car occupant fatalities. Figure 8 shows the closing speed of the two approaching vehicles in this type of accident.

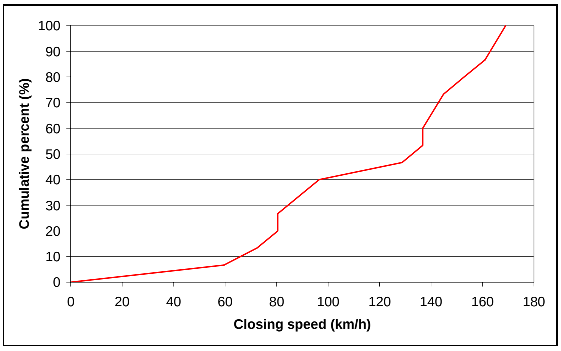


**Figure 8. Closing speed of vehicles in car front to LCV front accidents**

It is clear that very few of these fatalities occur in accidents with low closing speeds. Approximately 10% occur at a closing speed of up to 66km/h, which is the equivalent of each vehicle travelling 33km/h. Almost 60% of the fatalities result from impacts with closing speeds in excess of 100km/h.

The impacts are coded using part of the SAE collision damage classification (CDC) [3]. Figure 9 shows part of the CDC that can be applied to impacts to the front of the vehicle. All codes can be applied to both the front and rear of the vehicle.

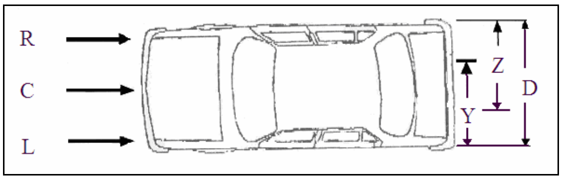


**Figure 9. Part of CDC used for coding impacts**

The observed damage to the vehicles taken from photographs and report was used to assess the part of each vehicle that impacted the other vehicle. Table 4 summarises the four most frequent types of front to front impact damage between cars and LCVs accounting for 63% of these types of accident.

**Table 4.**

**Four most frequent types of front to front impact between cars and LCVs**

| Impact part | | Number of fatalities |
|---|---|---|
| **Car** | **LCV** | |
| D | D | 11 |
| R | R | 8 |
| D | Z | 5 |
| Z | Z | 5 |

The most frequent type of damage seen on vehicles covers the whole of the front of each vehicle. For cars this is most likely to involve a full width impact with the LCV. This would be similar in configuration to a full width full scale crash test into a deformable barrier, which is not currently included in European Regulations or EuroNCAP and is more severe than the 40% overlap that is used. However, the 50th percentile closing speed for accidents of this type is over 130km/h, considerably higher than current test speeds for cars. Also, the LCV is likely to undergo a change in velocity during the impact, which would not occur in a full width barrier test.

Table 5. summarises the potential countermeasures that may avoid accidents or reduce the severity of injuries sustained by car occupants in front to front collision with LCVs.

**Table 5.**

**Summary of countermeasures for LCV front to car front accidents**

| Countermeasure | Estimate of fatality prevention | | |
|---|---|---|---|
| | **Quite likely** | **Probable** | **Maybe** |
| Fit collision avoidance | 2 | | |
| Eliminate defects | 1 | | |
| Fit lane following system | 2 | | 1 |
| Detect drowsy driver | 1 | 1 | |
| Warn of ice | | | 1 |
| Fit rigid FUP | | | 2 |
| Fit energy absorbing FUP | | 2 | |
| Fit ABS | | 1 | |
| Improve LCV to car compatibility | | | 3 |
| Prevent fire | 2 | | |
| Fit automatic fire extinguisher | 2 | | |
| Improve LCV to car compatibility and fit ABS | | 1 | |
| Improve LCV to car compatibility and car frontal crashworthiness | | 1 | |
| Improve LCV to car compatibility and car occupant wears seatbelt | | 1 | |

**Front of LCV to near-side (passenger) of car**

The second most frequent impact configuration was between the front of the LCV and the left side of the car. This type of impact accounts for more than 24% of the car occupant fatalities. There is very limited information about the speed of the vehicles involved in these types of accident. There were three cases where the impact speed of the car was known, two were stationary and one was travelling about 8km/h. There were eight cases where the speed of the LCV was known, which ranged from 40km/h to 64km/h. There were no cases where the impact speed of both vehicles was known. The majority of LCVs, 64%, struck the passenger compartment area of the car. Twenty-one percent of the LCVs caused damage to the rear two-thirds of the car and 11% the front two-thirds of the car. There was one case (4%) where the LCV collided with the bonnet area of the car.

Table 6 summarises the manoeuvres being performed by the two vehicles prior to the accident.

**Table 6.**

**Vehicle manoeuvres prior to impact between front of LCV and left side of car**

| Car | LCV | Number of fatalities |
|---|---|---|
| Turning right | Going ahead other | 4 |
| Waiting to turn right | Going ahead other | 2 |
| Overtaking moving vehicle | Going ahead other | 2 |
| Going ahead on left hand bend | Going ahead on right hand bend | 8 |
| Going ahead on right hand bend | Going ahead on left hand bend | 1 |
| Going ahead on right hand bend | Going ahead other | 3 |
| Going ahead other | Going ahead other | 8 |

For all these fatalities, the LCV was not performing a specific manoeuvre. The majority of the cars, 71%, were also not making a specific manoeuvre. In 30% of the accidents where neither vehicle made a specific manoeuvre, there was loss of steering control under braking for the car.

The most frequently injured car occupants were drivers, 43%. Front seat passengers, which were positioned on the struck side of the vehicle, accounted for 34% of the car occupant fatalities. All of the impacts that resulted in front seat passenger fatalities were to the passenger compartment or the front two-thirds of the vehicle structure, including the passenger compartment. The larger number of drivers fatally injured, when they were impacted on the non-struck side is possibly a reflection of vehicle occupancy, which was 1.60 for the period 1996/1998 [4]. Where the use of seatbelts is known, 55% of drivers and 86% of front seat passengers were wearing the seatbelts provided. The figure for front seat passengers excludes the occupant of a child restraint. There were also six rear seat occupants, three on the struck side, one in the centre and two on the non-struck side. One of the rear nearside and one rear offside occupant were wearing seatbelts.

The only countermeasures identified to be applied to the LCV involved were to fit a lane following system or to prevent the vehicle being driven under the influence of alcohol. Fitting a lane following system would probably have prevented one accident that resulted in two fatalities. Preventing the LCV from being driven under the influence of alcohol would have been quite likely to have prevented the same accident and fatalities.

**Front of LCV to off-side (driver) of car**

Impacts between the front of the LCV and the right side of the car were the third most frequent type of accident that resulted in car occupant fatalities, accounting for almost 13% of the fatalities. The location of the impact was mostly in the area of the passenger compartment or bonnet, 78%. Fifty-six percent of these accidents occurred when the car was turning right and the LCV was not making a specific manoeuvre. This combination was by far the most frequent. All the car occupants that were fatally injured were drivers, who were on the struck side of the vehicle. Where the seatbelt use was known, 85% were being used. Where the fitment of airbags was known, there were no side airbags fitted.

The analysis of countermeasures for accident avoidance and reduction of the severity of injuries to non-fatal for this type of accident are summarised in Table 7.

**Table 7.**

**Summary of countermeasures for LCV front to car off-side accidents**

| Countermeasure | Estimate of fatality prevention | | |
|---|---|---|---|
| | Quite likely | Probable | Maybe |
| Fit ABS | | 1 | |
| Fit lane following system | | 1 | |
| Fit lane following system and detect drowsy driver | 1 | | |
| Detect drowsy driver | | 1 | 1 |
| Improve LCV to car compatibility | | | 2 |
| Remove bull bars | | 1 | |

**LCV occupant casualties**

LCV occupants were the second most frequently killed road users in accidents that involved LCVs.

There were a total of 89 LCV occupant fatalities in the sample. Analysis of the ownership of the LCV involved in the accidents showed that where the ownership was known, 68% were being driven by an employee, 26% by the owner and 6% by someone who had hired the vehicle. Sixty percent of the LCVs involved these accidents were used for trade, 20% for delivery, 17% for roadside assistance and 3% for personal use.

In two of the accidents the LCV did not have an impact with another vehicle or object. One passenger fell from the vehicle whist trying to secure the door and the second fell from the tipping body of the LCV. Both of these accidents could have been prevented, the first one if the passenger had been wearing their seatbelt or if the vehicle had pulled over to allow them to secure the door, and the second fatality would have been prevented if they had not been riding in an unauthorised position. These cases have been excluded from the following analysis.

**Impact location**

Table 8 shows the impact location on the LCV for the remaining 87 fatalities.

**Table 8.**

**Impact location of most severe impact on LCV resulting LCV occupant fatality**

| Impact location | Number of fatalities |
|---|---|
| Back | 3 (3.5%) |
| Front | 52 (59.8%) |
| Left | 10 (11.8%) |
| Right | 21 (24.1%) |
| Top | 1 (1.2%) |
| Total | 87 |

Almost 60% of these 87 LCV occupant fatalities were injured during an impact to the front of the LCV. The objects that the front of the LCVs stuck are shown in Table 9.

**Table 9.**

**Struck objects for LCV frontal impacts**

| Struck object | Number of fatalities |
|---|---|
| Animal | 1 (1.9%) |
| Narrow object | 5 (9.6%) |
| Wide object | 6 (11.5%) |
| HGV | 26 (50.0%) |
| LCV | 2 (3.8%) |
| OMV | 1 (1.9%) |
| PCV | 5 (9.6%) |
| Car | 6 (11.5%) |
| Total | 52 |

Half of the LCV occupant fatalities were caused by impacts with an HGV. Wide objects were the second most frequent impact object resulting in an LCV occupant fatality.

Although there are many more cars registered in the UK than HGVs, a higher proportion of LCV fatalities are sustained in impacts with HGVs compared with cars. This is because of the difference in mass of the collision partners. An impact between a car and an LCV is less likely to result in an LCV fatality because the LCV is heavier than the car, whereas the HGV is much heavier than the LCV and so is more likely to result in an LCV occupant fatality.

**Front of LCV to front of HGV**

For impacts between the front of the LCVs and HGVs, 48% of the impacts were to the front of the HGV. The closing speed for the vehicles was known in five cases and ranged from 64km/h to 156km/h. In two of these cases the LCV under-ran the front of the HGV, in one case the closing speed was estimated to be 88km/h and in the other it was 153km/h.

For the majority, 83%, of front to front accidents, both the LCV and the HGV were not performing a specific manoeuvre. In the two remaining accidents the HGV was also not making a specific manoeuvre. The LCVs in these two cases were waiting to turn right and held up.

Table 10 summarises the assessed countermeasurs for LCV front to HGV front impacts.

**Table 10.**

**Summary of countermeasures for LCV front to HGV front accidents**

| Countermeasure | Estimate of fatality prevention | | |
|---|---|---|---|
| | Quite likely | Probable | Maybe |
| Fit collision avoidance | 1 | | |
| Fit lane following system | | 4 | |
| Detect drowsy driver | 1 | 2 | 1 |
| Fit lane following system and detect drowsy driver | 1 | | |
| Improve frontal crashworthiness | | | 1 |
| Wear seat belt | | | 5 |
| Wear seat belt and fit airbag | | 3 | 2 |
| Improve LCV to HGV compatibility – rigid FUP | | 1 | |
| Improve LCV to HGV compatibility – energy absorbing FUP | 1 | | |
| Improve LCV to HGV compatibility – energy absorbing FUP and improve LCV frontal crashworthiness | | | 1 |
| Improve frontal crashworthiness and wear seat belt | | 1 | |

**Front of LCV to rear of HGV**

Forty-four percent of the LCV frontal impact occupant fatalities were caused when the LCV struck the rear of an HGV. The closing speed was known for six of the 11 fatalities and ranged from 25mph to 60mph. In three of the cases where the closing speed was known, the LCV under-ran the HGV despite a rigid rear underrun guard being fitted. There was also one case where there was no rear underrun guard fitted. There was also underrun in the five cases where the closing speed was not known. The HGV was fitted with a rear underrun guard in four of the accidents.

In accidents where the LCV struck the rear of the HGV, two of the LCVs were changing lane to their left. They collided with one HGV that was starting off from stationary and another HGV that was not making any specific manoeuvre. The remaining nine LCVs were not making any particular manoeuvre.  There were four cases where the LCV struck an HGV that was parked and two cases where the HGV was held up. The three remaining HGVs were stopping, overtaking a moving vehicle or not making a specific manoeuvre.

Table 11 summarises the countermeasures considered for impacts between the front of an LCV and the rear of an HGV.

**Table 11.**

**Summary of countermeasures for LCV front to HGV rear accidents**

| Countermeasure | Estimate of fatality prevention | | |
|---|---|---|---|
| | Quite likely | Probable | Maybe |
| Prevent LCV being driven by someone who is under the influence of alcohol | 2 | | |
| Fit ABS | | 1 | |
| Detect drowsy driver | | 1 | |
| Fit collision avoidance system | 1 | 3 | |
| Improve frontal crashworthiness | | | 1 |
| Improve frontal crashworthiness and fit airbag | | | 1 |
| Improve frontal crashworthiness and minimum regulatory rear underrun guard on HGV | | 1 | |
| Wear seat belt | | | 1 |
| Wear seatbelt and minimum regulatory rear underrun guard on HGV | | 1 | |
| Wear seatbelt and rear underrun guard on HGV that is stronger and lower | | 1 | 1 |
| Wear seatbelt and energy absorbing rear underrun guard on HGV | 1 | | 1 |

### Use of seatbelts

Of the 87 LCV occupant fatalities, 78% were driving the vehicle at the time of the accident. The use of the seatbelt was known for 84% of the drivers. Where the seatbelt use was known, 63% were not using the seatbelt provided. Therefore approximately only 50% were wearing seatbelts

Seventeen (20%) of LCV occupant fatalities, were front seat passengers. The use of seatbelts was known for 13 (76%) of the passengers. Where the use of the seatbelt was known, ten (77%) of the passengers were not wearing a seatbelt.

Of the two LCV occupants sitting in "other" seat positions (as coded in the database) one was not using the lap belt provided. The status of the second occupant was unknown. The rear-offside passenger was sitting on a wooden bench behind the driver that was not fitted with a seatbelt.

The low seatbelt wearing rate in this data could indicate that a substantial benefit may be gained from installing seatbelt warning systems in LCVs and the encouragement of seat belt use.

### Load movement

There were no cases where the load was known to have moved prior to impact. There were 18 cases where the load moved after the impact. In ten of the cases the load was shed and in the remaining eight cases the load shifted.

In the cases where the load was shed, it was known that this caused injury in one case and not in eight cases. In the remaining case it was not known if the load being shed caused injury.

Of the eight cases where the load shifted, this lead to injury in two cases. In one of these cases the LCV was 8% overweight with fruit and vegetables. In the second, the load was insecure and caused the driver to be trapped between their seat and the steering wheel. There were four cases where it was known that the load shift did not cause injury and two where it is not known.

The comparison of the HVCIS sample with the national statistics showed that HGVs were over-represented in the HVCIS data. Therefore it is possible that the estimated benefits within this study of protecting LCV occupants in impacts with HGVs may actually be lower than predicted.

### <u>Pedestrian casualties</u>

Pedestrians were the third most frequent type of road user that was fatally injured, accounting for just over 17% of fatalities resulting from accidents involving LCVs. The majority of pedestrians, 76%, were fatally injured when struck by the front on an LCV. Twelve percent had an impact with the left side and 8% with the back of the LCV.

For impacts to the front of the HGV, 73% of the LCVs were not making any specific manoeuvre. The remaining 27% were turning right, parked or overtaking on the nearside or offside

The impact speeds for LCVs in a frontal collision with a pedestrian are shown in Figure 10.

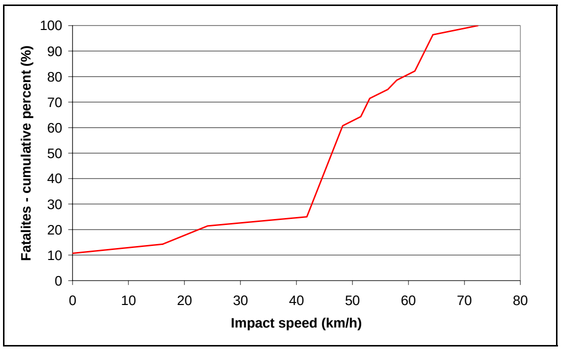


**Figure 10. LCV impact speed for frontal impacts with pedestrians**

Figure 10 shows that for approximately 25% of the pedestrian fatalities occur at impacts speeds of up to 40km/h for the LCV, which is the speed used for pedestrian tests for cars in EuroNCAP. For approximately 60% of the pedestrians that are struck by the front of the LCV, the LCV is travelling at 50km/h or less. The sharp increase in fatalities between 40km/h and 50km/h may be because the impact speed is taken from police records, based on eye witness accounts and reconstructions.

The most frequently selected countermeasure for impacts to the front of the LCV was to improve the design of the LCV to be less injurious to pedestrians, 26%. It was estimated that designing the front of an LCV to be less aggressive to pedestrians was quite likely to have reduced the severity of injuries for one pedestrian, probably would have prevented two pedestrian fatalities and may have prevented a further eight fatalities. The majority of the remaining countermeasures to help protect pedestrians, 48%, related to changes in the environment and the conspicuity of the pedestrians.

There were seven fatalities caused when the pedestrian collided with the left side of the LCV. Four of these fatalities were caused by an impact with the mirror on the LCV. Moving the mirrors on the LCV was considered to have quite likely prevented three of these fatalities and probably prevented one other. Making the mirrors compliant to pedestrian impact could probably reduce the severity of injuries for one of the pedestrians and may have reduced the severity for one other.

There were five fatalities where the pedestrian struck the rear of the LCV. In four of the accidents, the vehicle was reversing. In the fifth accident, the vehicle was parked and rolled back down a hill. Assessment of potential countermeasures for these accidents suggests that improving the rear vision for the driver of the LCV was considered to have quite likely prevented three of the fatalities. Improving rear vision on the LCV may have prevented one other fatality, but in conjunction with an audible reversing alarm was quite likely to have prevented the fatality.

## DISCUSSION

The preceding analysis has presented the findings of a study of fatal accidents involving LCVs from the period 1995 to 1998. The HVCIS database contains 36% of the fatalities that resulted from accidents involving LCVs identified in the national statistics.

### HVCIS estimate of benefits

Table **12** summarises the LCV based countermeasures and the best estimate of benefits. The six most effective countermeasures identified are shown in red. These estimates were made from consideration of the accident cases on a case by case basis. The estimated benefits relate to the number of fatalities which may be prevented for the four year period covered by the sample. The number of fatal savings is calculated using the equation below:

Number of fatal savings = (quite likely x 1) + (probably x 0.75) + (maybe x 0.25)

**Table 12.**
**Summary of LCV based countermeasures for HVCIS sample**

| Counter-measure | Estimate of fatality prevention | | | Number of fatal savings |
|---|---|---|---|---|
| | Quite likely | Probable | Maybe | |
| Fit lane following | 2 | 6 | | 6.5 |
| Fit ABS | 1 | 8 | 1 | 7.25 |
| Detect drowsy drivers | 2 | 6 | 1 | 6.75 |
| Eliminate defects | 1 | | 1 | 1.25 |
| Warn of ice | | | 1 | 0.25 |
| Prevent drink driving | 4 | | | 4.0 |
| Fit collision avoidance system | 3 | 4 | 5 | 7.25 |
| Prevent puncture | 1 | | | 1.0 |
| Fit intelligent speed limiter | | 1 | 1 | 1.0 |
| Monitor tyre pressure | | | 1 | 0.25 |
| Pedestrian friendly front | 1 | 2 | 8 | 4.5 |
| Wear seatbelt | | | 6 | 1.5 |
| Improve frontal crashworthiness | | | 3 | 0.75 |
| Improve LCV-car compatibility | | | 5 | 1.25 |
| Fit fire extinguisher in engine bay | 1 | | | 1.0 |
| Improve rear vision | 3 | | 3 | 3.25 |
| Improve rear vision and fit reversing alarm | 1 | | | 1.0 |
| Move mirrors – accident avoidance | 3 | 1 | | 3.75 |
| Make mirrors more compliant with pedestrian impacts | | 1 | 1 | 1.0 |
| Improve lighting | | 1 | | 0.75 |
| Remove bull bars | | 1 | | 0.75 |
| Prevent fire | 1 | | | 1.0 |
| Improve frontal crashworthiness + other | | 4 | 3 | 3.75 |
| Wear seatbelt + other | 1 | 6 | 4 | 6.5 |
| Improve compatibility + other | 1 | 1 | | 1.75 |
| Pedestrian friendly front + other | | | 1 | 0.25 |

There is currently no European Directive on the frontal impact protection for LCVs. Improving the frontal crashworthiness of the LCV alone was not considered to be one of the most beneficial countermeasures. However when combined with other countermeasures such as wearing the seatbelt and fitting an airbag, the benefits are substantially increased.

**Estimate of national benefits**

The HVCIS data sample contained an average of 86.25 fatalities per year. This figure has been used to estimate the annual benefits within the sample. These benefits can then be applied to the national figures to estimate the annual benefit of each countermeasure for the UK. The total number of fatalities resulting from LCV accidents in 2003 was 327. This figure has been used to estimate national benefits for the six countermeasures highlighted in the HVCIS sample, that showed the greatest potential benefits in Table 13.

**Table 13.**

**Estimated annual national benefits in terms of prevention of fatalities in the UK**

| Counter-measure | Estimated benefits in sample | Estimated benefits per year (HVCIS) | Estimated benefits per year (UK) |
|---|---|---|---|
| Fit lane following | 6.5 | 1.6 (1.9%) | 6.2 |
| Fit ABS | 7.25 | 1.8 (2.1%) | 6.7 |
| Detect drowsy drivers | 6.75 | 1.7 (2.0%) | 6.5 |
| Fit collision avoidance system | 7.25 | 1.8 (2.1%) | 6.7 |
| Pedestrian friendly front | 4.5 | 1.1 (1.3%) | 4.3 |
| Wear seatbelt + other | 6.5 | 1.6 (1.9%) | 6.2 |

The most beneficial countermeasures are ones that prevent the accident occurring. If successful, all costs associated with the accident would be eliminated. It is also suggested that such countermeasures may also reduce the severity of some accidents.

Sixty-three percent of LCV drivers and 77% of LCV passengers were not wearing a seatbelt at the time of their accidents. In Table **12** the benefit of wearing the seatbelt was assigned low probability of preventing fatalities. This is usually because of the severity of the impact causes large amounts of intrusion and no airbags. However, wearing the seatbelt in combination with some other countermeasures was considered to provide greater benefits than just a seatbelt, i.e. seat belt and air bag. The other countermeasures included, improving frontal crashworthiness of the LCV, fitting an airbag in the LCV and fitting energy absorbing rear underrun guards to HGVs.

Designing the front of the LCV to be less injurious to pedestrians was considered to be the most effective countermeasure to protect pedestrians. Initial research in this area could consider the feasibility of transferring technology that is currently being developed for passenger cars to LCVs. A low cost vehicle enhancement would be compliant or frangible mirrors that would yield when struck by pedestrian.

## CONCLUSIONS

The report analysis concluded that:

- In STATS19
    - car occupants were the most frequently killed road user group. The proportion of LCV occupants and pedestrians were very similar to each other and were the second most frequently killed.
    - Vulnerable road user casualties, such as pedestrians and pedal cyclists, were over represented when considering serious and fatal LCV accidents.
- From the HVCIS sample
    - Car occupants are the most frequently killed road users in LCV accidents, followed by LCV occupants and then pedestrians.
    - The use of seatbelts in LCVs is lower than for car occupants, 47%. If five (5.6%) of the LCV occupants had been wearing seatbelts at the time of their accident, they may have survived. The potential benefits of wearing seatbelts can be enhanced when worn in conjunction with other developments in the safety of LCVs such as improved crashworthiness and fitment of airbags.
    - Encouraging seat belt wearing in LCVs also has the advantage that this countermeasure is financially inexpensive and could be very cost effective.
    - Re-designing the front of the LCV to protect pedestrians in an impact was considered to be the most effective countermeasure for reducing the number of pedestrian fatalities in accidents with LCVs. Research could consider the feasibility of technology transfer from the passenger car industry.
    - Development of mirrors that are less aggressive to pedestrians would also provide benefits.
    - Overall, accident avoidance countermeasures such as fitting ABS, preventing departure from the lane of travel or fitting collision avoidance systems were considered to provide the greatest benefits, with ABS and collision avoidance systems both estimated to be capable of preventing approximately 7 fatalities per annum.
    - Without performing further research or a detailed cost benefit study, it is suggested that:

- Reductions in fatal injuries could easily be achieved through the increased use of seatbelts, possibly supplemented by fitment of airbags.
- Further consideration, maybe with further research, should be given to improved braking (i.e. ABS), lane following, alertness monitoring, collision avoidance and consideration of pedestrian impacts.

## RECOMMENDATIONS

Future research on the safety of LCV may wish to focus on:

- A detailed cost benefit study for the important countermeasures discussed in this paper
- The feasibility of technology transfer from the car industry with respect to pedestrian protection, crashworthiness and compatibility.
- The assessment of ABS for LCVs
- Considering application of future lane following and collision avoidance systems for cars and HGVs to LCVs.

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