Published Project Report
PPR514

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Sideguards on heavy goods vehicles: assessing the effects on pedal cyclists injured by trucks overtaking or turning left

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Transport Research Laboratory

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Sideguards on heavy goods vehicles:

Assessing the effects on pedal cyclists injured by trucks overtaking or turning left

by R Cookson & I Knight (TRL)

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Heavy Vehicle Crash Injury Study (HVCIS)

Client: Department for Transport, Transport Technology and Standards division

	Name	Date Approved
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Executive summary

Background

In recent years there has been a substantial increase in pedal cycle traffic but at the same time the number of pedal cyclists killed and seriously injured in road accidents has reduced, implying a very substantial reduction in the casualty risk per km ridden. Transport for London (TfL) has stated that it wishes to encourage much greater future increases in pedal cycle traffic for reasons of public health, congestion, and CO_2 emissions. This led them to develop and publish a “Cycle Safety Action Plan” (TfL, 2010) that proposes a wide range of actions to improve cycle safety. The actions include, under the heading “technology”, working with the freight industry to identify the most cost-effective commercial vehicle safety measures that could be fitted either to new vehicles or to the existing fleet. The action specifically states that sideguards and motion sensors will be considered.

Objectives

The objective of this study was to draw together the findings of research literature, in particular three recent studies that consider heavy vehicle safety generally and/or sideguards specifically, and to undertake analysis of relevant accident data in order to inform consideration of the likely effectiveness of sideguards in terms of mitigating pedal cycle casualties in London and in GB as a whole.

Scope of the study

This was a desk based study of limited scope and duration. It included the following activities:

- A brief review of scientific literature, focussing on the results of three recent GB studies relating to the effectiveness of sideguards and other commercial vehicle safety countermeasures.
- A “before and after” study where the injury severity distribution of pedal cyclists in collision with HGVs that were passing or turning left in a period before the introduction of sideguards was compared with the same distributions in a period after the introduction of sideguards when the fleet was likely to be fully equipped.
- A comparison of the frequency and severity of pedal cycle casualties (from one recent time period) in accidents involving vehicles likely to be required to be fitted with sideguards with vehicles likely to be exempt from this requirement.
- A comparison of the frequency, severity and type of pedal cycle to HGV accident occurring in London and the rest of Great Britain.
- A brief review of in-depth accident mechanisms and countermeasures from the HVCIS fatal accident database.

Main findings

Collisions between pedal cycles and HGVs have higher relative priority in London than in the rest of GB. In addition to this, the most common type of collision is different; in London accidents where the HGV is turning left are more important (relative to other pedal cycle to HGV collisions) than in the rest of GB.

Sideguards have no effect on the frequency of accidents where pedal cycles collide with the side of a passing/overtaking HGV but have been very effective in reducing the severity of injuries in such accidents. Modest additional benefits would be possible in these accidents if the exemptions to current regulations were ended and/or if the technical requirements were enhanced. However, a review of commercial vehicle safety priorities (Robinson & Chislett, 2010) suggested that the most cost effective sideguard improvements were still a relatively low priority compared to other commercial vehicle safety measures.

Almost all of the literature and the "before and after" study suggest there should be little if any effect of sideguards on accidents involving pedal cycles colliding with HGVs making left turns. In-depth accident case studies suggest that turning left accidents often involve a collision with a cyclist towards the front of the vehicle which knocks the cyclist to the ground. As the HGV progresses with its turn, the rear of the vehicle "cuts-in" to the corner and the sideguard passes over the top of the prone cyclist who gets run over by the rear wheels.

The analysis of exempt vehicles has suggested that vehicles equipped with sideguards are both less likely to become involved in a left turn collision with a cyclist and less likely to cause serious injury when they do become involved in such a collision. The explanation for this contrasting finding is not clear but neither the "before and after" nor the exempt vehicle analysis has attempted to control for confounding factors so there are at least two possible explanations for the apparent conflict of results based on different methods:

- Some new trend or confounding factor has emerged between 1982 and 2006 that has masked the positive effect of sideguards on left turn accidents such that it was not visible in the "before and after" analysis.
- Some other feature of vehicles exempt from sideguard regulation (e.g. tippers, skip loaders, refuse vehicles) is responsible for their over-involvement in serious left turn collisions. Such features could include an increased exposure to risk due to a higher than average use in urban areas or perhaps differences in the direct or indirect field of view.

Which explanation of the results is correct could not be proven with the available data. However, the fact that the physical tests and theory reported in the literature supports the view that sideguards are primarily effective when trucks are passing in a straight line suggests that the 2nd explanation is more likely.

Keigan et al (2009) and the analysis of HVCIS fatal data both suggest that there is some chance that improved sideguard design could potentially improve injury outcomes for cyclists in collision with an HGV turning left. However, both allow considerable uncertainty.

The basis of the possibility that improved sideguards could influence left turn accidents is that if the bottom edge of the sideguard was closer to the ground then it would not pass over a prone cyclist in the same way as a current sideguard design does but would instead push the cyclist out of the way of the rear wheels. The uncertainty comes from the fact that it is not known what injuries might be caused as the cyclist is pushed out of the way and whether in fact various parts of the body could be squeezed and crushed into the smaller space under the sideguard. Testing for these possible effects would not be easy because existing test tools (e.g. anthropometric dummies) do not adequately represent the friction or compression/crush characteristics of the human body in these circumstances.

The HVCIS database suggests that alternative measures may be more effective in these left turn collisions, in particular "improve side vision". The benefits of "improved side vision" could be achieved either by improvements to direct or indirect field of view or, potentially, by a properly developed electronic warning system that is capable of alerting drivers to the presence of vulnerable road users such as cyclists and pedestrians.

1 Introduction

The number of killed or seriously injured pedal cyclists has in general decreased considerably compared with the period from 1994 to 1998 (which was used as the baseline over which the Government's 2010 casualty reduction targets were set) although there has been a levelling of the trend or even a slight increase since 2003. At the same time, there has been a substantial increase in cycling and traffic has increased across Great Britain by 17 percent from the 1994-1998 average as shown in Figure 1-1 (Department for Transport, 2009). In combination, these two trends mean that the number of pedal cyclist deaths per billion pedal cycle kilometres has fallen much more substantially and is now 47 percent below the 1994-98 average.

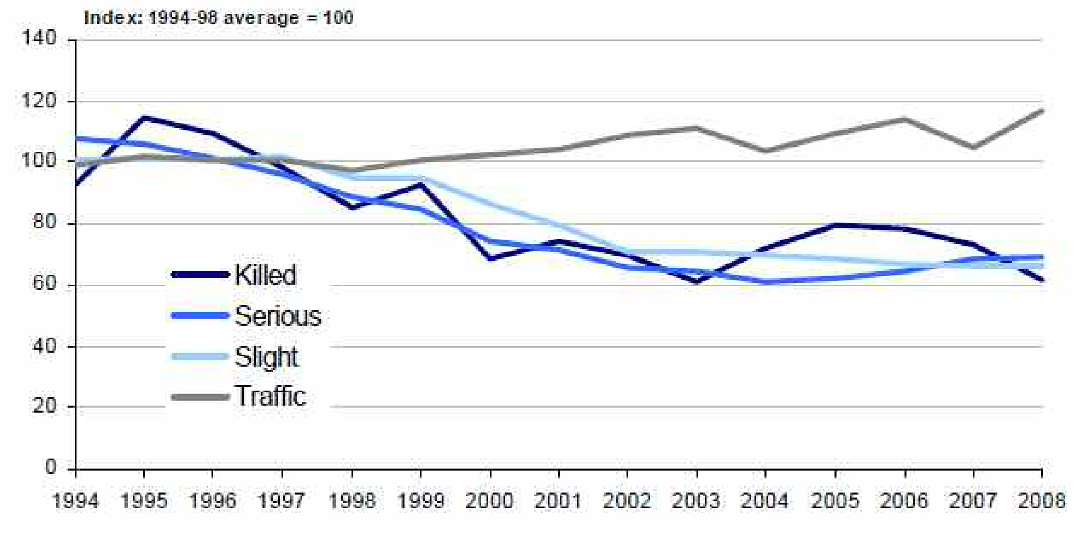

Figure 1-1. Pedal cycle traffic and reported casualties by severity: GB 1994-2008 (Department for Transport, 2009)

The volume of both pedal cyclist and other road user traffic has increased and the former has been encouraged for public health, congestion and CO_2 reasons. This led Transport for London (TfL) to create a "Cycle Safety Action Plan" (TfL, 2010) which aims to improve cycle safety in London. This plan proposes a wide range of actions to improve cycle safety. This includes, under the heading "technology", working with the freight industry to identify the most cost-effective vehicle safety measures that could be fitted either to new vehicles or the existing fleet. The action specifically states that sideguards and motion sensors will be considered.

TRL have been involved in several recent studies that could be used to inform the consideration of what effect sideguards would have on cycle safety both in London and in GB as a whole:

- Robinson & Chislett (2010) undertook a comprehensive review of commercial vehicle safety priorities for GB
- Keigan et al (2009) studied 92 fatal pedal cyclist collisions in London between 2001 and 2006.
- Knight et al (2005) assessed the benefits of integrating safety guards and spray suppression technology, which included consideration of the benefits of both ending exemptions to the sideguards regulations and of requiring improvements in sideguard design.

The objective of this current study was to interpret the findings of these three studies and to update them where applicable with analysis of recent accident data in order to inform consideration of whether further action on sideguards is likely to be one of the most cost effective truck safety measures for the protection of pedal cyclists, both in London and in GB as a whole.

2 Literature review

An amendment to the Road Vehicles (Construction and Use) Regulations came into operation in 1983 that required new goods vehicles registered in GB to be fitted with lightweight sideguards, including new trailers in excess of certain weights and some of the larger existing semi-trailers. At a later date an EC Directive[1] set out the type approval requirements for sideguards.

Riley et al (1985) undertook research into the effectiveness of sideguards based on full scale tests with trucks and dummies on pedal cycles. The manoeuvre simulated was a truck overtaking a cyclist when both vehicles were travelling in a straight line at low speed because this was considered to be a common accident type. In this type of accident it was considered that the cyclist could either be “nudged” by the passing HGV or become unstable as a result of some other factor, and fall towards the truck. In the absence of sideguards then the cyclist would fall in the gap between the wheels and would be run over by the rear wheels. The corresponding aim of sideguards was, therefore, to prevent the cyclist from getting between the wheels and being run over.

Tests involving a truck fitted with a sideguard just complying with the legal minimum requirements in the UK were found to prevent run over in 4 out of 10 cases. Where run over still occurred this was because the dummy slid down the sideguard sufficiently quickly that parts of the body could pass underneath the sideguard before the rear wheel had passed. Fitting sideguards with a lower ground clearance was found to eliminate this problem. In addition to this, it was found that varying the speed of the vehicles and the timing of dummy release could mean that the dummy was struck more violently by projections such as load hooks, the leading edge of the sideguard or the rear wheel. These problems could be improved by fitting stronger guards flush with the outside of the vehicle and it was noted that flat panelled guards were likely to offer further improvements (although not tested).

Walz et al (1990) and deco et al (1994)[2] both reported very similar findings and both also restricted their analyses to accidents where vulnerable road users were overtaken by trucks. Although no paper has been identified that specifically provides the rationale behind the regulations, these reports strongly suggest that sideguards are intended to provide protection for pedal cyclists and pedestrians that are involved in impacts with the side of an HGV in the area in front of the rear axle(s) when the HGV is overtaking (i.e. passing in an approximately straight line). The primary aim of the sideguard system is to prevent pedestrians and pedal cyclists being run over by the rear wheels in such a situation.

Robinson (1996) investigated the legislative requirements regarding the strength and stiffness of sideguards. It was found that sideguards are not required to be strong enough to prevent underrun of other vehicles but in some cases they may provide limited protection against vehicle underrun, particularly when the angle of impact is acute.

Knight et al (2005) attempted to assess the effectiveness of sideguards at preventing serious injury to pedal cyclists and pedestrians both when the HGV they were fitted to was travelling in a straight line and when it was turning left. A before and after analysis suggested that sideguards have been effective at reducing the severity of pedal cycle accidents where the HGV was passing the cyclist but NOT where the HGV had been turning left. An analysis of the accident involvement of rigid vehicles when overtaking pedal cyclists and pedestrians in a straight line also showed that vehicles that are likely to be exempt from fitting sideguards are over-represented in fatal and serious collisions, when compared with the proportion of such vehicles registered, and that this difference was statistically significant. This appeared to corroborate the findings of the before and

[1] Council Directive 89/297/EC of 13 April 1989

[2] Both cited in Robinson (1996)

after analysis. However, the analysis of exempt vehicles also suggested that there was some, albeit lesser and not statistically significant, effect on accidents where the truck was turning left when it collided with a pedal cycle.

Knight et al (2005) used case studies of in-depth accident data from HVCIS and TCIS to investigate possible reasons for the differences between the effectiveness in the two manoeuvres. It was found that when considering fatal accidents where an HGV is turning left and collides with a cyclist at the nearside, a typical accident mechanism is for the initial contact between the side of the HGV and the cyclist to be near the front of the truck. This knocks the cyclist to the floor. As the HGV continues its manoeuvre the rear of the vehicle/trailer “cuts in” to the corner and the prone cyclist is then run over by the rear wheels. In this accident mechanism, a sideguard complying with the UK minimum requirements (i.e. 550mm ground clearance) would not be expected to offer any benefit because the prone cyclist would still be expected to pass underneath.

Two possible improvement measures were considered by Knight et al (2005):

- Ending exemptions such that all HGVs would be subject to the existing sideguard requirements
- Requiring all vehicles to fit improved sideguard designs with a reduced ground clearance and a flat panel design integrated with the vehicle body.

It was found that ending exemptions would be likely to prevent two to three GB fatalities per year and that improving the design could prevent up to another four GB fatalities per year. It should be noted that all of these benefits were predicted based on analyses relating only to overtaking accidents, effectively assuming that there would be no effect on left turn accidents, in line with most, but not all, of the available accident data.

Smith & Chislett (2010) undertook a comprehensive review of commercial vehicle safety priorities and their findings were broadly consistent with the findings of Knight et al (2005). They identified a list of 253 accident types and ranked them according to the casualty prevention value associated with the killed and seriously injured casualties from that accident type. Collisions between pedal cyclists and the side of HGVs were ranked number 49 of 253 with an average casualty prevention value of £22m per year (compared with £341m for the top priority group). Accidents where the HGV was overtaking the cyclist in a straight line at the time of the collision would represent only a sub-set of this group. Several measures to improve sideguards were considered and the most effective was ranked as number 53 on the list of priorities, reflecting the relatively small number of casualties involved. By contrast, a hypothetical system that would detect the presence of a pedestrian or pedal cyclist in close proximity anywhere around the vehicle and warn the driver was considered to be one of the top 5 vehicle design countermeasures that could be considered. The main reason for the difference in ranking is the fact that it was considered that the warning system could be effective in a range of different collision types, including for example when pedestrians are run-over as an HGV pulls away from rest, whereas the sideguards were likely to affect only overtaking accidents.

Keigan et al (2009) undertook an analysis of 92 fatal accidents involving pedal cycles that occurred in London and TfL combined the findings from this analysis with information from other studies and statistics to produce their cycling action plan (TfL, 2010). Keigan et al’s (2009) analysis was undertaken using the systematic approach of studying each collision and the factors that contributed to the event using Haddon’s matrix. A collision typology was developed to categorise the collisions and propose interventions. The most common collision type in this sample of London accidents was when the pedal cyclist fatality was struck by a large vehicle changing lane to the left or turning left, which accounted for 23 of the 92 accidents. Keigan et al. (2009) reported a number of recommendations under a range of topics including cyclist training, other road user training, vehicle engineering, and highway improvements. One of the vehicle engineering interventions proposed was to add or improve the installation of sideguards on all heavy goods vehicles. It was suggested that this could potentially be of influence in 20 of the 92 London fatalities studied, a much larger proportion than implied by either Knight et al (2005) or Robinson and Chislett (2010). There are two possible reasons for the differences in results, firstly that the type of collision relevant to sideguards is more prevalent in London and secondly that Keigan et al identified only possible influence and did not attempt to estimate actual effectiveness, which was done by the other two studies.

It is worth noting that 15 of the 20 fatalities considered to be within the influence of sideguards were those where the HGV involved had turned left and 5 were where the cyclist had fallen into the side of an HGV. The report does not state how many of the HGVs involved were already fitted with sideguards so it is not possible to state how many of the reported fatalities could potentially have been influenced by ending exemptions to the current regulations and how many by updating the current regulations to require improved performance.

3 Analysis of Stats19 2006-2008 data

In this section, Stats19 data has been analysed from before and after the introduction of sideguard regulations in order to show how this has affected the injury severity distribution. This can then be used to understand the effects of physically changing the side structures of HGVs on accidents involving pedal cycles. Stats19 data that has been enhanced with vehicle licensing data has also been used to compare the involvement rates of exempt vehicles. Accidents that occurred between 1980 and 1982 inclusive and 2006 and 2008 inclusive have been used for this analysis, as sideguards were introduced in 1983. This replicates the analysis by Knight et al (2005), where a comparison was made of 1980-1982 to 1990-1992. By using 2006 to 2008 as the “after” period then there should be a slightly bigger proportion of the fleet equipped with sideguards but there is also a lot more opportunity for other factors to have influenced the findings of this analysis such as the introduction of speed limiters, drivers hours regulations, cycle helmet wearing and revised requirements for truck mirrors. Investigating the likelihood of confounding factors influencing the results of the analysis would be complex and is beyond the scope of this work. The results must, therefore, be considered in light of the possible influence of safety measures or trends that have developed during the time period studied.

3.1 Injury Distribution for pedal cyclists; comparing 1980-1982 to 2006-2008

Table 3-1 shows a clear and strong downward trend in the number of pedal cyclist casualties arising from a collision with an HGV, regardless of injury severity. In total there were approximately 60% fewer pedal cycle vs HGV road casualties in the period 2006-2008 than there were between 1980-1982.

The distribution of accident severity and how this has changed since the introduction of sideguards is also shown in Table 3-1. This shows that for those pedal cycles that are still involved in HGV accidents, there has been a reduction in the proportion that are seriously injured but an increase in the proportion of fatally and slightly injured pedal cyclists. The reason for this change is unknown and it is possible that this could be a function of random fluctuations over time rather than a firm trend.

Table 3-1. Summary of pedal cyclist casualties in collision with HGVs (Source: Stats 19)

Severity	1980-1982	1990-1992	2006-2008	% change (80/82 to 06/08) in proportion of casualties of each severity
Fatal	165	127	81	
	7%	7%	9%	22%
Serious	661	465	216	
	28%	24%	23%	-19%
Slight	1533	1322	651	
	65%	69%	69%	6%
Total	2359	1914	948	
	100%	100%	100%	

The literature suggests that sideguards are primarily designed to be effective in only a very specific type of accident where a pedestrian or pedal cyclist falls against the side of a passing HGV. In order to consider the benefits of sideguards further, an analysis of impact point and HGV manoeuvre was required. The categories of manoeuvre in Stats19 that are the most relevant for assessing the effectiveness of sideguards are those where the HGV was "going ahead other", and "overtaking a moving vehicle on its offside" i.e. the pedal cycle, where the first point of impact was to the nearside of the HGV. The manoeuvre of "turning left" has also been analysed because it was this type of accident that was most prominent in the analysis by Keigan et al (2009).

These three types of manoeuvre were the most frequent for accidents involving HGVs and pedal cycles in both year groups. The manoeuvre that accounted for the greatest proportion of accidents in the 1980-1982 group was "going ahead other" (23%) followed by "overtaking a moving vehicle on its offside" (22%) and then "turning left" (18%). In the 2006-2008 group of accidents, the most frequent manoeuvre was "going ahead other" (30%) followed by "turning left" (23%) and then "overtaking a moving vehicle on its offside" (11%). The increase in the proportion of accidents where the HGV was turning left is of particular interest because these are the type of accident highlighted by Keigan et al (2009). It should be noted that although the proportion of left turn accidents has increased, the overall number of accidents has decreased so the absolute number of left turn accidents has decreased. Put another way, all three of the largest manoeuvre groups have decreased in frequency but "overtaking a moving vehicle on its offside" has decreased more substantially than the other groups.

The accident groups were then further filtered by selecting only HGVs where the first point of impact with the pedal cyclists was to the nearside. Figure 3-1 highlights the distribution of HGV manoeuvres for this sub-group of accidents, which shows a similar trend.

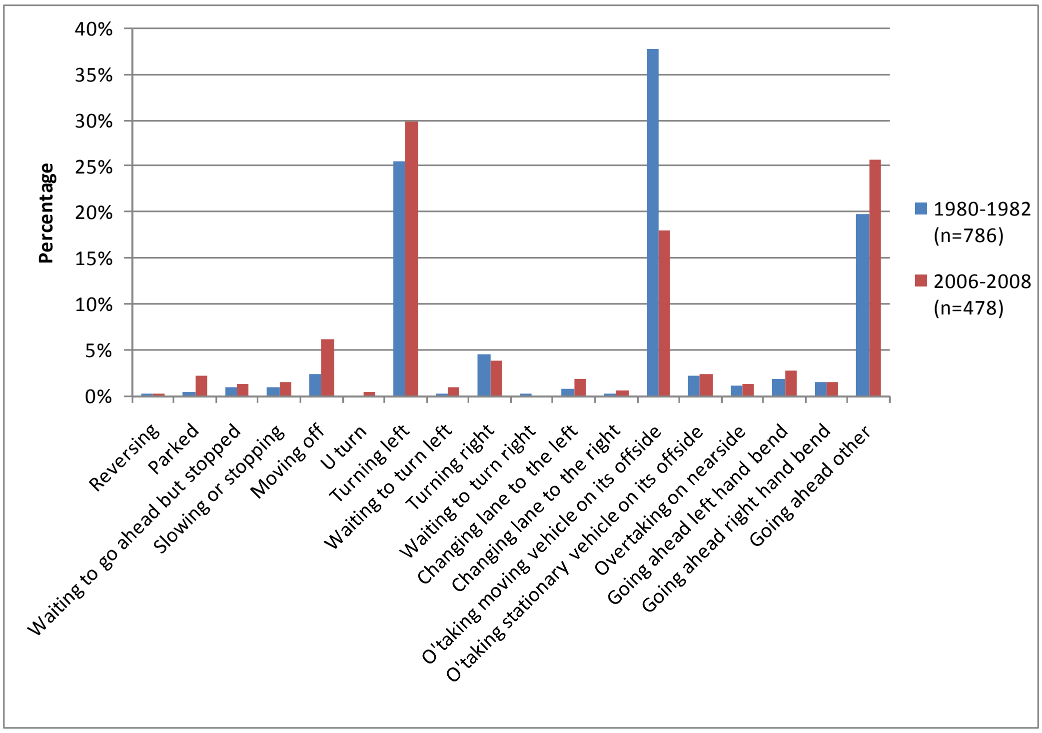

Figure 3-1. Manoeuvre of HGVs where pedal cyclists impacted their nearside (Source: Stats 19)

During the period 2006 to 2008, there were 123 pedal cyclist accidents where the HGV was "going ahead other" and the pedal cyclist impacted the HGV on the nearside, compared to 156 during 1980 to 1982. However, sideguards are not expected to affect the frequency of collisions between cyclists and HGVs, only the severity of the injury consequences that result from such collisions. For this reason, Table 3-2 shows the injury severity distribution for casualties that have collided with the nearside of an HGV “going ahead other” and how this distribution has changed since the introduction of sideguards.

Table 3-2. Injury distribution for accidents where the HGV was "going ahead other" and was impacted on its nearside by a pedal cycle (Source: Stats 19)

Severity	1980-1982 Total	2006-2008 Total	% change in proportion of casualties of each severity
Fatal	23	8	
	14.7%	6.5%	-55.9%
Serious	51	39	
	32.7%	31.7%	-3.0%
Slight	82	76	
	52.6%	61.8%	17.5%
Total	156	123	
	100%	100%	

It can be seen that the percentage of fatally and seriously injured pedal cyclists has reduced since the introduction of sideguards, with the effect on fatal injuries being much greater than the effect on serious injuries. The large reduction for fatalities in this situation is consistent with the intended effects of introducing sideguards.

For the “overtaking moving vehicle on its offside” manoeuvre where the pedal cycle impacted the nearside of the HGV, there were 86 HGVs in the 2006-2008 group, compared with 296 in the 1980-1982 group. Table 3-3 shows the severity of these pedal cyclist casualties and how the distribution has changed since the introduction of sideguards.

Table 3-3. Injury distribution for accidents where the HGV was "overtaking moving vehicle on its offside" and was impacted on its nearside by a pedal cycle (Source: Stats 19)

Severity	1980-1982 Total	2006-2008 Total	% change in proportion of casualties of each severity
Fatal	15	2	
	5.1%	2.3%	-54.1%
Serious	64	17	
	21.6%	19.8%	-8.6%
Slight	217	67	
	73.3%	77.9%	6.3%
Total	296	86	
	100%	100%	

Again, it can be seen that the number of fatally and seriously injured pedal cyclists has reduced since the introduction of sideguards, with the effect on fatal injuries being much greater than the effect on serious injuries. This is also consistent with the intended effect of sideguards.

For the “turning left” manoeuvre where the pedal cycle impacted the nearside of the HGV, there were 143 HGVs in the 2006-2008 group, and 201 in the 1980-1982 group. Table 3-4 shows the severity of these pedal cyclist casualties and how the distribution has changed since the introduction of sideguards.

Table 3-4. Injury distribution for accidents where the HGV was "turning left" and was impacted on its nearside by a pedal cycle (Source: Stats 19)

Severity	1980-1982 Total	2006-2008 Total	% change in proportion of casualties of each severity
Fatal	26	22	
	12.9%	15.4%	18.9%
Serious	64	39	
	31.8%	27.3%	-14.3%
Slight	111	82	
	55.2%	57.3%	3.8%
Total	201	143	
	100%	100%	

For these accidents, the percentage of seriously injured pedal cyclists has reduced since the introduction of sideguards but the percentage of fatally injured pedal cyclists has actually increased. This is not consistent with a benefit as a result of introducing sideguards and supports the theory that sideguards would not help to prevent pedal cyclists being run over by the rear wheels when the HGV was turning left.

3.2 Exempt vehicles

Information about the body type of the vehicles involved in accidents can be obtained by enhancing Stats19 with a link to the DVLA registration database, although in some cases the information remains unknown, particularly for semi-trailers, which are not registered in the same way as rigid vehicles. Where the body type is known, it is possible to estimate the number of vehicles that did or did not have sideguards fitted. The European Directive (89/297/EC) provides an exemption from the requirement to fit sideguards to vehicles designed and constructed for special purposes where it is not possible, for practical reasons, to fit sideguards. There can be a number of different reasons for sideguards not being practical and this is open to a degree of interpretation. The UK Construction and Use Regulations (1986) lists specific types of exempt vehicle based either on their body type or intended purpose and this list has been used to estimate the proportion of vehicles likely to be exempt. The percentage of vehicles that were exempt and involved in the accidents can then be compared with the percentage of the UK vehicle stock that was exempt. This allows conclusions to be drawn about the involvement of exempt vehicles in fatal and serious accidents.

The information about vehicle stock was obtained from vehicle registration statistics from 2008 (Department for Transport, 2009). Figure 3-2 shows the goods vehicle stock divided by body type for all rigid HGVs on the road in 2008.

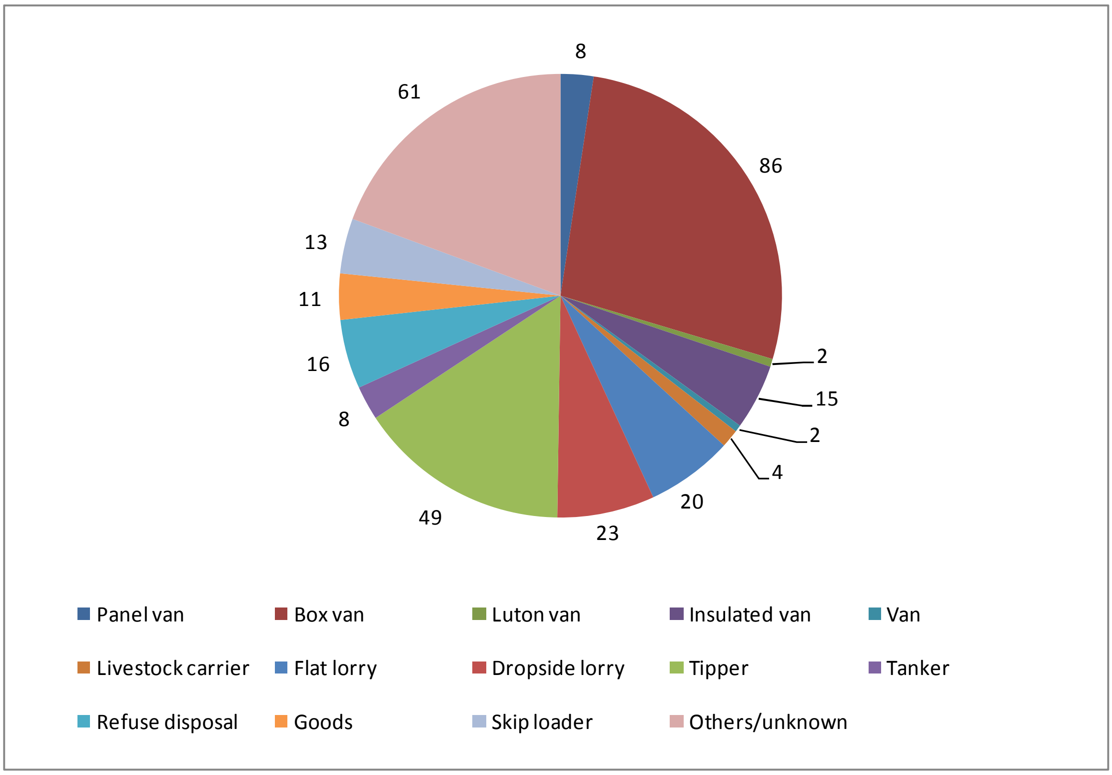

Figure 3-2. 2008 rigid goods vehicle stock by type of body (1,000s of vehicles) (Source: DfT, 2009)

Using this data it is possible to estimate the percentage of the vehicle stock that was exempt from fitting sideguards. It has been assumed, based on the exemptions from Construction and Use Regulations, that the following vehicle categories from Figure 3-2 are exempt from the requirement to fit sideguards:

- Tipper
- Refuse disposal
- Skip loader

There are a large proportion of vehicles where the body type is listed as “other” or “not known”. It is possible that some of these vehicles may be specialist vehicles that are also exempt from fitting sideguards, but this cannot be quantified. Table 3-5 shows the percentage of the vehicle stock in 2008 that were estimated to be exempt from fitting sideguards. The lower boundary assumes that all of the “other” and “not known” vehicles were not exempt and would have had sideguards fitted. The mid value assumes that the distribution of exempt and not exempt vehicles in the “other/ not known” category is the same as for the rest of the data where the body type is known. The upper boundary assumes that all the “other” or “not known” vehicles are exempt. In this way the full range of possibilities can be considered.

Table 3-5. Vehicle exemptions (Source data: DfT, 2009)

	2008 vehicle stock		
	Lower	Mid	Upper
Exempt Vehicles	78	97	139
Not Exempt	239	220	178
Total	317	317	317
Percentage Exempt	24.6%	30.5%	43.9%

The following analysis compares the number of exempt vehicles that were involved in accidents with the number of exempt vehicles that are registered. It should be noted that tipping vehicles represent the largest body type that are exempt from the regulations and that the number of other types of vehicle that may be exempt will be small in comparison. Therefore the proportion of “not known” or “other” body types that are exempt is likely to be less than the proportion of known vehicle types that are exempt, because tipping vehicles account for 19% of all (exempt and not exempt) known vehicle body types. It is, therefore, likely that the overall percentage of exempt vehicles will be lower than the mid value presented in the table above. However, the proportion will not be as low as the lower boundary because some of the “unknown/other” vehicles will inevitably be exempt. It is highly unlikely that the proportions will be as shown for the upper boundary so the analysis will focus on the mid and lower figures, suggesting that between 24% and 31% of all rigid HGVs are likely to be exempt from fitting sideguards.

A similar technique to that above has been used on the enhanced STATS 19 data for 2006-2008 to estimate the number of vehicles in the accident sample that were exempt from sideguard fitment. The enhanced STATS 19 database involves linking the STATS 19 database to the DVLA vehicle registration database, based on the recorded vehicle registration mark (VRM). This linking process is imperfect because VRMs are often recorded incorrectly, either by the reporting officer or during the data entry process. The enhanced data set is, therefore, just a sub-set of the STATS 19 data recorded in Table 3-2 to Table 3-4, above.

Comparing exempt and non-exempt vehicle stock and accidents in this way allows a number of theories to be tested, outlined below as null hypotheses:

1. Whether or not a vehicle is exempt from sideguard regulations has no effect on the frequency with which accidents involving a pedal cycle colliding with the side of a passing HGV occur
2. Whether or not a vehicle is exempt from sideguard regulations has no effect on the severity of injury sustained by a pedal cyclist when an accident involving a collision with the side of a passing HGV does occur
3. Whether or not a vehicle is exempt from sideguard regulations has no effect on the frequency with which accidents involving a pedal cycle colliding with the side of an HGV which is turning left occurs
4. Whether or not a vehicle is exempt from sideguard regulations has no effect on the severity of injury sustained by a pedal cyclist when an accident involving a collision with the side of an HGV turning left does occur

Theory number 1 effectively states that installing sideguards will not have an effect on the ability of the vehicle to avoid a passing/overtaking accident. If this is true then the proportion of all casualties from such accidents that involve exempt vehicles should be the same as the proportion of all vehicle stock that is exempt. The results of the analysis are shown in Table 3-6, below.

Table 3-6. Comparison of the involvement of exempt vehicles in all accidents involving a pedal cyclist colliding with the side of an HGV “going ahead other” or “overtaking a vehicle on its offside” and the proportion of vehicle stock, based on the “mid estimate” method described above (Source: enhanced Stats 19 2006-2008 and DfT, 2009)

	Number of HGVs involved in accidents of all injury severity	Vehicle stock
Number exempt	30	97
Number not exempt	69	220
Total	99	317
Proportion exempt	29.6%	30.5%

If it is assumed that the distribution of exemptions amongst rigid HGVs of unknown body type is the same as for those with known body types for both accident and stock figures, then the proportion of exempt vehicles involved in accidents is similar to the proportion of vehicle stock likely to be exempt. This means that the involvement of exempt vehicles in accidents is as would be expected based on the number in existence. This suggests that theory number 1 is correct; the fitment of sideguards has no effect on the ability of an HGV to avoid accidents that involve a pedal cyclist colliding with the nearside of a passing HGV.

Theory number two states that sideguards will have no secondary safety effect on the severity of injuries received by the cyclist in the same type of collision with a passing HGV. If correct, accidents involving exempt HGVs would have the same injury severity distribution (i.e. proportion fatal, proportion KSI etc) as accidents involving HGVs required to fit sideguards (not-exempt). The injury severity distributions are shown in Table 3-7, below.

Table 3-7: Accident severity distribution where exempt and not exempt vehicles were involved in collisions with a pedal cycle on their nearside while “going ahead other” or “overtaking a moving vehicle on its nearside” (Source: enhanced Stats 19 data 2006-2008)

	Fatal	Serious	Slight	Total	% fatal	% KSI
Exempt	4	11	15	30	14%	52%
Not Exempt	3	23	43	69	4%	37%
Total	7	34	58	99	17%	41%

It can be seen that, where exempt vehicles are involved, a larger proportion are involved in fatal or serious accidents when compared with those where sideguards are a requirement. This strongly suggests that the null hypothesis of theory number 2 is not correct and sideguards do in fact reduce the severity of injuries sustained by pedal cyclists in collision with the nearside of an HGV passing in an approximately straight line.

Table 3-9 and Table 3-9 repeat the above analyses for accidents involving an HGV that was turning left in order to assess theories 3 and 4 respectively.

Table 3-8: Comparison of the involvement of exempt vehicles in all accidents involving a pedal cyclist colliding with the near side of an HGV “turning left” and the proportion of vehicle stock (both based on “mid estimate” of exemptions) (Source: enhanced Stats 19 2006-2008 and DfT, 2009)

	Number of HGVs involved in accidents of all injury severity	Vehicle stock
Number exempt	45	97
Number not exempt	59	220
Total	104	317
Proportion exempt	43.5%	30.5%

It can be seen that when the HGV is turning left and collides with a pedal cycle at the nearside, the proportion that are exempt from sideguards is substantially higher than would be expected based on the number of exempt vehicles registered. This suggests that the null hypothesis of theory 3 is incorrect and the fitment of sideguards does affect the ability of a vehicle to avoid such a left turn accident.

Table 3-9: Accident severity distribution where exempt and not exempt vehicles were involved in collisions with a pedal cycle on their nearside while “turning left” (Source: enhanced Stats 19 data 2006-2008)

	Fatal	Serious	Slight	Total	% fatal	% KSI
Exempt	9	21	15	45	20%	67%
Not Exempt	7	8	44	59	12%	25%
Total	16	29	59	104	15%	43%

The data also shows that a larger proportion of the exempt vehicles are involved in fatal or serious accidents than for those vehicles that are not exempt, thus suggesting that theory 4 is incorrect and sideguards do have an influence on the injury severity when the HGV is turning left.

The results in respect of passing/overtaking accidents (theory 1 and 2) conform entirely with the results of the literature survey and the “before and after” study. That is, sideguards do not affect the frequency of accidents but do affect the severity, offering substantial scope for improved injury outcomes.

However, the results in respect of turning left accidents are unexpected. These results suggest that sideguards influence both the frequency and severity of turning left collisions. The literature suggests that neither of these should be the case and the “before and after” study showed only a smaller effect on the severity of turning left accidents that was not statistically significant.

None of the analyses in relation to exempt vehicles controls for potential confounding factors, effectively assuming that the fitment of sideguards is the only difference between the groups of vehicles. In reality, there will be other differences in the groups because exempt vehicles are typically tippers, construction vehicles and special purpose vehicles, whereas those that are not exempt include most of the general freight (e.g. box and curtain sided) vehicles. It is, therefore, possible that other factors could explain the results such as the use of the vehicles in different environments (motorways, urban, rural etc.), driver behaviour, or the field of view, for example the fitment of close proximity mirrors (as required by 2003/97/EC, which came into force for new vehicle types in January 2006).

4 Comparing the relative priority of different HGV to pedal cycle accidents in London and GB

This section compares the frequency and type of HGV versus pedal cycle accidents in London with those occurring in the rest of Great Britain in order to identify any differences between the accident characteristics in these two regions. These analyses were based on Stats 19 data relating to accidents that occurred between 2006 and 2008 inclusive. Accidents in London were identified as those occurring in the Police regions of the Metropolitan (MET) and City of London. There were 249 in the MET and none in the City of London in the Stats19 2006-2008 set of accidents. There were 699 in other regions of Great Britain. Fifteen percent of all accidents recorded in Stats19 between 2006 and 2008 occurred in London, whereas 37% of pedal cycle versus HGV accidents were in London, suggesting that this type of accident is more important in London than in the rest of GB.

Figure 4-1 shows the distribution of the pre-impact manoeuvre of HGVs in accidents with pedal cycles for the MET compared with the rest of Great Britain. The most noticeable differences are the much greater proportion of accidents in which the HGV is “turning left” in London and the greater proportion of HGVs “going ahead other” and “overtaking a moving vehicle on its offside” in the rest of Great Britain. Keigan et al (2009) identified similar trends for accidents in London, and noted that London is likely to have a different pedal cyclist accident typology compared to Great Britain as a whole.

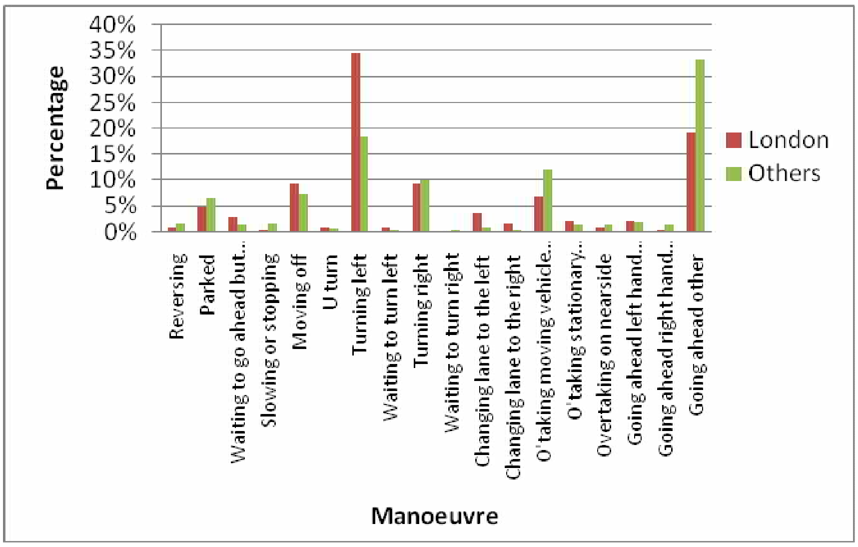

Figure 4-1. Pre-impact manoeuvre of HGVs in collision with pedal cyclists (all impact points) in London and the rest of GB (Source: Stats 19 2006-2008)

Impacts to the nearside of the HGV were the most frequent for both regions but accounted for a larger proportion of the accidents in the MET than in the rest of Great Britain. Impacts to the front of the HGV occurred more frequently in the rest of Great Britain. This is consistent with the differences in the type of manoeuvre.

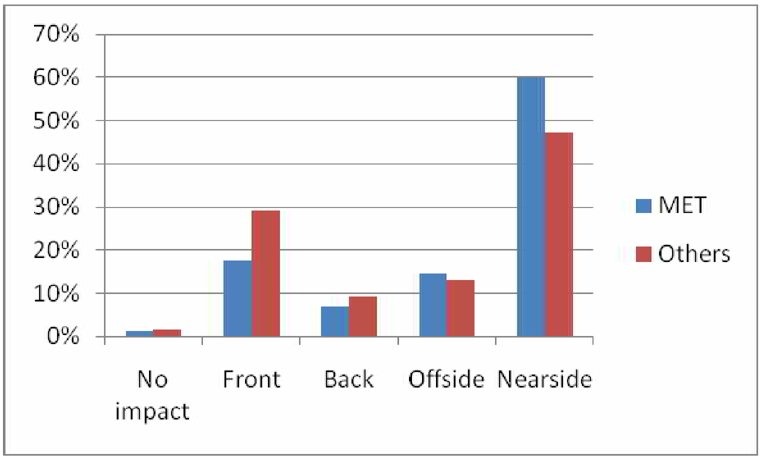

Figure 4-2. Distribution of first point of impact comparing London to the rest of GB (Source: Stats 19 2006-2008)

In section 3.2 an analysis was reported based on data for GB where the proportion of accidents involving rigid HGVs likely to be exempt from sideguards was compared with the proportion of rigid HGVs registered that were likely to be exempt. It is not possible to repeat this analysis for London alone because the number of exempt vehicles registered in London is not known and even if it was it may not be indicative of the distance driven by such vehicles in London.

However, it is possible to identify the proportion of exempt HGVs involved in any type of accident involving a pedal cycle (i.e. overtaking, turning left, frontal collision etc.) that occurred in London (31%) and to compare this with the proportion of exempt HGVs involved in equivalent accidents in the rest of GB (24%) This shows that accidents with exempt HGVs are a greater problem in London than in the rest of GB.

The proportions of fatal, serious and slight injuries for all pedal cyclist casualties were found to be the same for the two regions, suggesting that the over-representation of exempt vehicles and the greater proportion of turning left collisions have not resulted in a significant difference in casualty severity.

5 In-depth analyses of accident characteristics

This section contains analysis of detailed fatal accident data from the Heavy Vehicle Crash Injury Study (HVCIS), which aimed to identify the characteristics of pedal cycle versus HGV accidents in more depth. Comparison was made between those HGVs fitted and not fitted with sideguards and the countermeasures that were considered appropriate for the vehicles and environment.

5.1 Accident mechanisms

The HVCIS fatal dataset includes accidents that occurred between 1997 and 2006 inclusive. These years were selected because they comprise a more representative sample of GB (prior to 1997, the data includes a pilot study of light goods vehicles with a gross vehicle weight less than or equal to 3.5t, which can slightly bias analyses) and there are only low numbers of cases from 2007 (Robinson et al, 2009). This selected sample consisted of 142 accidents involving an HGV and a pedal cycle.

Table 5-1 shows the distribution of the side of most severe impact for HGVs versus that for pedal cycles. The most frequent combination of impact points was found to be the nearside of the HGV to the offside of the pedal cycle, followed by the front of the HGV to the back of the pedal cycle and the front of the HGV to the offside of the pedal cycle. Overall, impacts to the front and nearside of the HGV were the most common together with impacts to the offside of the pedal cycle.

Table 5-1. HGV to pedal cycle impact configurations (based on for the impact rated most severe for both vehicles) (Source: HVCIS fatal 1997-2006)

HGV	Pedal Cycle					
	Back	Front	Nearside	Offside	Unknown	TOTAL
Back		1				1
Front	28	3	5	26	2	64
Nearside		5	3	50	7	65
Offside		3	1		5	9
Underside		1			1	2
Unknown			1			1
TOTAL	28	13	10	76	15	142

The most common manoeuvre for HGVs in accidents with pedal cycles are turning left (38%) and going ahead other (34%), which also accounted for the greatest proportion in Stats19 with 23% and 30% respectively (section 3.1). For pedal cycles, the most common manoeuvre is going ahead other (62%) and undertaking (on nearside) (15%). The combinations of these manoeuvres can be seen in Table 5-2.

Table 5-2. Manoeuvre for pedal cycle versus manoeuvre for HGV in collisions between the two (Source: HVCIS fatal 1997-2006)

HGV	Pedal Cycle						
	Starting	Turning left	Undertaking (on nearside)	Going ahead other	Other	Unknown	TOTAL
Starting	1		6	4		1	12
Turning left	3	5	14	30	2		54
Turning right				6	1		7
Overtaking moving vehicle	2			9	3	2	16
Going ahead other	3	2	2	36	2	4	49
Other				2	2		4
TOTAL	9	7	22	87	10	7	142

Sideguards are primarily designed to prevent pedal cyclists being run over so a comparison was made of the percentage of those run over where the HGV was fitted with sideguards to those that were not fitted with sideguards, as shown in Table 5-3. It can be seen that the data was only known for 33 of 142 fatalities (because the field is only a recent addition to the database) and this means that the numbers were too small for meaningful conclusions. However, it appears as if most of the fatalities in this type of accident were run-over, regardless of sideguard fitment.

Table 5-3. Comparison of the proportion of pedal cyclists being run over in relation to sideguard fitment in collisions with HGVs (Source: HVCIS fatal 1997-2006)

	Not run over	Run over
No Sideguards	2 (10%)	18 (90%)
Sideguards fitted	1 (8%)	12 (92%)

5.2 Countermeasures

In the HVCIS fatal accident database, countermeasures are assigned to each accident with a probability of preventing a fatality of “definitely”, “probably” or “maybe”. These can either be assigned in conjunction with other countermeasures or as a sole countermeasure. When analysing these countermeasures, the number of fatalities potentially prevented are weighted by the probability of prevention i.e. the number of “definite” are multiplied by 1, “probable” by 0.75 and “maybe” by 0.25. The assessment of the effectiveness of these countermeasures is based on consideration of the wide range of evidence in the source police file and a series of guidelines about each measure considered. However, it inevitably involves a degree of subjective judgement on behalf of the coder. The main aim of the database is to inform policy with respect to vehicle design. Although it is intended that measures relating to infrastructure and road user behaviour should be flagged they are not the main subject of the data and thus, the vehicle countermeasures are generally considered to be backed by more robust and less subjective guidelines than those relating to other features. The limitations of the data should be borne in mind when considering the results.

Table 5-4 shows the countermeasures that were coded for pedal cycle vs HGV accidents as a sole countermeasure, not linked to any other countermeasures. Those highlighted are the top 5 in each column; the weighted total provides the predicted number of fatalities in HVCIS that could have been saved by each countermeasure. For the total of the weighted values, “provide cycle lane” came out as the most effective countermeasure followed by “improve side vision” and “fit aerodynamic side skirt”. The HVCIS definitions for each of the countermeasures were most frequently coded for these accidents can be found in Appendix A.

Table 5-4. The influence and effectiveness of single countermeasures on HGV to pedal cycle fatalities in GB (Source: HVCIS fatal 1997-2006)

Countermeasure	Frequency				Weighted			
	D	P	M	Total	D	P	M	Total
Improve Forward Vision	3	4	8	15	3	3	2	8
Improve Side Vision	3	15	27	45	3	11.25	6.75	21
Fit Current Side Guards	0	3	17	20	0	2.25	4.25	6.5
Fit Stronger and Lower Side Guards	2	8	21	31	2	6	5.25	13.25
Fit Aerodynamic Side Skirt	3	20	12	35	3	15	3	21
Provide Cycle Lane	24	12	5	41	24	9	1.25	34.25
Other	3	5	12	20	3	3.75	3	9.75

It can be seen that when fitting current sideguards is considered (i.e. ending exemptions) it is cited as a possible influence in a relatively large number of cases but it is usually considered to have a great deal of uncertainty, that is, most of the cases are coded only as “maybe” with none coded as “definite”.

Countermeasures that were recorded in combination with others for this type of accident were also analysed. For this, the combination of improve forward vision and improve side vision was the most frequent followed by improve lighting with improve conspicuity, where half were related to the pedal cycle and half to the HGV.

The countermeasures were also analysed with respect to the manoeuvres of the HGV. Table 5-5 shows the countermeasures considered most likely to reduce fatalities for each manoeuvre. For turning left accidents, “improve side vision” was recorded as the most likely, followed by “provide cycle lane” and “fit aerodynamic side skirt”. Again, see Appendix A for countermeasure definitions used in HVCIS.

Table 5-5. Sole countermeasures most likely to reduce pedal cycle fatalities in collisions with HGVs split by HGV manoeuvre (Source: HVCIS fatal 1997-2006)

Manoeuvre	Countermeasure	Frequency				Weighted			
		D	M	P	Total	D	M	P	Total
Turning Left	Improve Side Vision	3	20	12	35	3	5	9	17
	Provide Cycle Lane	5	3	6	14	5	0.75	4.5	10.25
	Fit Aerodynamic Side Skirt	0	6	11	17	0	1.5	8.25	9.75
	Fit Stronger and Lower Side Guards	0	10	2	12	0	2.5	1.5	4
Going Ahead Other	Provide Cycle Lane	9	1	2	12	9	0.25	1.5	10.75
	Fit Aerodynamic Side Skirt	1	3	4	8	1	0.75	3	4.75
	Improve Conspicuity	1	5	3	11	1	1.25	2.25	4.5
	Fit Stronger and Lower Side Guards	1	4	3	8	1	1	2.25	4.25
Overtaking	Provide Cycle Lane	8		3	11	8	0	2.25	10.25

It should be noted that fitting current sideguards (i.e. ending exemptions) was not among the top measures for either manoeuvre. The confidence that coders had in the ability of the improved sideguard measures also varied by manoeuvre. For turning left accidents it was considered to have a possible influence in a substantial number of collisions but there was never sufficient confidence to consider classifying it as “definite”. When “going ahead other” the probability levels for the sideguard measures were slightly more evenly distributed.

6 Discussion

The aim of this report was to inform consideration of the likely effectiveness of sideguards on HGV to pedal cycle accidents where the HGV was either passing or turning left, both with respect to the aims and recommendations of the TfL cycle strategy for London and for GB nationally.

The analyses have clearly shown, based on the national accident database Stats 19, that collisions between pedal cycles and HGVs have higher relative priority in London than in the rest of GB. In addition to this, the most common type of collision is different; in London accidents where the HGV is turning left are more important (relative to other pedal cycle to HGV collisions) than in the rest of GB. These findings are consistent with those of Keigan et al (2009).

When the effect of sideguards on accidents where cyclists collide with the side of an HGV passing in an approximately straight line are considered, then all of the existing literature and new analyses are in agreement. Sideguards have no effect on the frequency of accidents but have been very effective in reducing the severity of injuries received by pedal cyclists when such accidents do occur. The literature, the analysis of exempt vehicles and the HVCIS countermeasures all suggest that modest additional benefits would be possible if the exemptions to current regulations were ended and/or if the technical requirements were enhanced, typically to cover increased area with reduced ground clearance and fewer projections. However, a review of commercial vehicle safety priorities (Robinson & Chislett, 2010) suggested that the most cost effective sideguard improvements were still a relatively low priority compared to other commercial vehicle safety measures.

However, when the effect of sideguards on accidents where a cyclist collides with the nearside of an HGV turning left the findings are more variable. Almost all of the literature and the “before and after” study suggest there should be little if any effect on accidents involving left turns. This has been explained theoretically, based on in-depth accident case studies, which suggest that these turning left accidents often involve a collision with a cyclist towards the front of the vehicle which knocks the cyclist to the ground. As the HGV progresses with its turn, the rear of the vehicle “cuts-in” to the corner and the sideguard passes over the top of the prone cyclist who gets run over by the rear wheels.

In contrast to these findings, the analysis of exempt vehicles has suggested that vehicles equipped with sideguards are both less likely to become involved in a left turn collision with a cyclist and less likely to cause serious injury when they do become involved in such a collision. The explanation for this contrasting finding is not clear but neither the “before and after” nor the exempt vehicle analysis has attempted to control for confounding factors so there are a number of possible explanations for the apparent conflict of results based on different methods:

- Some new trend or confounding factor has emerged between 1982 and 2006 that has masked the positive effect of sideguards on left turn accidents such that it was not visible in the “before and after” analysis.
- Some other feature of vehicles exempt from sideguard regulation (e.g. tippers, skip loaders, refuse vehicles) is responsible for their over-involvement in serious left turn collisions. Such features could include an increased exposure to risk due to a higher than average use in urban areas or perhaps differences in the direct or indirect field of view.

Which explanation of the results is correct cannot be proven with the available data but the fact that the physical tests and theory reported in the literature supports the view that sideguards are primarily effective when trucks are passing in a straight line suggests that the 2nd explanation is more likely.

Keigan et al (2009) and the analysis of HVCIS fatal data both suggest that there is some chance that improved sideguard design could potentially improve injury outcomes for cyclists in collision with an HGV turning left. However, both allow considerable uncertainty:

- Keigan et al (2009) did not attempt to assess the likely effectiveness
- The HVCIS database uses a probability system to assess effectiveness and none of the cases where improved sideguards were considered as a possible measure in turning left accident were coded as “definitely” being effective.

The basis of the possibility that improved sideguards could influence left turn accidents is that if the bottom edge of the sideguard was closer to the ground then it would not pass over a prone cyclist in the same way as a current sideguard design does but would instead push the cyclist out of the way of the rear wheels. The uncertainty comes from the fact that it is not known what injuries might be caused as the cyclist is pushed out of the way and whether in fact various parts of the body could be squeezed and crushed into the smaller space under the sideguard. Testing for these possible effects would not be easy because existing test tools (e.g. anthropometric dummies) do not adequately represent the friction or compression/crush characteristics of the human body in these circumstances.

The HVCIS database suggests that alternative measures may be more effective in these left turn collisions, in particular “improve side vision”. It should be noted that the countermeasure “improve side vision” can be used to represent any countermeasure enabling the presence of the other road user to be detected and, in time, the benefits may therefore be achieved by a properly developed electronic warning system that is capable of alerting drivers to the presence of vulnerable road users such as cyclists and pedestrians. Robinson & Chislett (2010) ranked such a vulnerable road user warning system as one of the top 5 commercial vehicle safety priorities, based on the assumption that it would work all around the vehicle, not just at the side.

7 Conclusions

Accidents between HGVs and pedal cyclists have higher relative priority in London compared with the rest of GB. In London, left turn accidents are a higher relative priority than other HGV/Pedal cycle collisions but in the rest of GB this is not the case. It is, therefore, likely that the most cost effective safety measures may be different if implemented only in London compared to if they were implemented across GB.

All of the evidence suggests that existing sideguard designs have been very effective at reducing the severity of injury sustained by cyclists in collision with an HGV passing in an approximately straight line.

There is conflicting evidence of the effects of sideguards on accidents where pedal cyclists collide with an HGV which is turning left. Most evidence suggests that there will be little, if any, effect. However an analysis of exempt vehicles suggests that sideguards have a significant effect both on reducing the frequency of such collisions and on reducing the severity of injuries sustained when these collisions do occur. Which analysis is correct cannot be proven with the data available to this study.

All of the evidence suggests that if the exemptions to the fitment of current sideguards were ended and/or the design of existing sideguards was improved it would produce additional casualty savings in accidents. However, these savings are likely to be relatively modest and were not ranked highly in the Robinson and Chislett (2010) study of commercial vehicle safety priorities.

There is some evidence to suggest that improved sideguards with a lower ground clearance could have some effect on left turn accidents but there is also considerable technical uncertainty regarding the likely effectiveness of such a measure. The HVCIS database and the Robinson and Chislett (2010) review of commercial vehicle safety priorities both suggested that countermeasures that improved the field of view would be more effective. In this context, improved field of view could mean any system that improved the ability of the HGV driver to recognise the presence of a cyclist in a dangerous area. It could potentially be implemented either through changes to direct or indirect vision, or by the introduction of emerging technologies such as vulnerable road user warning systems, which was ranked by Robinson and Chislett (2010) as one of the top five commercial vehicle safety priorities.

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Appendix A HVCIS Countermeasure Definitions

A.1 Improve forward vision

This should be considered as a countermeasure when an accident has occurred because the driver was definitely, probably, or maybe unable to see the other party because the visibility from the front of their vehicle was restricted by the vehicle structure. A classic example is when an HGV is waiting at a pedestrian crossing and a pedestrian attempts to cross just before the lights change. When a pedestrian is very close to the front of an HGV the driver is sometimes completely unable to see them, particularly if they are not very tall. Hence, when the lights turn green the HGV driver pulls away, because they cannot see anything in front of them, and the pedestrian is run over. If the forward vision is improved such that the driver is physically able to see the pedestrian it is almost certain that the accident could be avoided. It becomes less clear cut in other accident situations where it is less clear whether a third party wasn't seen because they were in a blind spot or whether the driver simply wasn't looking. In these cases lesser probabilities should be used at the discretion of the person coding.

A.2 Improve side vision

This should be considered as a countermeasure when an accident has occurred because the driver was definitely, probably, or maybe unable to see the other party because the field of view down the side of their vehicle was restricted by the vehicle structure. A classic example is a Bus or Coach waiting at lights to turn left. As it pulls forward it moves out to the right to make room for the turn and a pedal cyclist moves up the inside not realising that the Bus or Coach is about to turn left. There can be blind spots for a Bus driver by the nearside front wheels and to the rear of them (dependent on mirror size and position). If the view to the side was improved such that the cyclist could be seen (irrespective of the means by which it is achieved, direct field of view, mirrors, cameras or other, electronic, means) then this countermeasure should be coded. The probability to be assigned will be dependant on whether the coder considered that the driver was paying full attention, reasonable attention, or little attention. If the driver wasn't checking his mirrors it doesn't matter how good they are, he still won't see the cyclist.

A.3 Fit current side guards

Previous accident data has shown that in general side-guards have been effective at preventing the type of accident for which they were designed. These accidents are those where an HGV overtakes a pedal cyclist or a pedestrian and they fall sideways into the side of the HGV between the front and rear axles. They were not designed to protect when a cyclist gets knocked to the ground by the cab of an HGV and then gets run over as the vehicle turns left. They cannot stop a person who is already lying on the ground from passing underneath. In general they are not strong enough to stop a car from under-running the side of the lorry.

Most HGVs now have side-guards fitted but some older semi-trailers are exempt on the grounds of age whereas tipping (and other special use) vehicles are exempt on grounds of use. Code current side-guards as a countermeasure when an overtaking accident as described above happens, the HGV involved is not fitted with, or has inadequate side-guards, and the cyclist/pedestrian is run over by the rear wheels.

A.4 Fit stronger and lower side guards

Test work has suggested that side-guards that just met the minimum requirements of legislation reduced the incidence of pedal cyclists being run over to 40% of the total. The incidence could however, be eliminated by reducing the ground clearance to 300mm. Survey work has shown that typical side-guards fall approximately half way between the two in terms of ground clearance. Reducing the height of a guard to the level recommended by the research could completely eliminate running over so this should be coded where a cyclist has fallen into the side of an HGV equipped with current side-guards but has still been run over. Use lesser probabilities if it looks like the existing guard is already very low (350mm or less). Legislation allows ground clearances of up to 550mm.

If the side-guard was made substantially stronger it might also be able to protect car occupants and riders of heavy motorcycles, in narrow angle glancing impacts with the side of an HGV. This is difficult to rigidly quantify though due to lack of test work and should be coded cautiously.

A.5 Fit aerodynamic side skirt

An aerodynamic side skirt is essentially a side-guard covered with a smooth sheet of glass-reinforced plastic. Survey and strength testing work has shown that current examples of these are stronger and that they typically have lower ground clearances than current rail-type side-guards. In general they also fill far more of the space between the wheels. This means that they should be coded in every situation where "stronger and lower side-guard" is a countermeasure. They have the added advantage that they present a smooth uninterrupted surface to the accident victim and are usually flush with the outer edge of the vehicle. All of these differences from rail side-guards are to enhance aerodynamic performance but test work has shown that they are all good features for improved safety. So, in addition to the benefits of stronger and lower side-guards also code this where a cyclist or pedestrian has fallen against the side of a passing HGV fitted with sideguards and not been run over. This is because the smooth surface helps to prevent severe impacts between the cyclist's head and projections such as load hooks, top edges of guards or supports and helps to prevent heavy contact between the chest and the outer edge of the rear tyre. An added benefit is that clothing and limbs are less likely to be caught in the structure of the sideguard resulting in the cyclist being dragged along by the vehicle. Tests also suggest that the cyclist is typically thrown to the ground with less force. In theory, young, healthy adults wearing cycle helmets should not be killed when involved as a pedal cyclist falling against the side of a passing HGV if this type of protection is fitted.

A.6 Provide cycle lane

Within the HVCIS fatal accident database, "provide cycle lane" is coded where it is considered that separation of the two vehicles could have prevented the accident. There is no specification for how this will be achieved and, therefore, the results for this should be considered "aspirational" rather than a prediction of the effects of a particular design of cycle lane.

A.7 Other

This countermeasure is used where the coder can think of other methods of reducing the severity of the casualties or avoiding the accident. The measure is then described in the comments box.

Sideguards on heavy goods vehicles: assessing the effects on pedal cyclists injured by trucks overtaking or turning left

In recent years there has been a substantial increase in pedal cycle traffic but at the same time the number of pedal cyclists killed and seriously injured in road accidents has reduced, implying a very substantial reduction in the casualty risk per km ridden. Transport for London (TfL) developed and published a “Cycle Safety Action Plan” (TfL, 2010) that proposed a wide range of actions to improve cycle safety. The actions include, under the heading “technology”, working with the freight industry to identify the most cost-effective commercial vehicle safety measures that could be fitted either to new vehicles or to the existing fleet. The action specifically states that sideguards and motion sensors will be considered.

This study has drawn together the findings of research literature, in particular three recent studies that consider heavy vehicle safety generally and/or sideguards specifically, and undertaken analysis of relevant accident data in order to inform consideration of the likely effectiveness of sideguards in terms of mitigating pedal cycle casualties in London and in GB as a whole.

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