

ECF report on HGV cabs direct vision and amendments to Directive 96/53

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1.0 Introduction

The vast majority of trucks are designed to maximise the load space that can be achieved within the legally permitted maximum dimensions. These dimensions are laid down in Directive 96/53 which is currently under review for amendment. This means that the 'brick' shaped cab above the engine is virtually universal across the EU. We believe that the current dimensions play a part in the cycling serious injuries and fatalities that we see on European roads and that with an amendment to the law comes an opportunity to combat some of the features that make HGVs a threat to cyclists and others on our roads.

There are many problems with the current dimensions including

- The inefficient aerodynamic structure
- The lack of direct vision at the front and front/side of the cab because of the poor shape, the high position of the cab and lack of sensible windscreen and side door coverage
- The box shape tends to knock cyclists/pedestrians over and then into the path of the wheels rather than deflecting away from the vehicle
- There are no absorption qualities at the front of the HGV for impacts with other road users
- There is no 'crumple zone' to protect the driver or other vehicles (usually cars) in the event of an accident

This brief report will focus on the possible advantages of changing the shape of the HGV for the reduction of direct vision blind spots. We also believe that extra dimensions allowed should also be used for the benefit of a Crash Management System to increase the safety of accident of other vehicles and the deflection of cyclists and vulnerable road users.

2.0 Accidents with HGVs

Heavy Goods Vehicles (HGVs) make up 3% of the European vehicle fleet and 7% of driven kilometres, yet they are involved in 18% of fatal accidents, costing over 7000 lives across the EU in 2008¹. Some 22% of the cyclists killed in the EU die following collisions with all types of goods vehicles²;

“This proportion is 43% in Belgium, higher than the number of deaths following collisions with cars. The same is true for the Netherlands where 38% of cyclist deaths follow collisions with goods vehicles. Goods vehicle collisions also account for a considerable proportion of cyclist deaths in Great Britain with 33%, Denmark with 31% and Slovakia with 29%.³” (Note these figures include light as well as heavy goods vehicles)

Vehicle Type	Number of vehicles	
	London	Rural
Motorcycle	4	-
Car/taxi	33	32
Minibus	-	1
Bus/coach	8	1
Goods vehicle <3.5t	13	-
Goods vehicle >3.5t	37	8
Other motor vehicle	-	2
Ridden horse	-	1*
Total	95	45

Figure 1 types of other vehicle involved in pedal cycle collisions, London and rural areas, showing the high numbers of HGV collisions with cyclists

HGV fatalities involving cyclist are more likely to result in serious injury or death than collisions with other vehicles. For example in the UK 10% of accidents between HGV and bicycles led to a fatality and over a third leading to serious injury or death. This has been shown to be a serious issue within urban areas. For example Transport Research Laboratory TRL (Figure 1 below) has shown this to be a particular problem in London. Indeed during the latter part of 2013 there were 14 cycling deaths, 9 of which were as a result of a crash with an HGV.

The most common incident involving HGVs occur when the HGV turns right (or left in Cyprus, Ireland, Malta and the UK) without being able to see the cyclist sitting in an unsighted area to the side or just in front and to the side. The cyclist is knocked off the bicycle and falls under the HGV as the HGV turns and the cyclists goes under the wheels. In the Netherlands SWOV have estimated⁴ that 68% of accidents between cyclists and HGV's occur at the front-right of a right turning

¹ TRL 2010 for EC DG Enterprise and Industry

² ETSC, Pedalling towards Safety, 2012 http://www.etsc.eu/documents/BIKE_PAL_Safety_Ranking.pdf

³ ETSC, Pedalling towards Safety, 2012 http://www.etsc.eu/documents/BIKE_PAL_Safety_Ranking.pdf

⁴ De toedracht van dodehoekongevallen en maatregelen voor de korte en lange termijn Ing. C.C. Schoon, dr. M.J.A. Doumen & D. de Bruin, 2008

HGV. A Transport for London (TRL) report⁵, figure 2, shows that the high number of HGV collisions in London occurs with blind spot right turn (left in the UK) manoeuvres at junctions.

Collision Type	Number of Collisions
Vehicle turning into side road (cycle on inside)	18
Cyclist crossing or entering road into path of vehicle	1
Cyclist lost control – fell/went into path of vehicle	3
Vehicle moved to nearside colliding with cyclist	1

Figure 2 Types of collision involving HGVs at London junctions

TNO⁶ found that some 36% of fatalities were in “blind spot” accidents, defined as goods vehicles turning right and cycles/mopeds going straight ahead. With regards to positioning of the blind spot accidents TNO found that though many of the incidents occur behind the door and along the side of the HGV there are also a significant amount that occur at the front, front/side and side, in other words to the front of the door or at the door of the HGV.

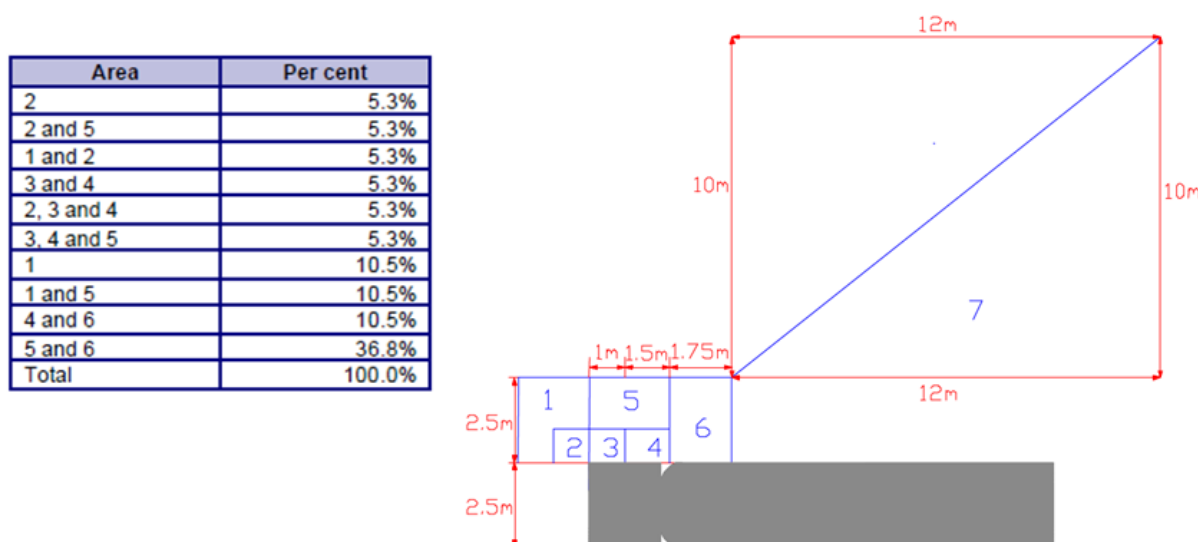


Figure 3; position of accidents with HGV and two wheel vehicles

3.0 Some HGV Vision problems

A Danish report for the Danish Road Accident Investigation Board found limited and poor visibility at the front and side/front of the cab graphically⁷ pictured below

⁵ Keigan, Cuerdan and Wheeler (2009) Analysis of police collision files for pedal cyclist fatalities in London, 2001-2006. TRL report PPR 4338. Wokingham: TRL Limited

⁶ Fields of vision related victims among small two-wheeled vehicles: a European perspective, TNO, November 2001

⁷ Danish Road Accident Investigation Board , 2006, Ulykker mellem højresvingende lastbiler og igeudkørende cyklister



Figure 4 Distance in front of vehicle, necessary for cyclist to be seen directly by driver and the view from the cab, showing little leeway for error

Again from the front and the cab

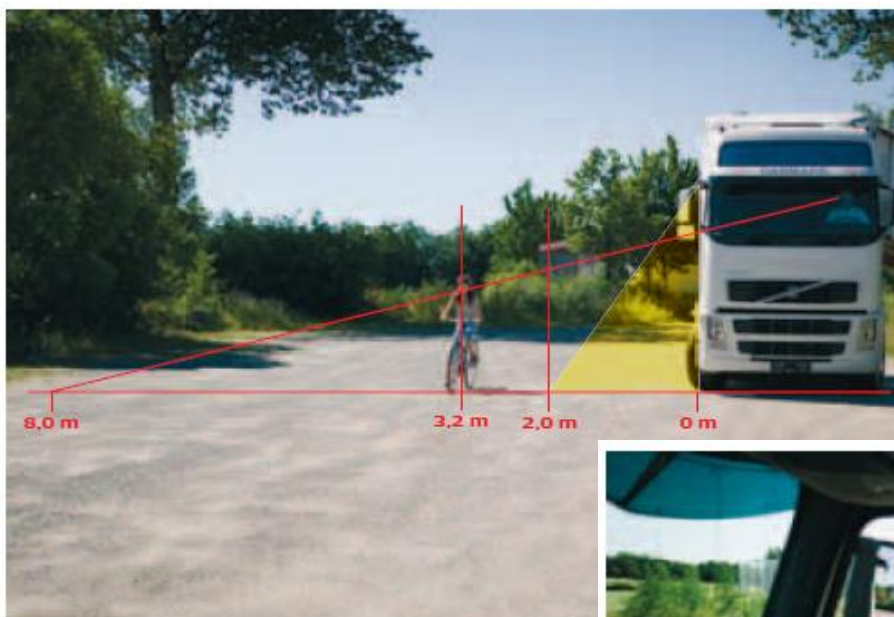


Figure 5 Distance to side of vehicle, necessary for cyclist to be seen directly by driver



The Danish report makes some recommendations to overcome some of these perceived limits to vision around the cab, including;

- Lowering the driver position
- a low-level window at the door to better see around the cab
- A lower windscreen level
- Restricted urban access to HGVs that have a high driver seating position

Possible future vision specifications suggested by the report state;

“The driver shall be able to directly see an object placed 1.5 m above ground level, at a distance more than 0.5m from the side or front of the vehicle, and in front of the rear cabin wall. Exceptions shall be allowed for areas around pillars, door-frames, and mandatory mirrors”⁸

Loughborough University, using their Digital Human Modelling systems SAMMIE, have shown that the combined vision of direct and indirect vision in compliance with current regulations still show some areas of blind spot and poor vision for drivers. Their analysis identified blind spots between the volume of space visible to the driver through the Class IV and V mirrors and the direct vision through the window⁹;

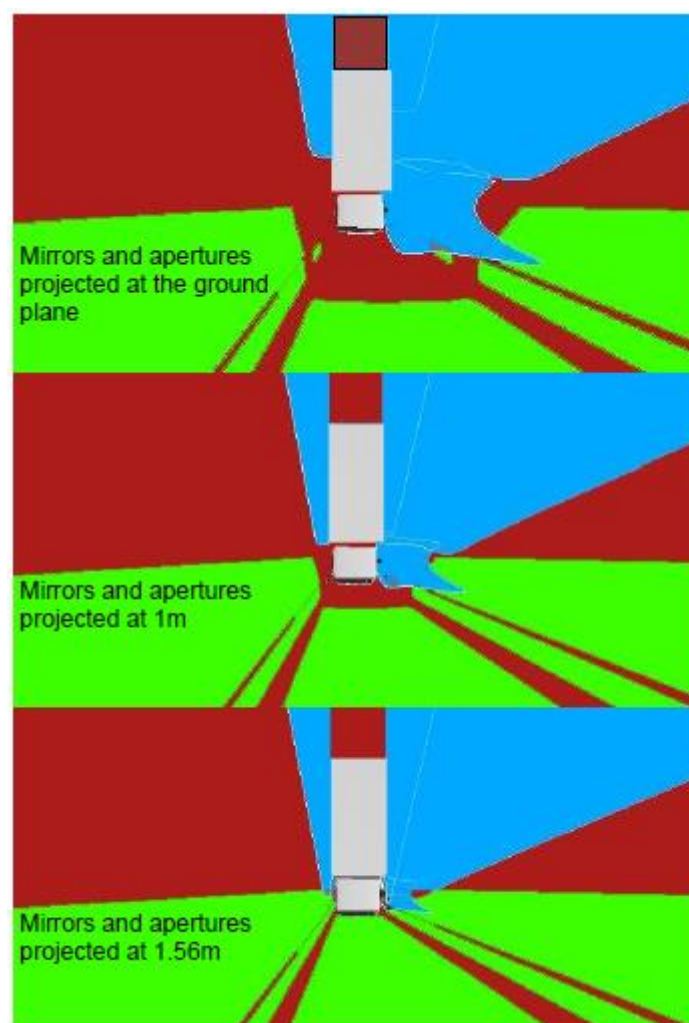


Figure 6 Projection of field of vision of an IVECO Eurocargo HGV. The first panel shows the projection of mirrors along the ground plane, the second at a height of 1 meter and the third at a height of 1.56m. Red indicates area of poor vision/blind spot

⁸ Danish Road Accident Investigation Board , 2006, Ulykker mellem højresvingende lastbiler og igeudkørende cyklister

⁹ Loughborough University, 2011, The Development of Improvements to Drivers' Direct and Indirect Vision from Vehicles – Phase 2



Figure 7 Blind Spot between the Class IV and V mirrors and window Direct Vision

Some recommendations raised from the Loughborough report include.

- An examination of the driving position. The position of the driver becoming higher and higher which “can lead to a significant zone of obscuration close to the vehicle at the sides and front”¹⁰
- The positioning of the windscreen and window panels in the doors need to take into account vision parameters and not just ‘stylised’ designs. (This is backed up by a UK DfT report “The size and shape of the passenger side window and the relative position of the drivers ocular point has a noticeable effect on the extent of the ground plane field of vision available to the driver of the HGV”¹¹)
- Proposing the Class V mirror being extended to attempt to compensate for the poor vision and blind spot for drivers around the side and front of the cab (eventually taken up by UNECE and will be introduced into 2014 type approval)¹²
- The need for some technological solutions such as braking sensors or cameras

The Phase 1 Loughborough report asks whether these issues “...prompts the question of whether the present standards for direct field of view, which currently only apply to cars and light goods vehicles, should be developed to also apply to the larger vehicle classes.”

A Transport for London report¹³ found that different vehicles had very different non-visible areas both at front, front/side and behind the cab. Mirrors, though set to EU standards, were often not able to cover major areas. Mirrors themselves were getting in the way of direct vision, dashboards and windscreen designs also had a major effect, as did the height and position of the driver in the cab. This was particularly the case concerning construction vehicles, tippers and cement mixer vehicles. This has major implications for cyclists and indeed all VRU’s since these types of HGVs are most commonly used in urban areas and settings. In fact this report was initiated due to extremely worrying figures from the city, such as “of the 16 fatalities in 2011, nine involved an HGV, and seven of these

¹⁰ The example they give is of the Renault Magnum the side window of which is 2.3 metres from the floor

¹¹ Todd, 2009, Follow up Study to the Heavy Goods Vehicle Blind Spot Modelling and Reconstruction Trial <http://www.dft.gov.uk/rmd/project.asp?intProjectID=12777>

¹² This recommendation to have the Class V mirror extended from 2 metres to 4.5 metres has been updated at UNECE and will be applied to new EU Type Approvals from 2014

¹³ Delmonte et al, Construction logistics and cyclist safety, Technical report, 2012, TRL <http://www.tfl.gov.uk/microsites/freight/publications.aspx> ; Construction logistics and cyclist safety - Summary report (PDF 1MB); Construction logistics and cyclist safety - Technical report (PDF 5MB)

were a construction vehicle". 2013 saw similar figures with regards to A high number of construction HGVs involved in cyclists collisions and fatalities.

The TfL report found that there are many problems with poor vision and full blind spots with these vehicles.

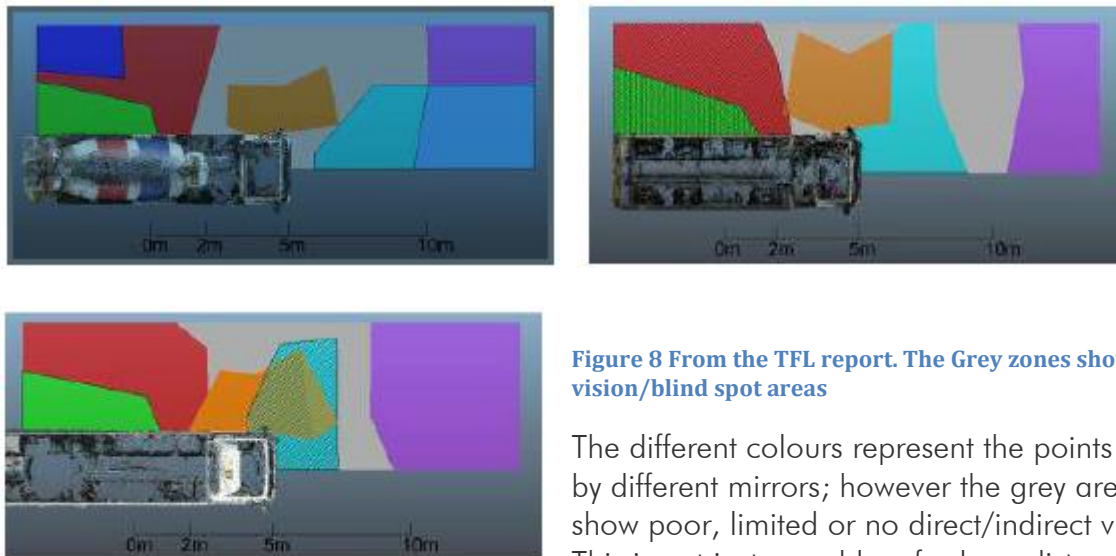


Figure 8 From the TfL report. The Grey zones show poor vision/blind spot areas

The different colours represent the points visible by different mirrors; however the grey areas show poor, limited or no direct/indirect vision.

This is not just a problem for long distance

freight lorries, but also, if not more importantly for construction and HGVs that operate within urban areas.

Some of the recommendations from the report (with relevance to Directive 96/53) include

- The driving position should be examined "the driving position in one of the construction vehicles studied in this research was higher off the ground, which may have resulted in an increased area directly through the side windows and windscreen that was not visible to the driver"
- Changes to windscreen and dashboard design to allow for greater direct vision, particularly to extend downwards
- New technologies and mirror design should be examined.
- Making sure any mirror modifications does not increase the drivers workload

4.0 Problems with indirect vision

A paper reviewing a number of sources on driver glances into mirrors shows that the mean glance time into a single mirror to be just over a second¹⁴. A review of mirror scanning¹⁵ shows that travel time between mirrors is around 0.32 – 0.34, so before a manoeuvre looking at all mirrors as well as the direct vision driver side glances could mean between 4-6 seconds between looking from the first mirror to the last before then starting the manoeuvre. This also discounts longer glances in certain mirrors, glancing at control

¹⁴ Taoka, 1990, Duration of Drivers' Glances at Mirrors and Displays

<http://www.ite.org/membersonly/itejournal/pdf/JJA90A35.pdf>

¹⁵ Sodhi, M. & Reimer, B., (2002) Glance analysis of driver eye movements to evaluate distraction

<http://link.springer.com/article/10.3758%2FBF03195482>

panels, perhaps a navigations system, the time between first looking into the first mirror and then starting on the manoeuvre can be a long time. Within that time cyclists can easily transverse the length of a lorry, or change direction into an area that the first mirror covers but was last viewed 5 seconds before a manoeuvre. This is essentially another blind spot, a temporal blind spot, rather than a spatial blind spot but a blind spot none the less.

There is also the problem of driver overload, being able to take on too much visually to make a decision.

This is compounded by the fact that some mirrors are curved convex to allow for a greater depth of view¹⁶, but again this adds to the drivers processing time as there will be variations in speed with these curved mirrors, as well as distance perspective. Another mirror issue is correct adjustment. Within the Danish report of 25 HGV and cyclist accidents, 21 had incorrectly adjusted mirrors, many of these were the blind spot mirrors, and many of the mirrors were creating a blind spot of their own. Some studies have shown that only a slight incorrect calculation in the mirror adjustment can bring about extra blind spots to appear around the cab¹⁷.

¹⁶ As with the proposed extension to the Class V mirror in 2014

¹⁷ Dodd, M. 2009. Follow on study to the heavy goods vehicle blind spot modelling and reconstruction trial. Published report PPR403

High cab position

Before the 1980's HGV cabs were based around the needs of the cab, the engine, cooling systems etc. with the arrival of the Volvo Globetrotter the cab began to bear the needs also of the driver in mind; and rightly so. However it seems that because of the space limitations resulting from Directive 96/53 there has been a battle for space in the design of HGV cabs. Up to now that battle has not considered the needs of the driver to be able to see around the cab. Directive 96/53 gives a limit on overall size, but not on cab size; payload considerations then give rise to incorporate driver comfort/safety and engine requirements. This has led to higher and higher cabs and seating positions, a lack of vision consideration through windscreen and side door panels and a reduction in the direct vision.



Figure 9, Comparison between a traditional construction HGV and its possible redesign with lower, better placed cab

There has been no regulation around direct vision (we have a direct vision regulation for a 1.5 tonne car but not for a 44 tonne HGV) and the regulation that we do have for lorries have created a dangerously high cab with limited direct vision. An excellent design has been proposed by London Cycling Campaign¹⁸ to lower the cab of HGV and construction HGVs to approximate the superior windscreen and cab position of N2, N3

vehicles such as buses and coaches that are used exclusively in urban areas and have much better safety records¹⁹

There have also been some designs that have already been prototyped²⁰.



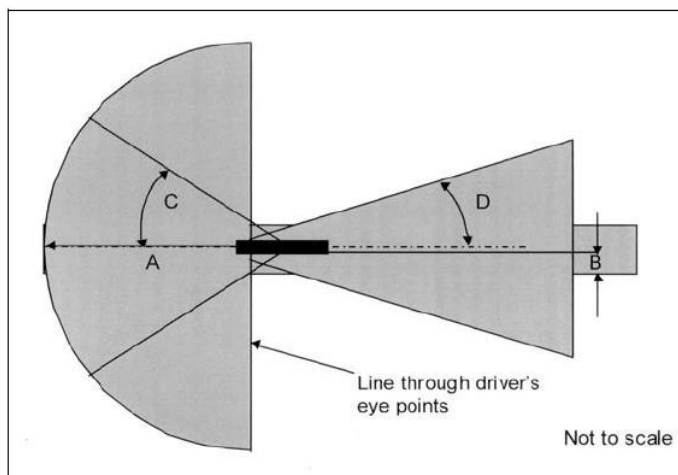
Figure 10 such as this prototype Mercedes Benz cab. Low driving position, large windscreen and fully glazed doors.

¹⁸ <http://lcc.org.uk/articles/lcc-challenges-construction-industry-to-adopt-its-safer-urban-HGV-to-reduce-HGV-cyclist-deaths>

¹⁹ A video of these two views can be found here <http://www.youtube.com/watch?v=Nqvd2fxlhXk&feature=youtu.be>

²⁰ Mercedes Benz Econic from picture from Daimler <http://media.daimler.com/dcmedia/0-921-614216-1-702589-1-0-0-0-0-1-12759-614216-0-0-0-31-0-0-0.html>

5.0 What should the driver be able to see – Vision requirements

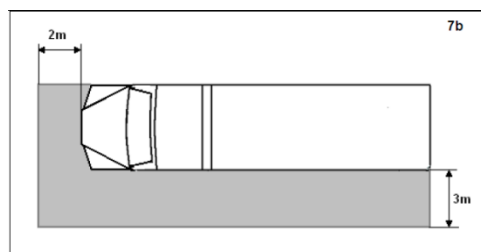


We have the basis for discussion on what the driver should be able to see. Tait and Southall²¹ proposed a method for defining the minimum field of vision for larger vehicles of all categories M2, M3, N2 and N3. This seems to be a reasonable benchmark for defining the full vision of larger vehicles it takes into account movements of the cab and its forward movement, braking distance etc.

- an average stopping distance for large road vehicles travelling at 90 kph
- Lane width 3.65m
- Takes into account the full lock position of a large vehicle

The idea is that all this area can be viewed by either direct or indirect means. This could be a starting point of what a driver must be able to see in these vehicles. However more to the point how much of this should be viewed by direct or how much by indirect vision. The best case scenario for direct vision requirements would be a full 180 degree vision (or more) around the cab. The problem is however at what height of coverage off the ground and through the windows/mirrors should be seen.

Danish Road Accident Investigation ²²report suggests “The driver shall be able to directly see an object placed 1.5 m above ground level, at a distance more than 0.5m from the side or front of the vehicle, and in front of the rear cabin wall. Exceptions shall be allowed for areas around pillars, door-frames, and mandatory mirrors”.



²¹ Tait and Southall. 1999. Drivers' field of view from large vehicles – Phase 4 Final report. Loughborough University. Report for the Department for the Environment, Transport and the Regions.

²² Danish Road Accident Investigation Board , 2006, Ulykker mellem højresvingende lastbiler og igeudkørende cyklister

Japan is another example of a country that uses vision performance based standards. They integrate direct and indirect fields of view into one performance-based standard. They take a vertical cylinder, 1m tall and 0.3m in diameter (representing a 6 year old child.) Some portion of this target must be visible to an observer in the driver’s seat, when the target is placed at any location within zones adjacent to the front or nearside of the vehicle (see picture below). The target may either be directly visible or else indirectly visible using mirrors, camera / monitor systems, or any other form of device. The US School bus vision requirements FMVSS111 are similar though the US standard also requires a required size of the object as it appears in the mirror to overcome problems with curved mirrors. These would perhaps seem well suited to urban areas and the lack of clear prescriptive rules may mean easier adaptation by manufacturers.

Immediate problems with this that spring to mind include difficulties of drivers moving from one type of vehicle to the next and having to adapt to a new HGV. This would be difficult to emerge into driving education, testing or qualifications perhaps. It could also lead to a reliance on indirect vision, though perhaps a similar requirement could be made for direct vision alone.

However there are tools that can be used to test the vision options for HGVs, for example Digital Human Modelling systems. As we have seen Loughborough University have their SAMMIE system an example was provided to ECF by Loughborough University of their system to exhibit how it could work showing, for example, improved direct vision through the addition of window side panels in doors.

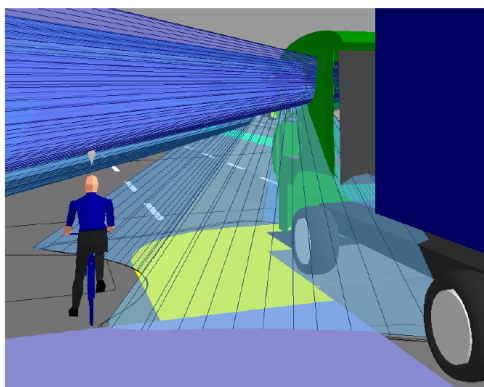
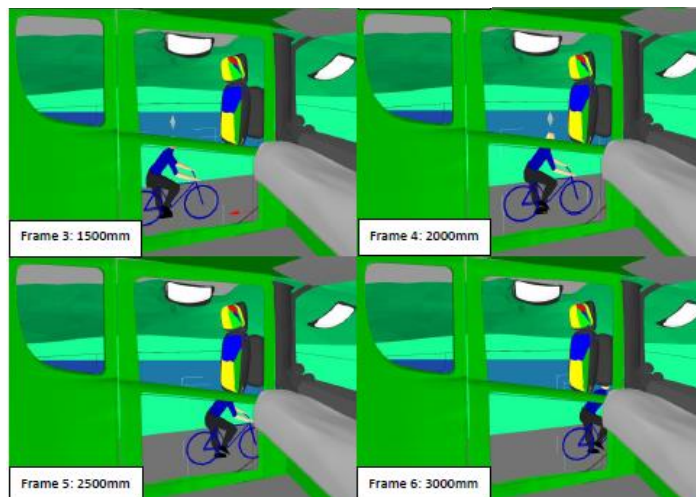


Figure 12 this sequence shows the direct vision possible from additional side panel windows in the door.

Figure 11 this is the current direct and indirect view from the cab showing the poor/blind spot vision from the cab



These types of analyses could be useful to indicate

- The direct vision benefits of a lowered seating position
- Additional/extended or better mirrors
- The impact of windscreen shape and size
- The impact of window side panels in the doors

And can also help to identify other safety specific provisions

6.0 Conclusion on problems for HGV vision

With regards to direct vision it seems that a major obstacle is

- the height of the seating position
- the design and style of the windscreen door windows
- lack of lower transparent door panels²³

With regards to indirect vision there are questions concerning

- the ability of drivers to physically be able to scan all mirrors within a sufficient enough time scale
- consistent correct adjustment of the mirrors
- Continued existence of blind spots without coverage

A conclusion of many of these reports is that it is important to lower the height of the cab, or more specifically to lower the eye line of the driver and bring the cab down from its very high position. Another is to provide better coverage through the windscreen and doors. Also we seem to be relying on indirect vision and mirrors currently, there is good reason to believe that though they are a good aid to a driver seeing around the cab it is a mistake to over rely on these tools, or at least to rely on these tool instead of, or at the expense, of good direct vision from the cab.

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²³ Loughborough conclude that side door panels on the driver side are not useful as the drivers body obscures the view

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