Direct Vision Standard: Pushing the Blind Spot
Agenda

Transport for London Update
HGV safety permit scheme proposals for London

**October 2019**
Scheme ‘go-live’

**October 2020**
0-star banned unless safe system met

**October 2024**
0-2 star banned unless progressive safe system met

+Procurement contracts
Direct Vision Standard (DVS) HGV Safety Permit Application

Start your application by checking if your vehicle meets the DVS HGV Safety requirements and apply for a permit if necessary.

Learn about the Direct Vision Standard

Single vehicle application

Enter number plate (Vehicle Registration Mark)

Eg. AB23XYZ

Select country of registration

- United Kingdom
- Non-UK

Multi-vehicle reference number (if applicable)

Multi-vehicle applications

Organise your vehicles by downloading the VRM list template (CSV format) to get started:

Download VRM list template

Ready to submit your vehicles?

Start multi-vehicle application

Check star rating
Enforcement – from October 2020

ANPR reads VRM

Is it an N3 HGV?

Check against DVS permit database

Issue PCN if not in database

On-street enforcement collaborations

Issue PCN if Safe System conditions breached
An international standard

TfL remain fully committed to, and supportive of, the current GSR proposals.

Reducing blind spots to the “greatest possible extent” requires an ambitious minimum star rating for all categories of vehicles.

Achieving a meaningful reduction in serious and fatal collisions between trucks and pedestrians and cyclists, particularly in urban areas, demands an ambitious minimum star rating.

“Vehicles of categories M2, M3, N2 and N3 shall be designed and constructed so as to enhance the direct visibility of vulnerable road users from the driver seat, by reducing to the greatest possible extent the blind spots in front and to the side of the driver, while taking into account the specificities of different categories of vehicles”.

"Every journey matters"
Thank you

Website: tfl.gov.uk/direct-vision-HGVs

Email: DVS@tfl.gov.uk
Looking out for vulnerable road users

Definition and testing of a Direct Vision Standard for Trucks – A physical test to supplement the virtual DVS method

Loughborough University Design School: Design Ergonomics Research Group
Research Sponsored by Transport for London

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Contents

• A reminder of the fundamentals of the TfL DVS process
• An update on the development of physical test
• An analysis of the potential benefits of adding an aerodynamic front end to the HGV cab
• The LDS view of applicable of star ratings for the Category N2 and N3 vehicles in Europe
The definition of a ‘real world’ test that can be used for on the spot checks

- At the last VRU Proxy meeting we showed developments for a physical test method

- As discussed at the last meeting the CAD approach should be seen as the gold standard in terms of the accuracy and ability to support the design process for improved direct vision, due to the high resolution nature of the test process

- The following content shows the development of the physical method which exploits the digital code and ability to generate results for multiple cab heights from a single cab analysis and data on the height range for the cab
Reminder – the digital DVS methodology

- The assessment volume is aligned to the truck sides and front
Reminder – the core DVS methodology

- The volume of space visible from the three defined eye points is projected through predefined window apertures.
Reminder – the core DVS methodology

- The visible volumes are intersected with the assessment volume to allow the proportion of the assessment volume that is visible to the virtual driver to be calculated
Reminder – the core DVS methodology

- The forward eye point is defined by an offset from the accelerator heel point (AHP)

- This eye point was defined with the agreement of manufacturers and is a standardised eye point which can be used with any vehicle

  - Multiple other options were considered including using standard hip point (SgRP) definitions and offsets for an eye point as defined in UNECE regulation 46, however these led to some manufacturers gaining an advantage when a full analysis of all trucks was performed due to variability in the use of the SgRP within the H-point envelope

- The eye point has been defined by taking into account the seat positions of all trucks (common h-point location identified), combined with an offset from the seat which replicates average European eye height for a truck driving posture
  
  - 50th%ile male and female offsets identified for UK, Germany, Holland, France, Italy, Sweden and then this is averaged with a 90:10 male female split.
Reminder – the core DVS methodology

- The ‘eye rig’ is generated to simulate the view of virtual driver to the front, left and right of the cab using the premise defined by reg 125.
The use of VRU simulations to validate the volumetric results

- Top Left – The VRUs are shown around the truck
- Bottom left - the visible volume through the left window is shown
- Top right – The head and shoulders of the VRU intersect with the visible volume at the locations shown and the distances of all VRUs from the side of the truck are measured
The results: Volume plotted against VRU distance

0.97 correlation between volume scores and VRU scores: 0.5 is strong, 1 is perfect
Real world test that is being prototyped

Part 1 – using the seat to support an eye rig that can support three small wireless cameras
Part 2 – The use of computer algorithms to process the camera images to generate a DVS score
Initial rig proposal – adapting the SAE MANIKIN

- Uses three wireless cameras to allow views to be remotely captured outside of the cab
- Uses a weighted form that is supported by the seat to correctly locate the front camera location
- Uses the AHP calculations in SAE 1516
  - The SGRP height defines the foot angle for interaction with the A pedal
- Eye points match those used in the virtual version.
Part 1 – using the seat to support an eye rig that can support three small wireless cameras

Initial rig proposal – adapting the SAE MANIKIN  
Revised proposal – new rig
Part 1 – using the seat to support an eye rig that can support three small wireless cameras

- **Key features of the rig design**

  - **Platform for the three cameras**

  - When platform is horizontal the eye point is replicated as per the CAD version of the test

  - Adjustment of camera platform angle possible through the window with an adjustment screw

  - Loaded at the hip point in the same manner as the SAE manikin

  - Location of the rig associated with the AHP location by placing the rig with the ‘foot’ resting on the A-pedal

  - **Aluminium – Lightweight to enable easy access to the cab**
Real world test that is proposed for prototyping

Part 2 – The use of computer algorithms to process the camera images to generate a DVS score

This has been the main effort since the last meeting
Example test method – Stage 1: Investigator sets up the physical rig

1. The investigators set up the eye rig inside the cab, representing the eyepoint in left, forward and side positions. Cameras will be positioned to represent these three eyepoints, and will capture still images of what can be seen (both in terms of cab interior and features external to the cab)
Example test method – Stage 1: Investigator sets up the physical rig

1. We have built a cab rig which allows the testing of the process to be completed in our labs

2 sets of QR code type markers to determine the distance from the camera to the wall, and the edge of the assessment volume

Camera rig (3 Go Pro type Cameras) on a 3D printed structure
Example test method – Stage 2: A wall is orientated next to the vehicle

2. A moveable assessment wall will be used. On each of these walls, a number of markers (similar to QR codes) will be positioned in a triangular arrangement; two will be positioned with a set distance from the floor, and a third higher up (although the exact location/distance of this third marker relative to the two lower markers is less important). All markers must be visible in each eye point camera.
Example test method – Stage 3: Cameras capture the images for each view (right front and left)

3. The automated script recognises the position of these markers. The physical size of the marker is detected, and this in turn then determines their distance from the camera. Using triangulation, the algorithm seeks to fit a ‘plane’ through these three markers which can then determine the distance but also angle of the wall relative to the camera. The two lower markers can also be used to identify/determine the assessment volume height which will then be used later in the algorithm for volume assessment definition. A further set of three markers now determine the location of the assessment volume next to the truck.

Yellow highlighted markers determine the distance to the wall

White highlighted markers determine the distance of the inside edge of the assessment volume

Red line shows the window aperture being automatically generated
Example test method – Stage 4: Removal of distortion due to camera lenses

4. Any camera lens will distort the real world image and so this distortion has to be removed. There are two methods currently being used for

1. Using image processing software and then reimporting the path into the algorithm
2. Using a mathematical process within the algorithm to remove the distortion
3. The images below show the image with distortion, (left) and the distortion removed (right)
Example test method – Stage 5: Contrast in the image used to derive a window path

5. With the positions of the walls now set up, the creation of apertures can now be determined.

- By illuminating the walls, and keeping all other aspects of the setup dark there is sufficient contrast between the inside of the cab and the wall.

- Using contrast threshold adjustment techniques, it will be possible to determine a clear boundary between light and dark regions of the camera.

- The script will fit a spline around the areas with highest levels of contrast.
Example test method – Stage 6: The path and other info gathered generate a visible volume

6. With the splines created to determine the apertures, a digital projection from the eyepoint can be set up. This is achieved as the camera position is represented in the script with a point that is known in relation the walls and the sides and front of the cab.

6. The existing Grasshopper algorithm developed by Loughborough University for the Digital DVS can then be used; the projections can be trimmed with the assessment volume, and if necessary, a range of height iterations could then be made with the existing script, but based on physical geometry.
Free to use for all

The process defined uses two plugins which are third party. We have requested and received permission to use these plugins for the DVS work as long as the credit is given to the authors at no cost.
An important benefit of this technique

- The digital DVS technique can quickly calculate the DVS score for hundreds of potential cab heights

- For example, the cab height range for one model of a Daimler truck that we have tested is over 800 millimetres between lowest possible height and maximum possible height, and 800 results can be produced in three hours.

- By using real world data to feed into the same technique that defines the digital DVS, the power of the digital DVS to calculate results for multiple cab heights can be leveraged

- This means that it does not matter what the cab height is for the real world test vehicle, we can calculate all possible heights from one measured vehicle from height range data provided by manufacturers
Next steps

– To validate the results from the physical test against the digital (June 2019) in a lab based experiment

– To then test the rig in a truck cab (July 2019)

– To demonstrate the test method to end users

  – The testing of a vehicle in the real world, when compared to CAD data testing, could result in differences in the volumetric score

  – The size of these differences will be determined in part by the manner in which the variables discussed above are controlled in terms of rig placement and fluid levels in the vehicle, for example

  – It is highly unlikely that the physical test will provide the exact same results as the virtual test.

  – If the 1 star boundary is adopted by the EU as a minimum requirement, it may be that a real word test vehicle must reach a 1.5, or 2 star performance to be allowed to operate

  – The size of this tolerance will be determined by testing of the technique with a sample of vehicles
Next steps

- We are still considering the potential for a more basic system which would use the same camera rig, but use more traditional visual markers.

- As discussed in the last meeting, this technique looses many of the efficiency advantages of the approach currently being explored.
LDS recommendations for DVS limits to Category N3 and N2 vehicles
What do the star rating mean in real terms?

- A 1 star rating means that the average VRU distance for an array of 5 VRU simulations can be seen by the driver (head and shoulders) at a distance less than 4.5m, to the front at a distance of 2m (3 VRUs) and to the right at a distance of 0.6m (5 VRUs).

- This basically means that the VRUs should be within the area covered by the mirrors. The VRU chosen was a 5th percentile Italian Female on the premise that over 99% of Europeans are taller.

- If a vehicle if zero star it fails this test and so VRUs can be hidden from both direct vision and indirect vision.
  - Therefore a Zero star vehicle has blind spots.

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Zero * Poor
Mercedes 2.3m cab (H)

3* Good
Volvo FE LEC

5* Excellent
Mercedes Econic

Images show average distances VRUs can be seen to each side of the cab.
How does the sample perform?

Show the volumetric and star rating scores for each cab design at its highest and lowest possible mounting heights.

The coloured bars show the potential improvement of zero star vehicles by adding an Aerodynamic front.

Each cab design was analyzed at its lowest and highest possible mounting heights.
Analysis of the benefits of Aerodynamic front ends to improve DVS scores
How can the star ratings be improved

- The results indicate that the design of some vehicles needs to improve significantly to enable even the 1 star threshold to be met.
- There are examples of vehicles with high cabs which still perform well in the DVS due to their superior design with respect to DV.
- However the potential of addition of Aerodynamic front ends to truck cab is an opportunity to improve DVS scores.
- In order to explore the benefit, 6 zero star have been assessed with the addition of an **800mm Aerodynamic feature**:
  - DAF XF
  - DAF CF
  - Mercedes 2.5m cab width
  - Volvo FM
  - SCANIA R (2015)
  - Renault C 2.5

*Please Note. This analysis did not use manufacturers data. The assessment volume was simply modified to reflect an additional 800mm to the front of the vehicle.*
Show the volumetric and star rating scores for each cab design at its highest and lowest possible mounting heights.

The coloured bars show the potential improvement of zero star vehicles by adding an Aerodynamic front.
How can the star ratings be improved

- Of the 7 vehicles tested 2 achieved an improvement from a Zero star rating to a 1 or 2 star rating
  - Mercedes 2.5m cab width and Volvo FM
- Two vehicles were close to achieving a 1 star rating
  - DAF CF and Renault C 2.5
- Three vehicles would require considerable improvements to achieve 1 star
LDS recommendations for DVS limits to Category N3 and N2 vehicles
LDS recommendation

- Defining a TfL DVS rating limit for Category N2 and N3 should in our view be based upon the evidence of the LDS analysis of truck design performed in the definition of the DVS.

- It is clear that the highest Volvo FM can achieve a 2 star rating with an Aerodynamic front end.

- Therefore the recommendation for Category N3 is TfL DVS 2 star.

- It is clear that multiple vehicle cabs which can be Category N2 can achieve TfL DVS 3 star or better e.g. Mercedes 2.3m cab width can achieve 4 star.

- Therefore the recommendation for Category N2 is TfL DVS 4.5 star.

Mercedes 2.3m cab width can achieve 4 star at minimum cab height.
Project information

Thank you for your attention, are there any questions?

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