LOUGHBOROUGH
DESIGN SCHOOL

Loughborough University

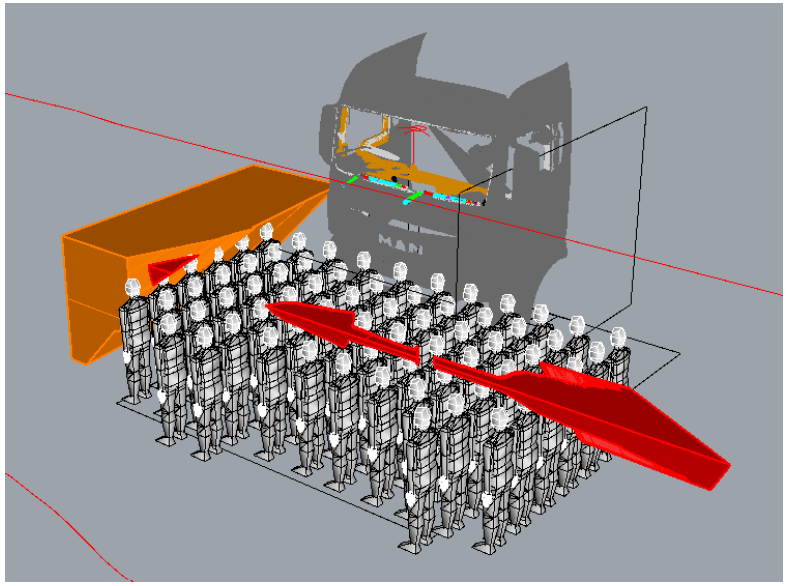
The potential application of the TfL Direct Vision Standard in UNECE regulation – Response to ACEA limit values

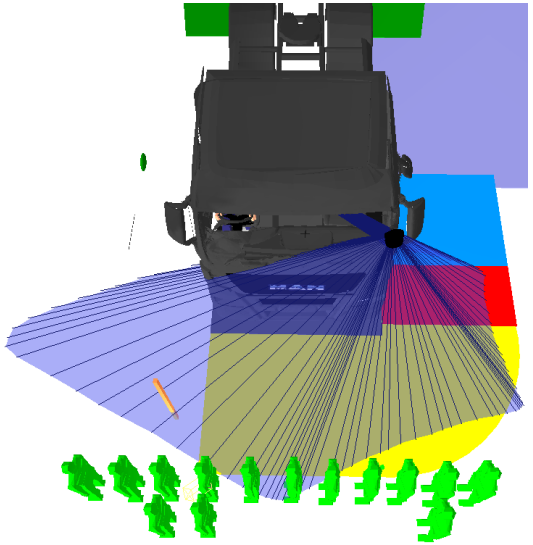
Loughborough University Design School (LDS): Design Ergonomics Research Group

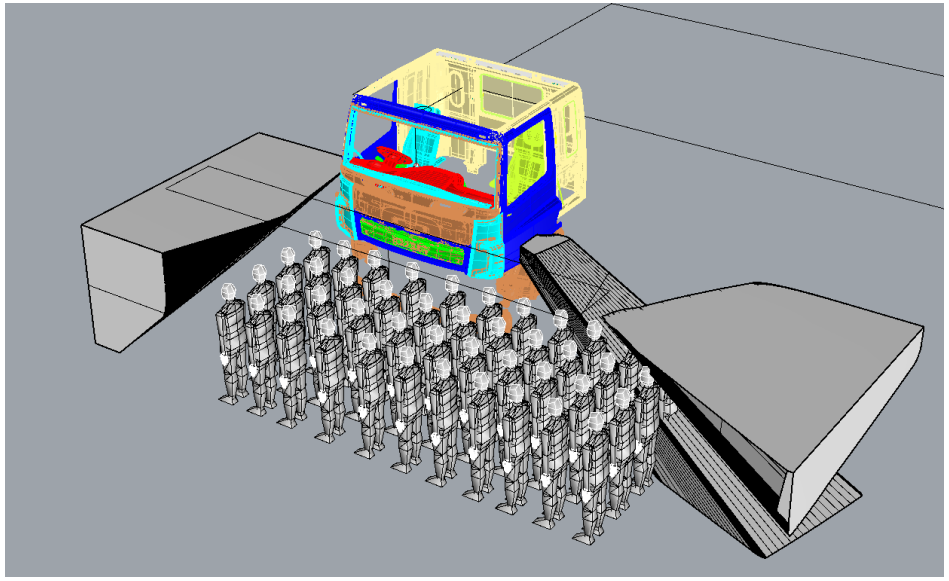
Research Sponsored by Transport for London and the UK Department for Transport

Dr. Steve Summerskill – Senior Lecturer in Industrial design and ergonomics

Dr. Russell Marshall, Dr Abby Paterson, Anthony Eland, James Lenard, Steve Reed







Contents

Introduction

- In a recent task force meeting ACEA presented a response to the LDS proposed limit values presented at the 15th UNECE VRU PROXI working group meeting

- The LDS proposal during the 15th meeting, recommended a separated approach to volume analysis for the UNECE Direct Vision Standard and provided suggested limits with the aim of removing blind spots in the combined direct and indirect vision afforded to a vehicle driver by the vehicle design

- The following presentation highlights the potential impact upon safety by adopting the ACEA levels through the analysis of improvements that can be made to the DVS performance of four vehicles, assuming that a combined approach is followed as suggested by ACEA

  - The LDS suggested limits can be seen in the 15th meeting presentation. To summarise the LDS team suggested the following
    - Category A (Urban) 11m^3. **The ACEA proposal for this level is 8.5m^3**
    - Category B (Rural) 8m^3. **The ACEA proposal for this level is 6m^3**

- The mechanisms for vehicle improvement that have been considered are as follows;

  - The use of a 250mm extra aerodynamic feature for Cat B vehicles
  - Removal of wing mirrors
  - Addition of lower door windows
  - Editing of lower window edge designs
  - Lowering of stowed windscreen wipers below the bottom edge of the windscreen

Introduction

- The new limits that have been proposed by ACEA cause us great concern.
- The evidence provided by the LDS team has highlighted that pedestrians to the front of the vehicle being killed or seriously injured by a vehicle pulling away from stand still is the most common accident for pedestrians with 42% of all cases in the UK.
- The UK Dept. for Transport has highlighted that the mandatory use of the Class VI mirror since 2007 has had no significant effect on this accident type.
- There is obvious potential for there to be workload issues associated with the use of six mirrors and three windows to gain situational awareness before performing a vehicle manoeuvre
- Research by Prof Richard Wilkie from Leeds University highlighted that the use of mirrors can increase reaction times by nearly a second when compared to the use of direct vision
- The ACEA proposals do not acknowledge the extensive evidence that has been provided to support the definition of the LDS proposed limits, for the method that has been defined by the LDS team and involved the analysis and testing of over 50 vehicle variants.
- The aim of the analysis in this presentation is to highlight that the ACEA proposal will most likely lead to a situation where vehicles with unacceptable blind spots to the front of the vehicle will be allowed to operate in both Cat A and Cat B vehicles if the ACEA limits for a combined approach are adopted

The use of VRU simulations (5th%ile Italian female)

- To provide context for the results that are presented today, the use of VRU simulations in the quantification of volumetric DVS results is required. A measure of direct vision performance to the front and sides of the vehicle has been used throughout the developing research effort that has been used to define and test a workable Direct Vision Standard in London, and subsequently at the UNECE level.

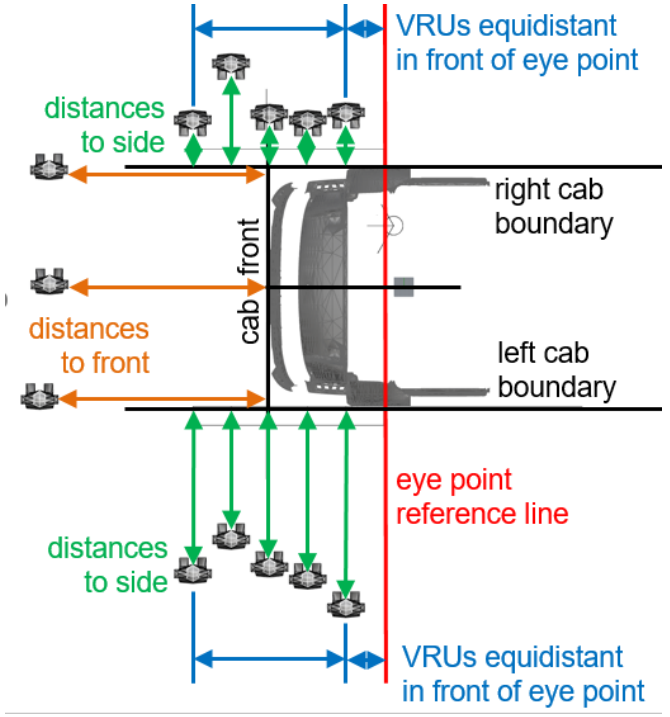
- For today the important measure is the distance from the front of the vehicle at which three vulnerable road user simulations can be placed to allow the head to be visible. This measure is based upon the premise that if the head and neck can be seen then the VRU can be recognised by the driver.

- This has been defined due to the lack of any research which specifies how much of a VRU is required to allow recognition.

- If the VRU simulations are placed beyond 2m in front of the vehicle with their heads visible due to the design of the vehicle, this represents a potential blind spot, where the VRU can be moved closer to the vehicle so that the head cannot be seen, and yet the VRU can not be seen in the class VI mirror to the front of the vehicle, if adjusted to meet UNECE reg 46

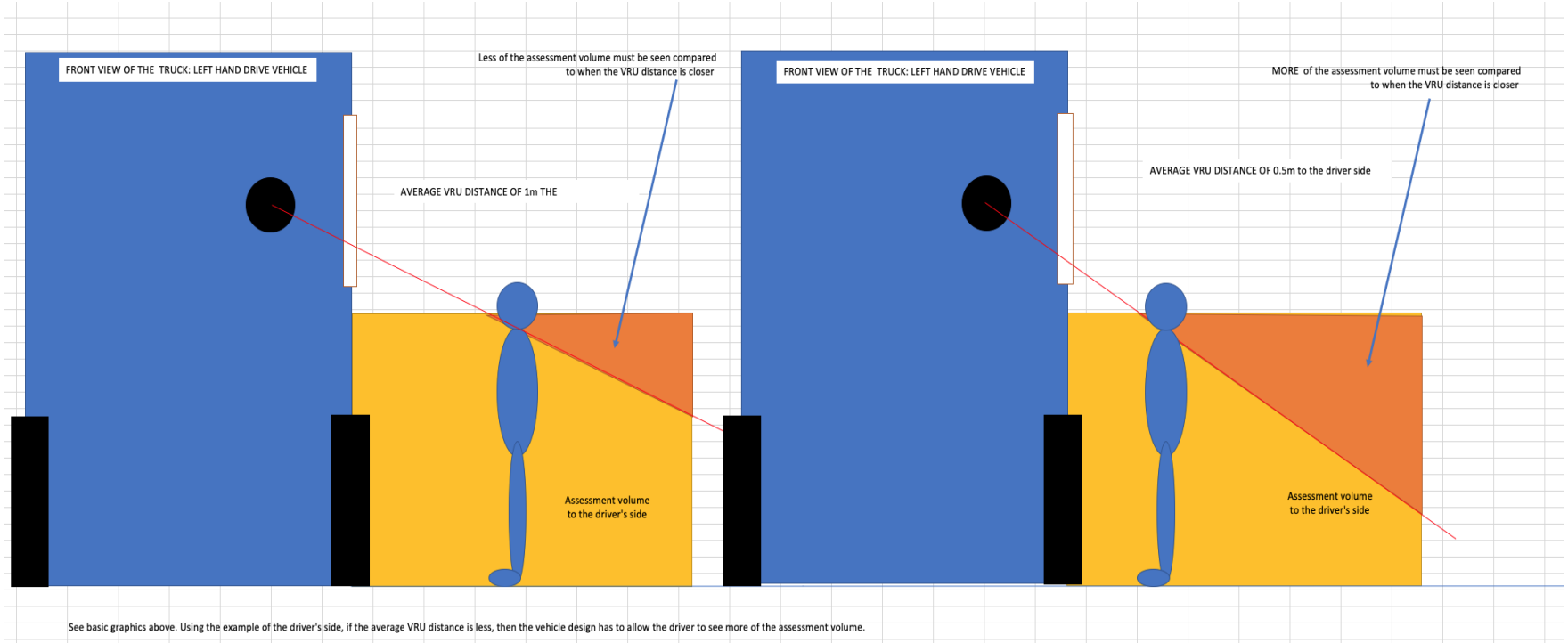
- A concession has been provided here, in that the average of the VRU distances to each side can be used. This in effect means that 1 of the three VRUs can be in a blind spot.

- It should be noted that the use of the VRU simulations is not part of the proposed test method. The VRU simulations have been used to define a measure to which the volumetric scores produced in the DVS method can be compared to the real world performance of a vehicle. The correlation between the volume and VRU Distance can be used to specify a required volume to allow a certain average VRU distance to be visible to the driver.



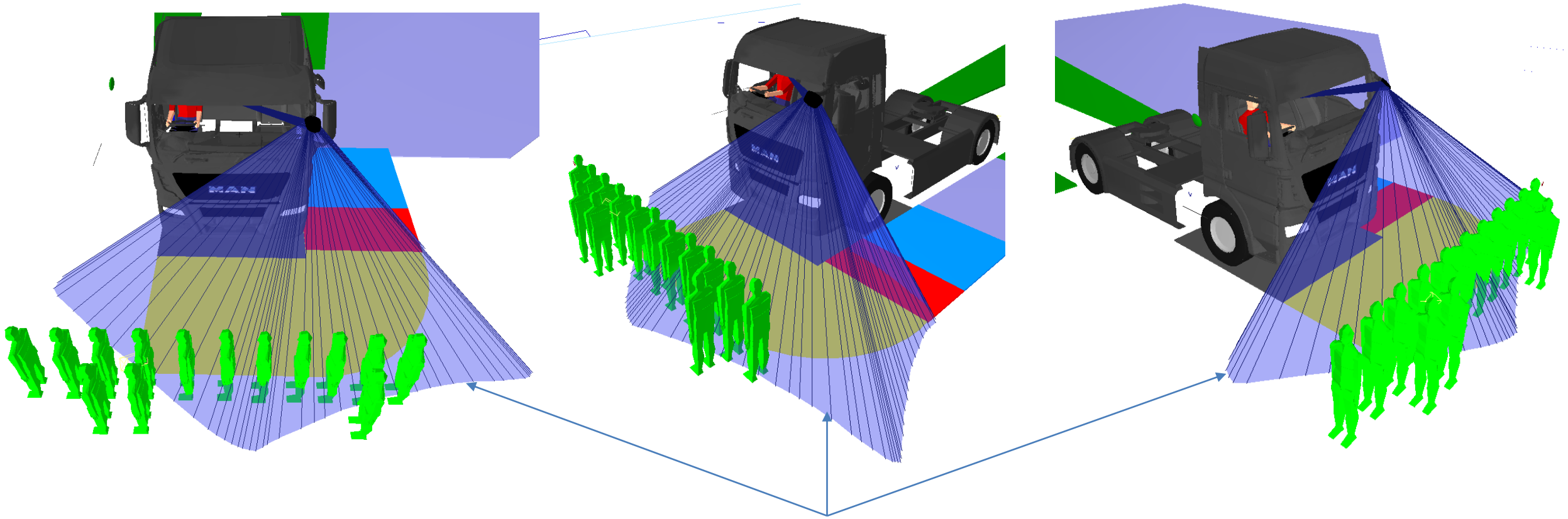
- Slide to be added for the presentation which highlights how VRUs are used as there has been some confusion over this in various meetings.

- Basically an improved version of this graphic



Class VI mirrors – Example, MAN TGX max height

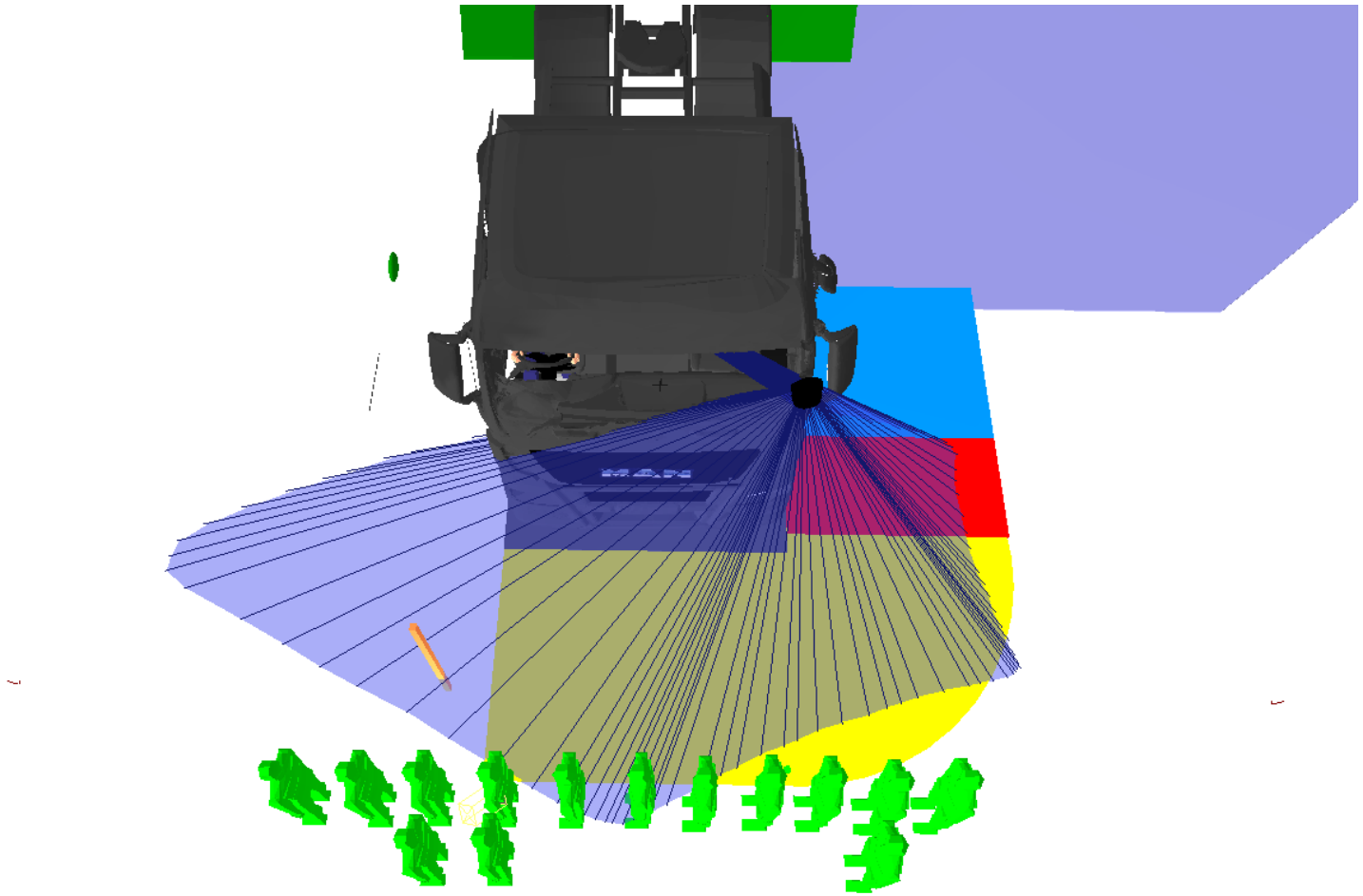
- Class VI mirrors are adjustable and so can be poorly adjusted
- The images shown visualises the volume of space that can be seen in a Class VI mirror (ROC 300mm)
- Radius of curvature of 300mm creates distorted image
- This Class VI has been adjusted to allow the whole mandatory area to be visible (UNECE REG 46)



Volume of space enclosed by this volume can be seen in the mirror

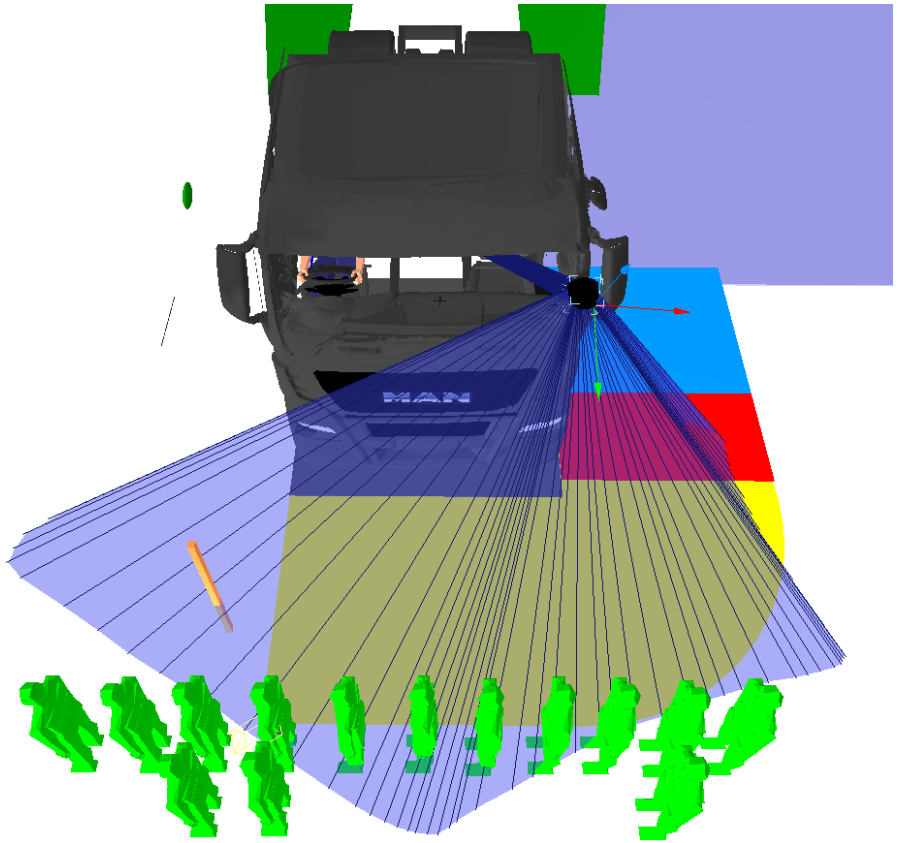
Class VI mirrors

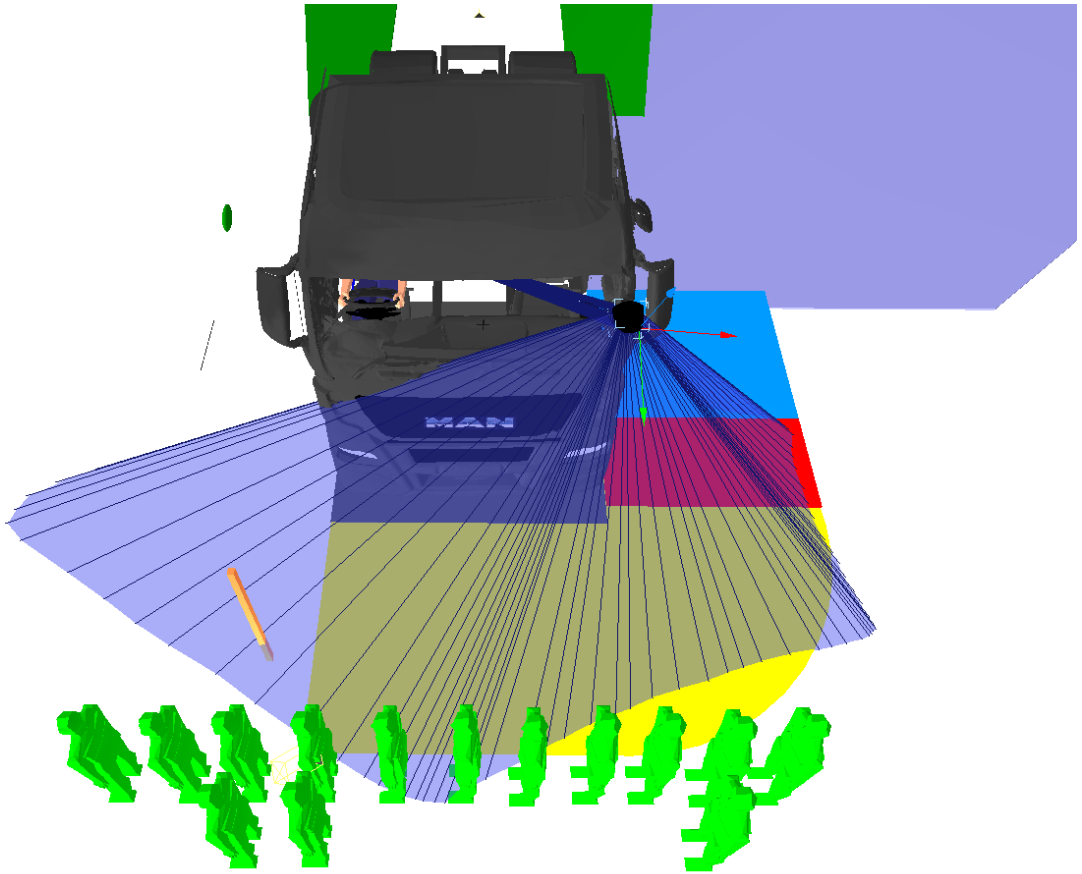
- A **poorly adjusted** mirror can see part of the required zone but not all



Class VI mirrors

- Left image – Class VI mirror adjusted for the 95%ile driver
- Right Image, same mirror position being used by the 5th%ile female driver
- Do drivers always adjust mirrors when sharing vehicles?
- These issues were explored in depth in the 2015 TfL project[2] performed by the LDS team



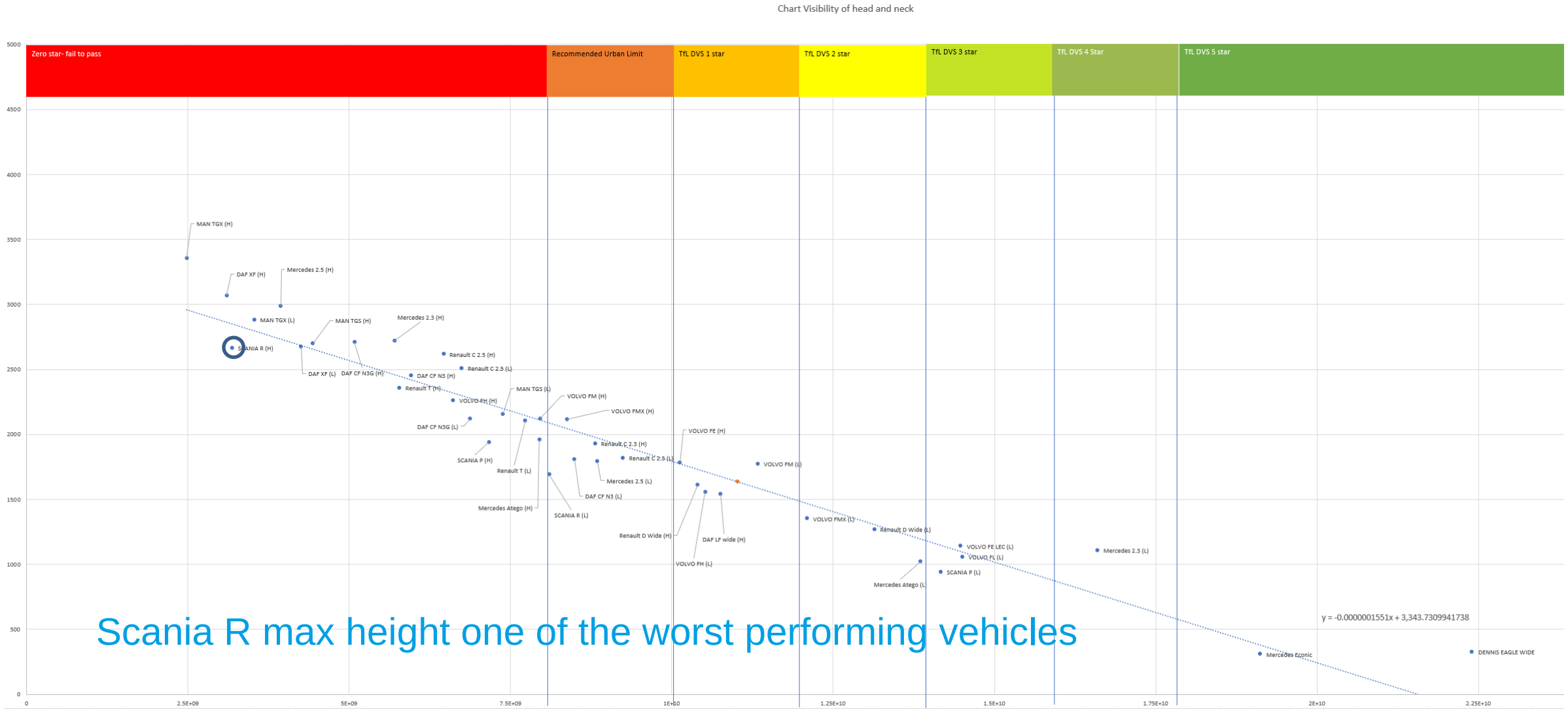


2 https://repository.lboro.ac.uk/articles/report/Understanding_direct_and_indirect_driver_vision_in_heavy_goods_vehicles/9354344

Case 1. NEW SCANIA P cab

- We have taken the 3D scanned data for the 2019 SCANIA P and mounted that cab at the same height as the 2015 Scania R maximum possible height
- The aim here was to explore the Scania design improvements with the following question
- What score can the 2019 Scania P cab achieve when mirrors are removed, and a 250mm Aerodynamic feature is added, **when mounted at a Long haul height**?

Analysis of Cat A – ACEA proposal (8.50m3) NEW SCANIA P CAB Mounted at height of OLD SCANIA R CAB



Scania R max height one of the worst performing vehicles

Analysis of Cat A – ACEA proposal (8.50m3) SCANIA new cab design

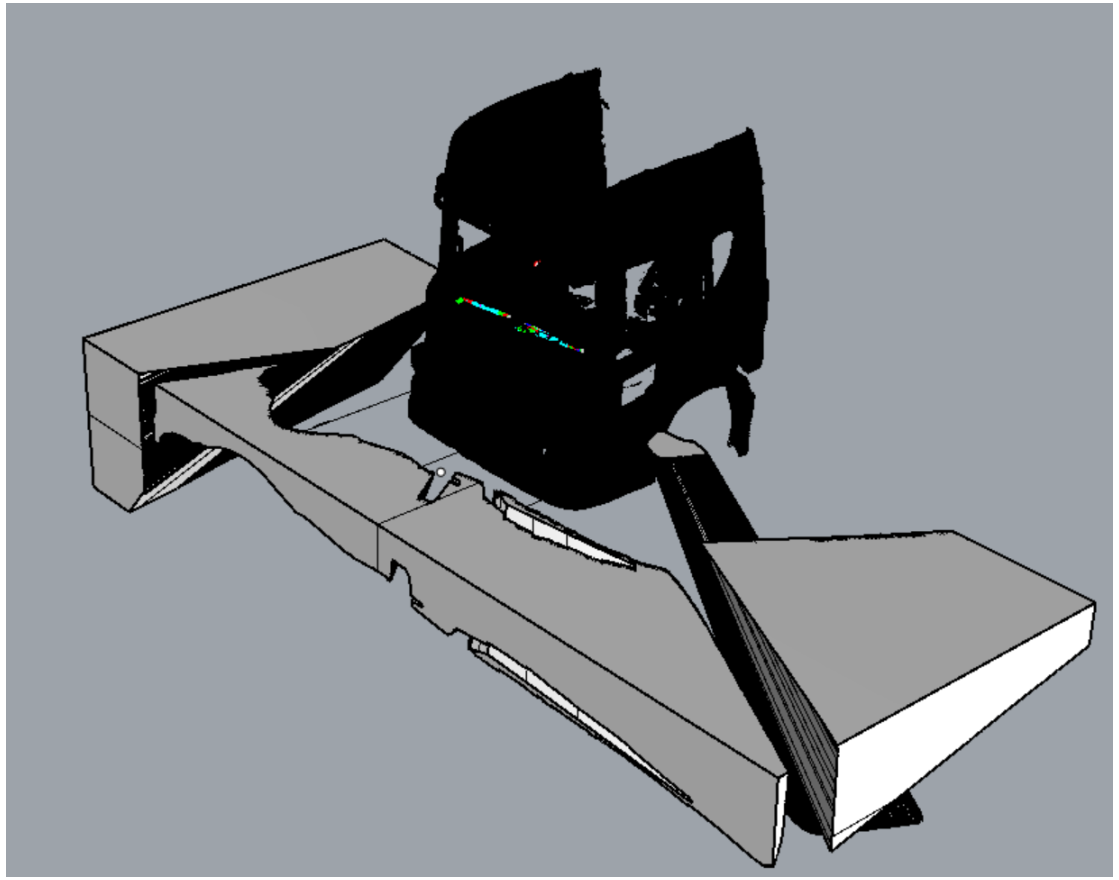
- New SCANIA P cab mounted at SCANIA R highest possible cab height **(LONG HAUL)**
- Removed mirrors
- Used 250mm aero to the front
- Total Volume 9.54m3
- Average VRU distance to the front = 2.025m
- NOTE: Scania R high average VRU distance = 2.6m
- Therefore a 2019 SCANIA P cab can be mounted at the maximum cab height of the 2015 SCANIA R, and surpass the ACEA CAT A limit, with a **very small VRU** blind spot to the front of the vehicle

Analysis of Cat A – ACEA proposal (8.50m3) SCANIA new cab design

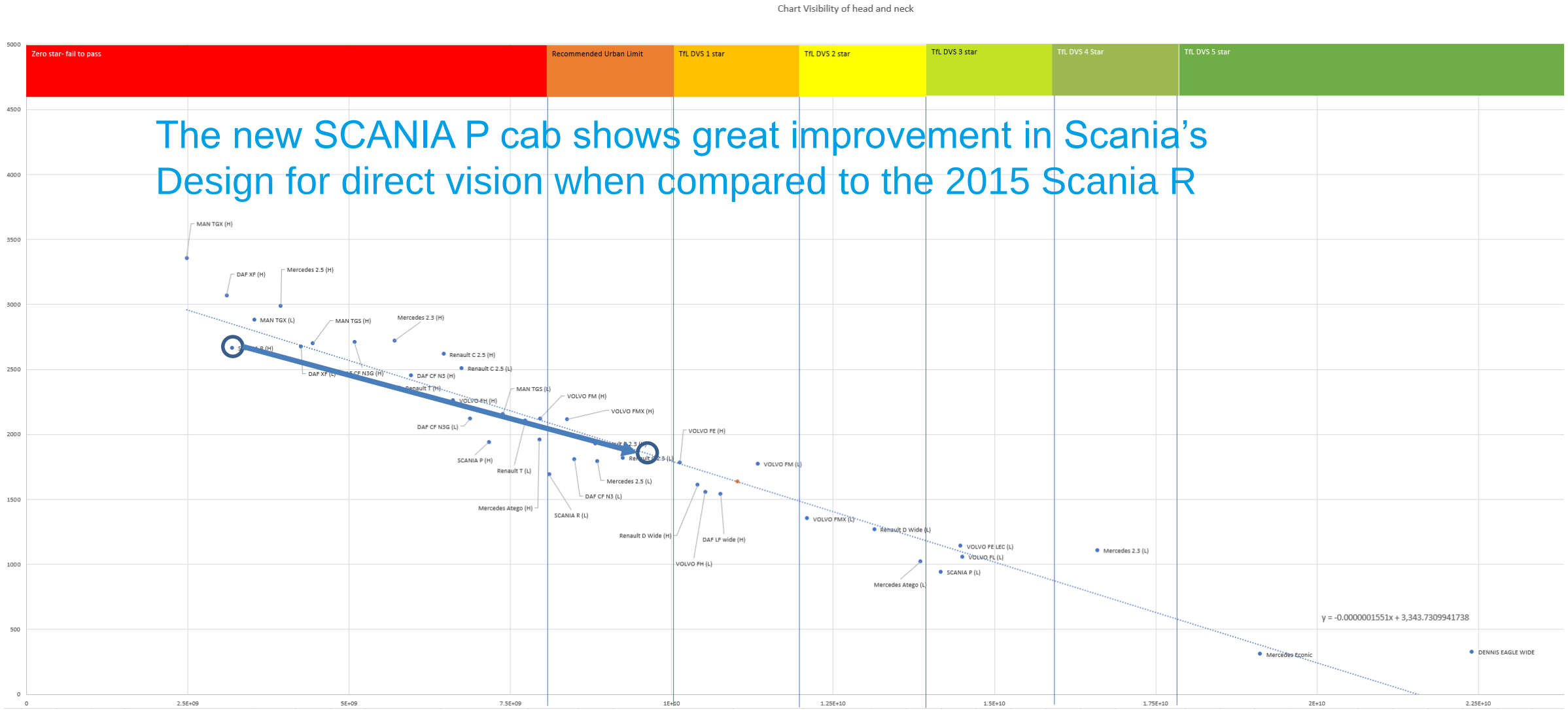
- New SCANIA P cab mounted at SCANIA R highest possible cab height **(LONG HAUL)**
- Removed mirrors
- Used 250mm aero to the front
- Total Volume 9.54m3
- Average VRU distance to the front = 2.025m

- Volume to the front = 1.73m3
- Volume to the passenger side = 2.54m3
- Volume to the driver's side = 5.27m3

- Cat A 11m^3 LDS = Fail
- Cat A 8.5m^3 ACEA = Pass
- Cat B 8m^3 LDS = Pass
- Cat B 6m^3 ACEA = Pass
- It is acknowledged that these volumetric score do not meet the minimum requirements suggested by the LDS in the 15th meeting for a separated approach



Analysis of Cat A – ACEA proposal (8.50m3) NEW SCANIA P CAB Mounted at height of OLD SCANIA R CAB



The new SCANIA P cab shows great improvement in Scania's Design for direct vision when compared to the 2015 Scania R

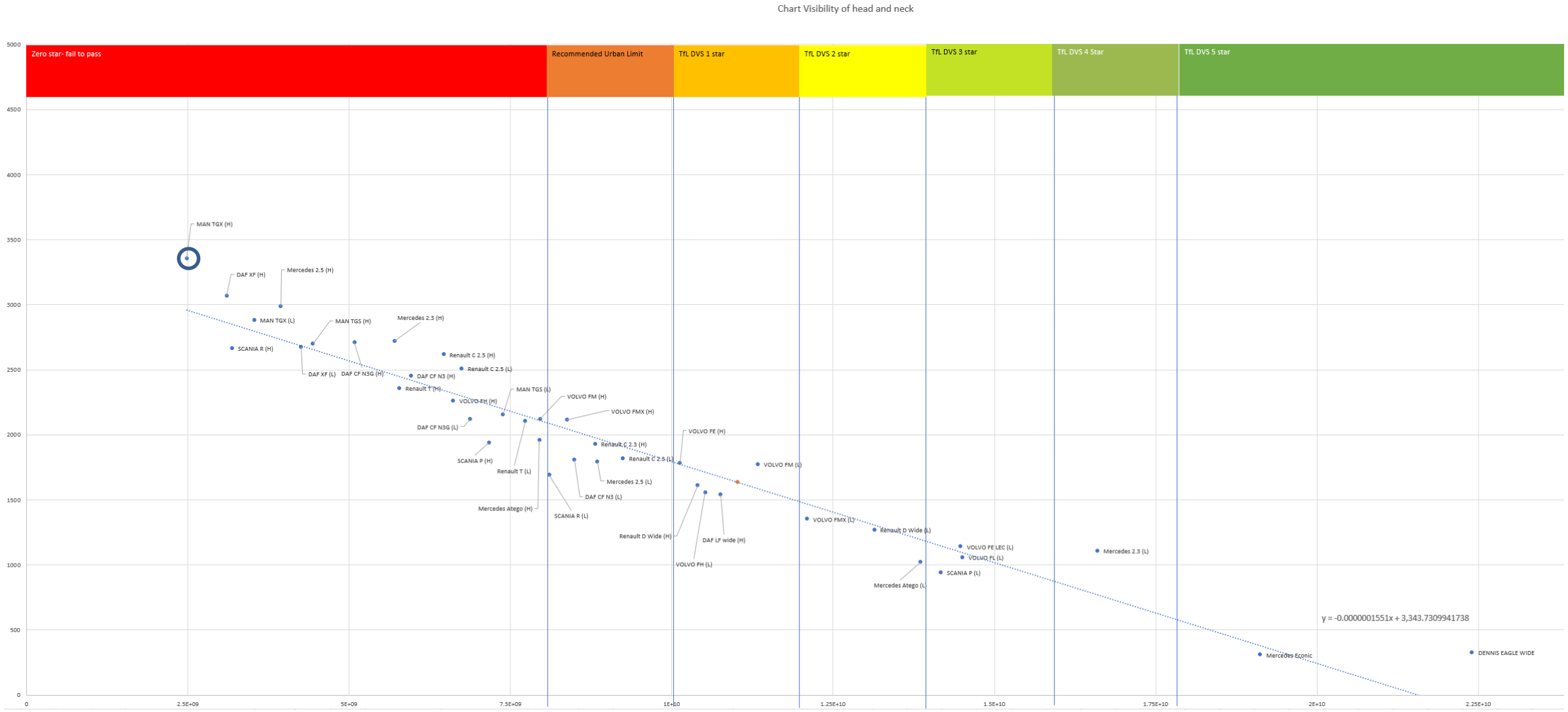
LOUGHBOROUGH
DESIGN SCHOOL

Case 2. MAN TGX

- In order to highlight the direct vision performance benefits that are possible through alteration of existing designs we have taken the 3D scanned data for the 2015 MAN TGX which was the worst performing vehicle in the London DVS

- The aim here was to explore whether design improvements can be used to enable the MAN TGX to pass the ACEA values

Analysis of Cat B – ACEA proposal (6m3) MAN TGX



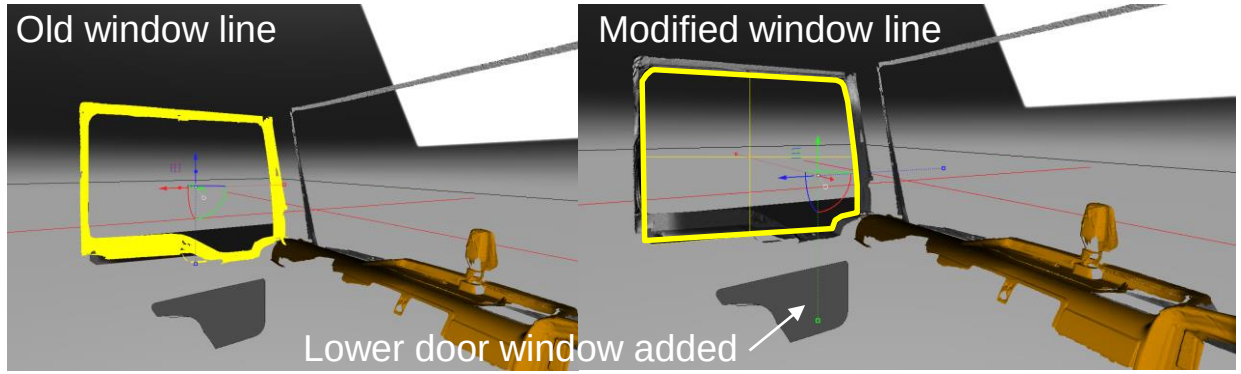
Analysis of Cat B – ACEA proposal (6m³) MAN TGX

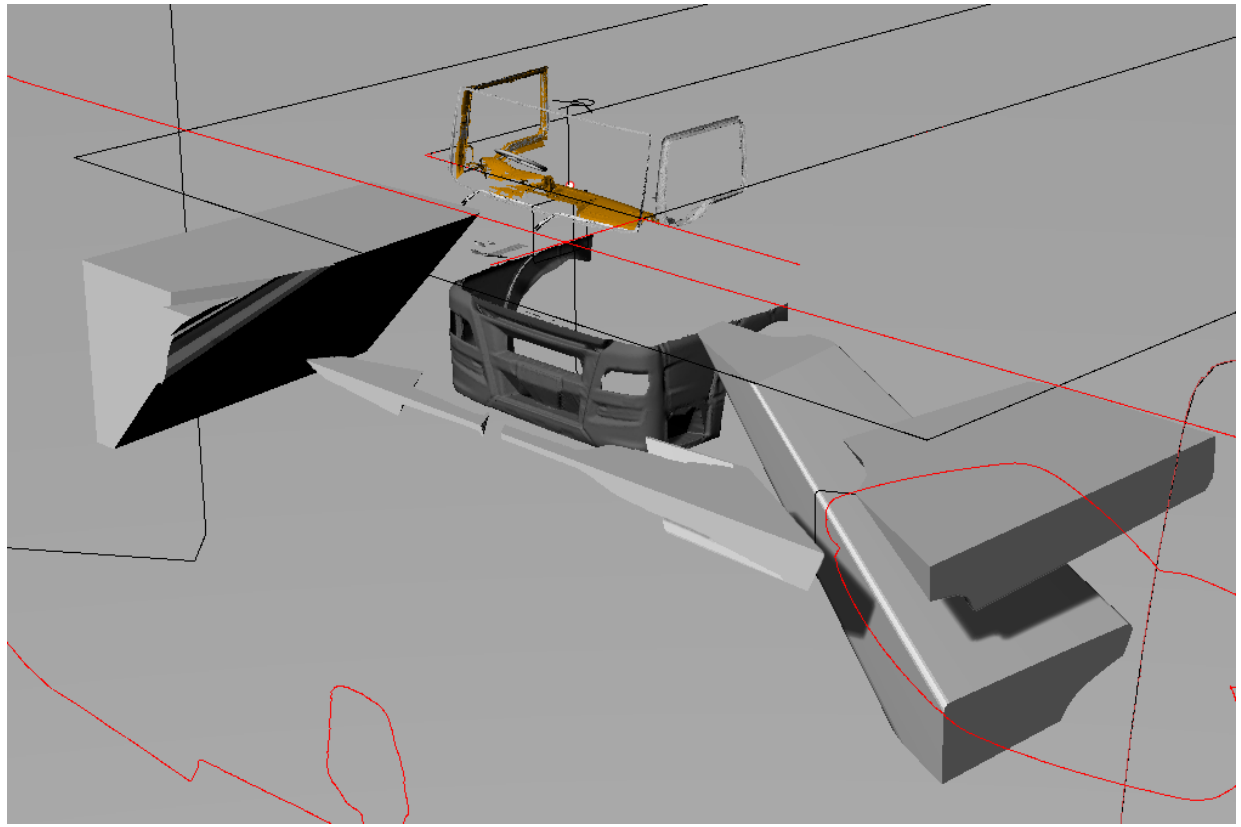
- Worst performing vehicle in the TfL analysis
- Removed mirrors
- Used 250mm aero feature to the front
- Adjusted window line to remove the ‘hump’
- Added lower door window
- **Total Volume 8.04m³**
- Average VRU distance to the front = **3.189m**

- Volume to the front = 0.14m³
- Volume to the passenger side = 3.57m³
- Volume to the driver’s side = 4.33m³

- Cat A 11m³ LDS = Fail
- Cat A 8.5m³ ACEA = Fail
- Cat B 8m³ LDS = Pass
- Cat B 6m³ ACEA = Pass

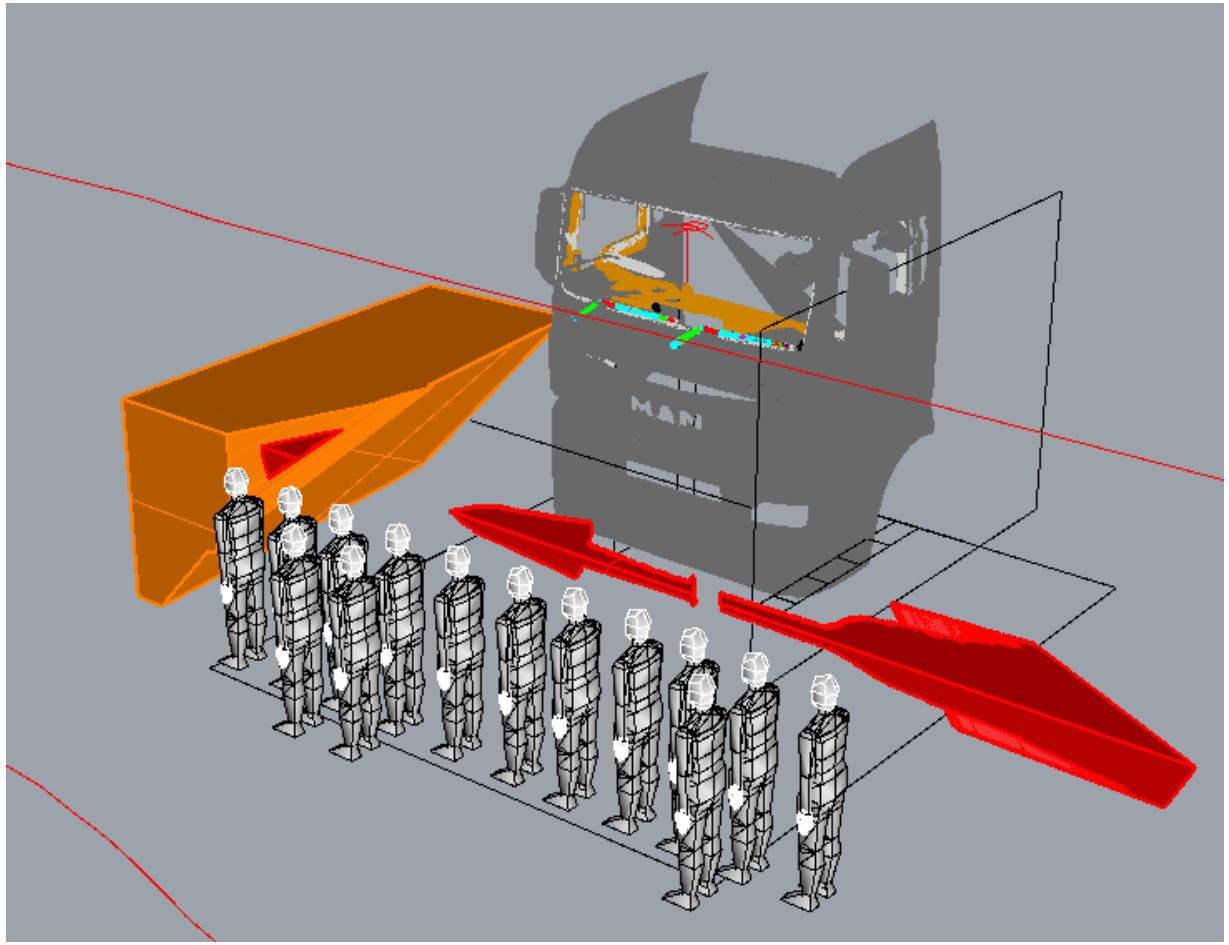
- Large blind spot exists to the front of the vehicle between what can be seen through indirect vision and direct vision

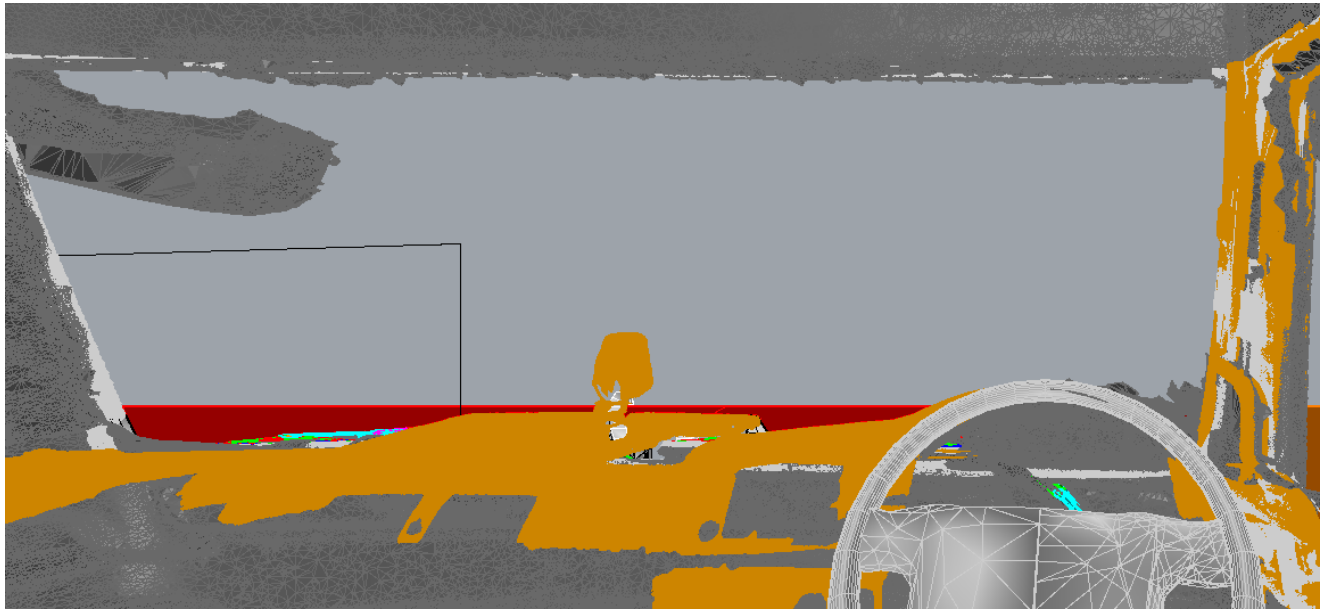




Analysis of Cat B – ACEA proposal (6m^3) MAN TGX

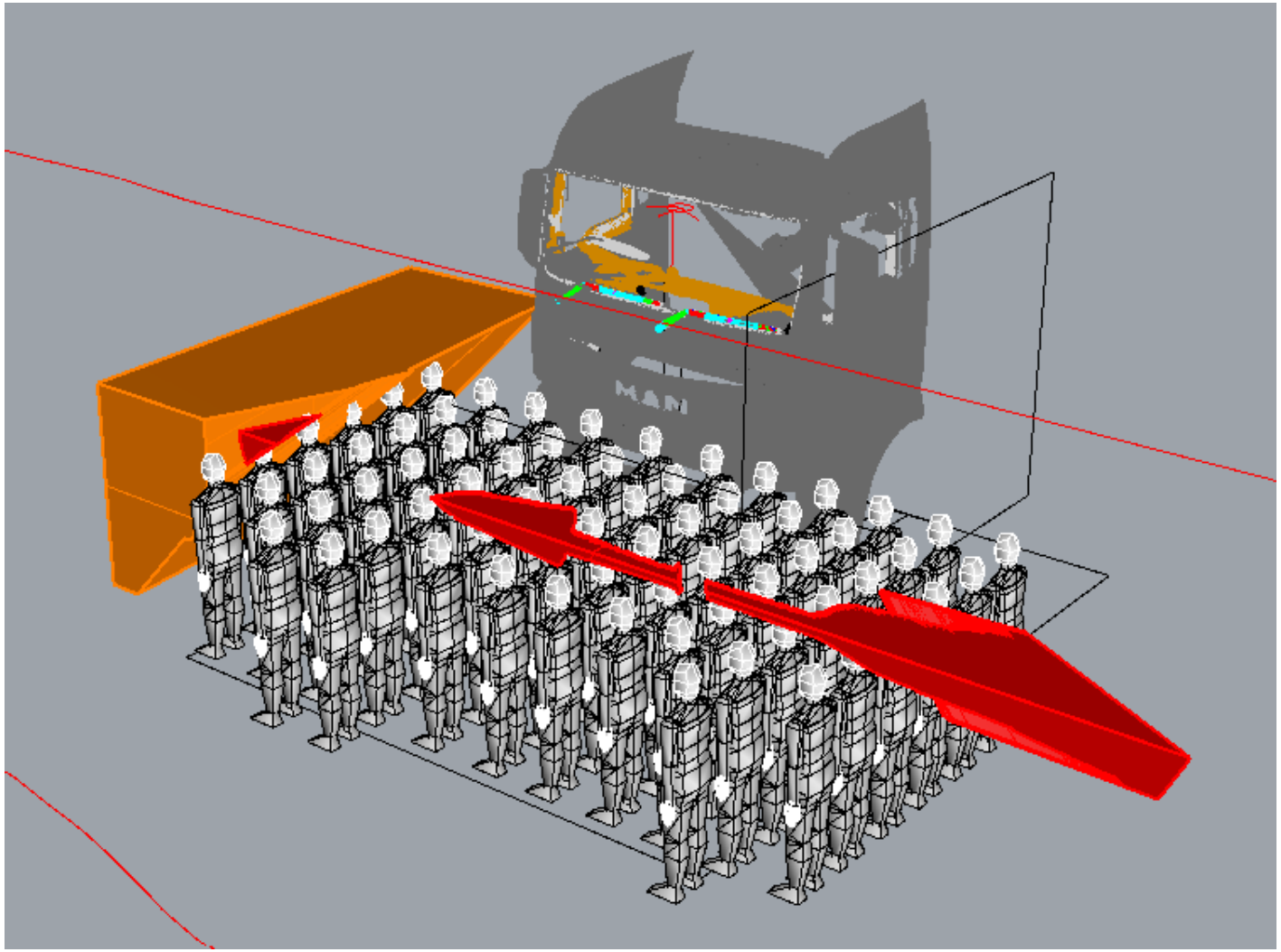
- All of these VRUS are not visible to the driver of this vehicle at the edge of the Class VI mirror zone. **They are in a blind spot**



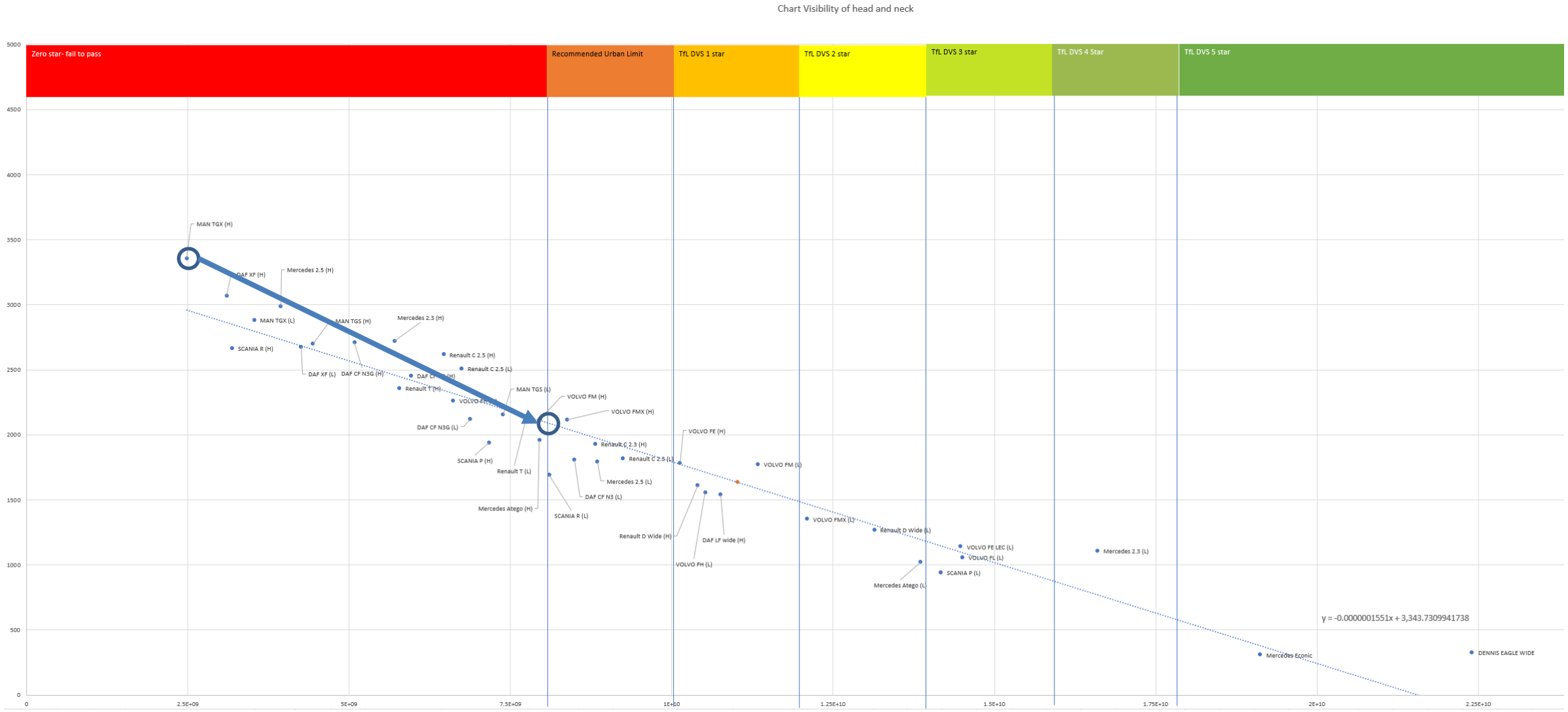


Analysis of Cat B – ACEA proposal (6m^3) MAN TGX

- If the driver does not use the Class VI mirror all of these VRUs are not visible using forward vision to the driver of this vehicle



Analysis of Cat B – ACEA proposal (6m3) MAN TGX



Case 3. DAF XF

- In order to highlight the direct vision performance benefits that are possible we have taken the DAF XF data and performed a number of alterations in line with the ACEA task force presentation

- The aim here was to explore whether design improvements can be used to enable the DAF XF to pass the ACEA values

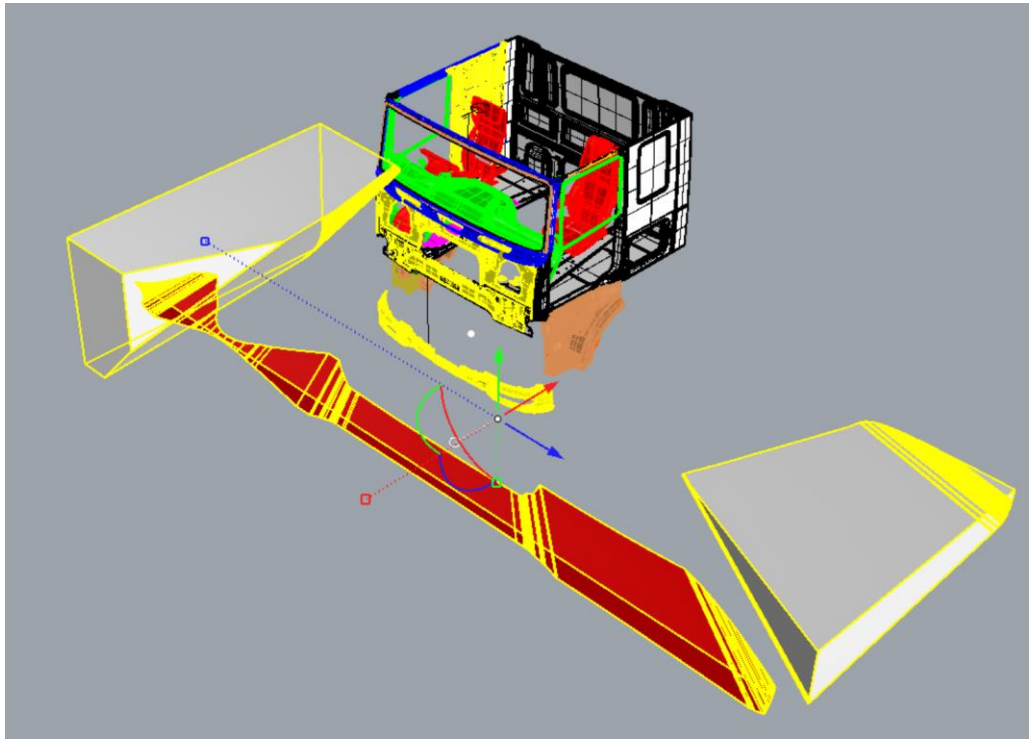
Analysis of Cat B – ACEA proposal (6.0m3) DAF XF

- 2nd worst performing vehicle in the TfL analysis
- Removed mirrors
- Used 250mm aerodynamic feature to the front
- Adjusted window line down by 50mm
  - Alternatively we could add a lower door window
- Total Volume **6.1m3**
- Average VRU distance to the front = **3.275m**

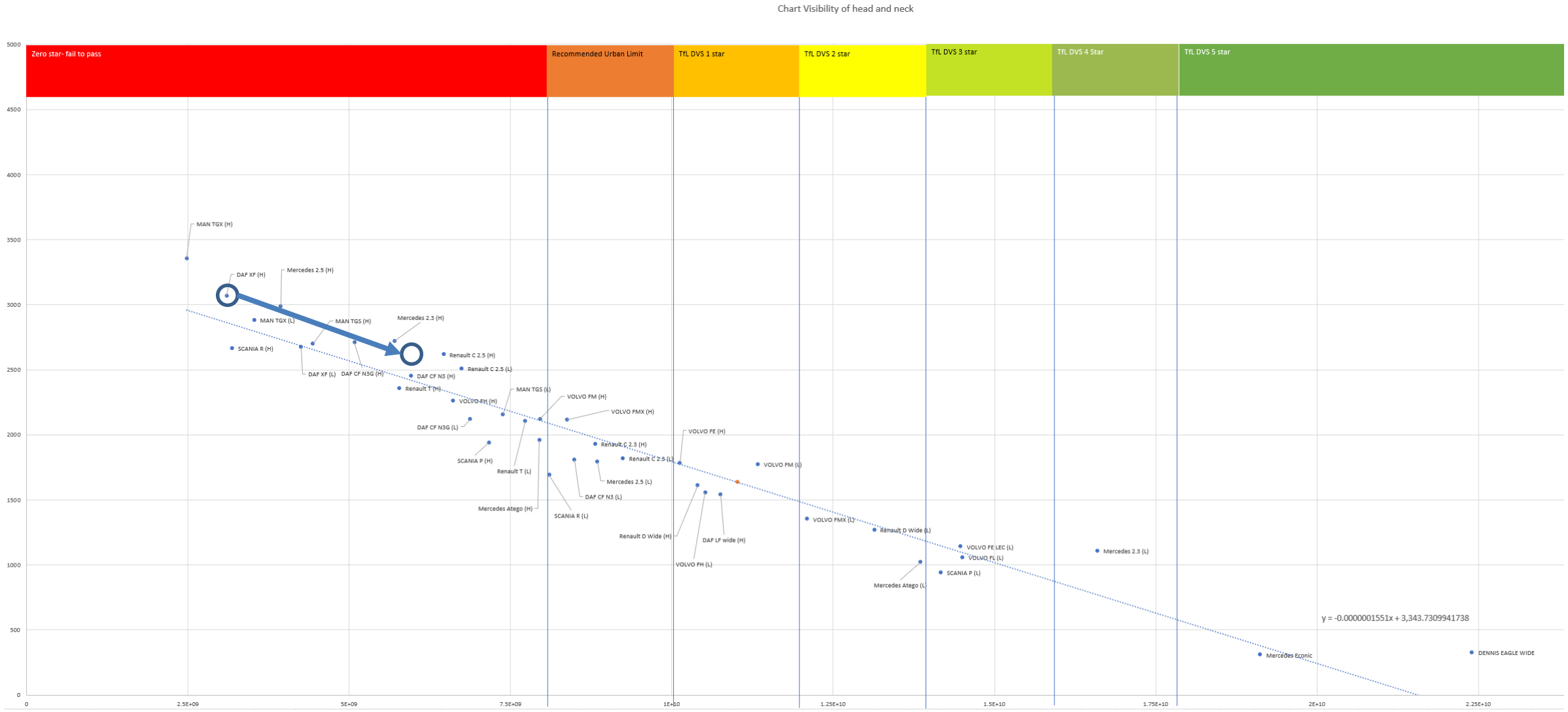
- Volume to the front = 0.31m3
- Volume to the passenger side = 1.03m3
- Volume to the driver's side = 4.72m3

- Cat A 11m^3 LDS = Fail
- Cat A 8.5m^3 ACEA = Fail
- Cat B 8m^3 LDS = Fail
- Cat B 6m^3 ACEA = Pass

- And leaves a large blind spot to the front of the vehicle with a similar VRU obscuration issue to the MAN TGX



Analysis of Cat B – ACEA proposal (6m3) DAF X CAB

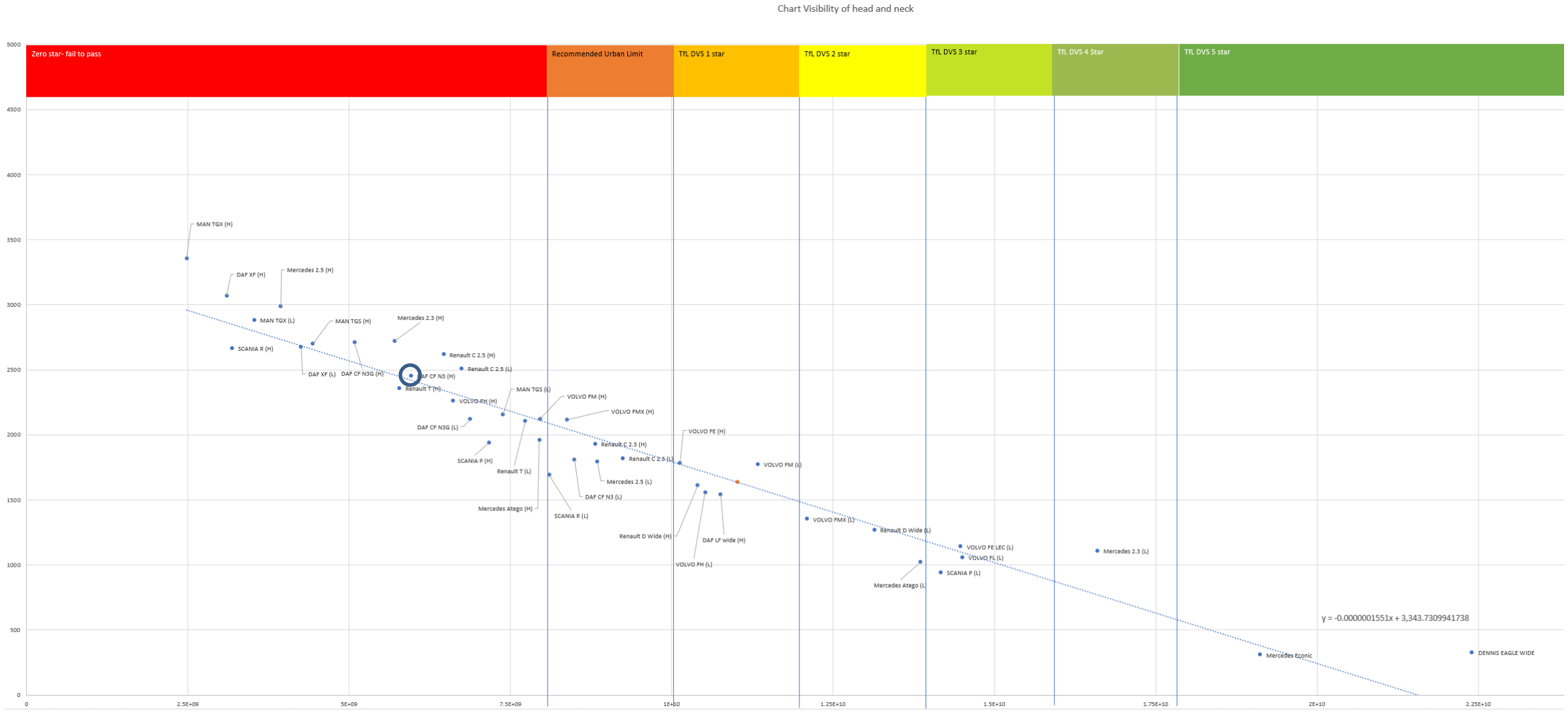


Case 4. DAF CF (highest possible cab)

- In order to highlight the direct vision performance benefits that are possible we have taken the DAF CF (highest) data and performed a number of alterations in line with the ACEA task force presentation

- The aim here was to explore whether design improvements can be used to enable the DAF CF to pass the ACEA values

Analysis of Cat A – ACEA proposal (8.5m³) DAF CF CAB



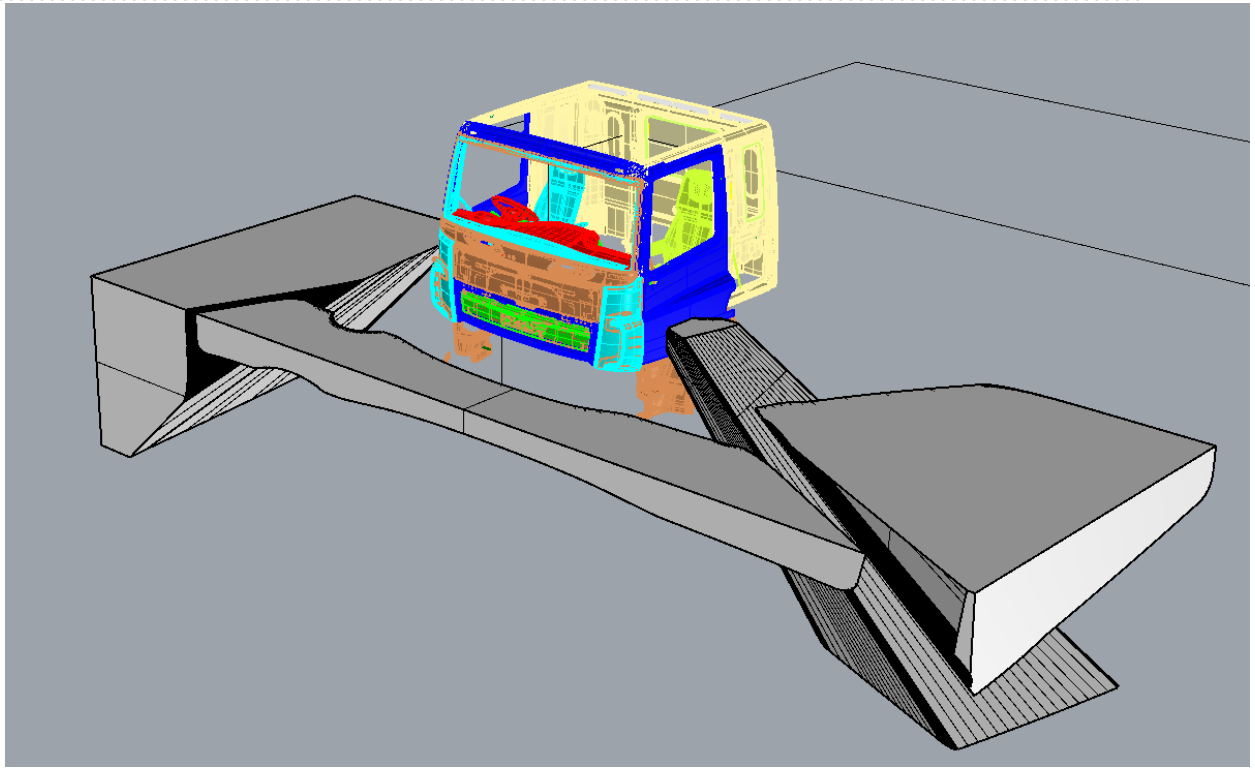
Analysis of Cat A – ACEA proposal (8.5m3) DAF CF (highest)

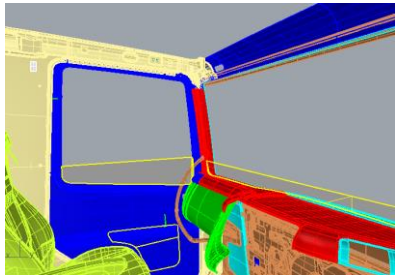
- 2nd worst performing vehicle in the TfL analysis
- Removed mirrors
- Added lower door window
- Removed wipers (e.g. lowered below windscreen line)
- **Total Volume 9.02m^3**
- Average VRU distance to the front = **2.641m**

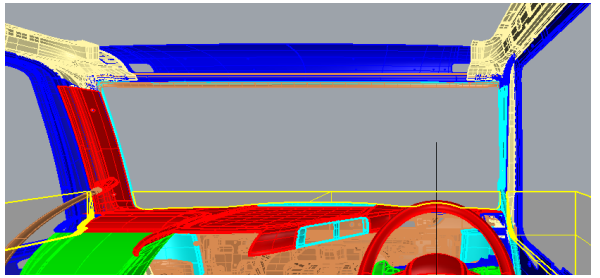
- Volume to the front = 0.57m^3
- Volume to the passenger side = 3.56m^3
- Volume to the driver's side = 4.89m^3

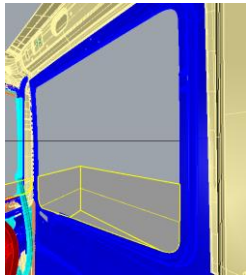
- Cat A 11m^3 LDS = Fail
- Cat A 8.5m^3 ACEA = Pass
- Cat B 8m^3 LDS = Pass
- Cat B 6m^3 ACEA = Pass

- And leaves a large blind spot to the front of the vehicle for a vehicle that would operate in an Urban Environment



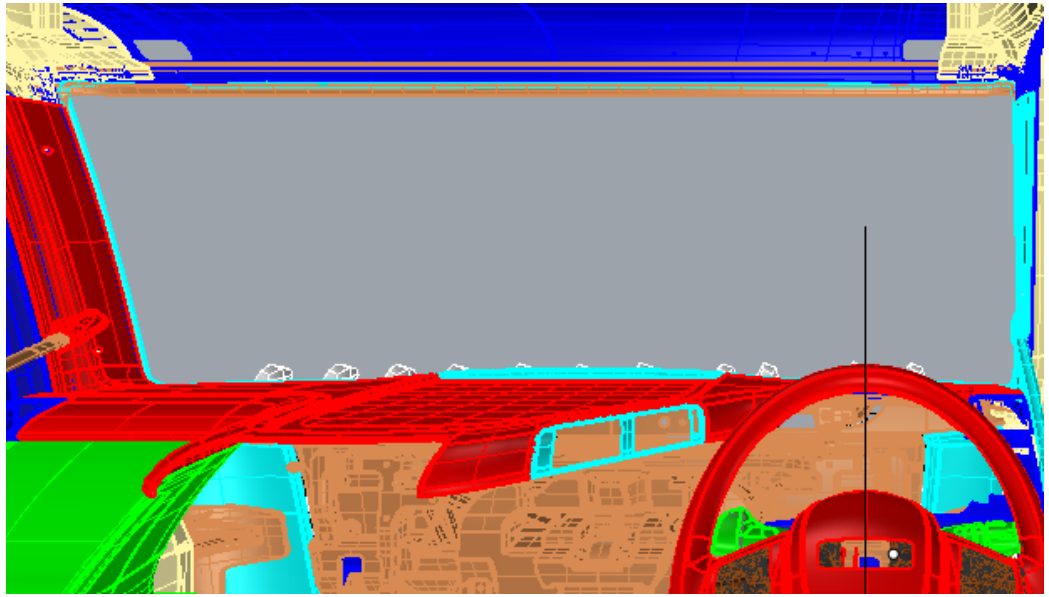


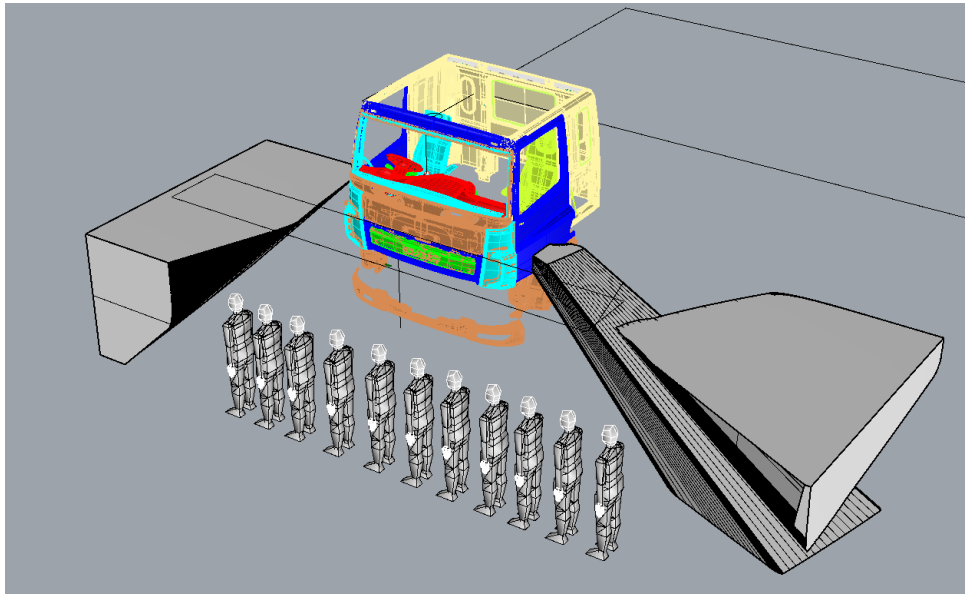




Analysis of Cat A – ACEA proposal (8.5m3) DAF CF (highest)

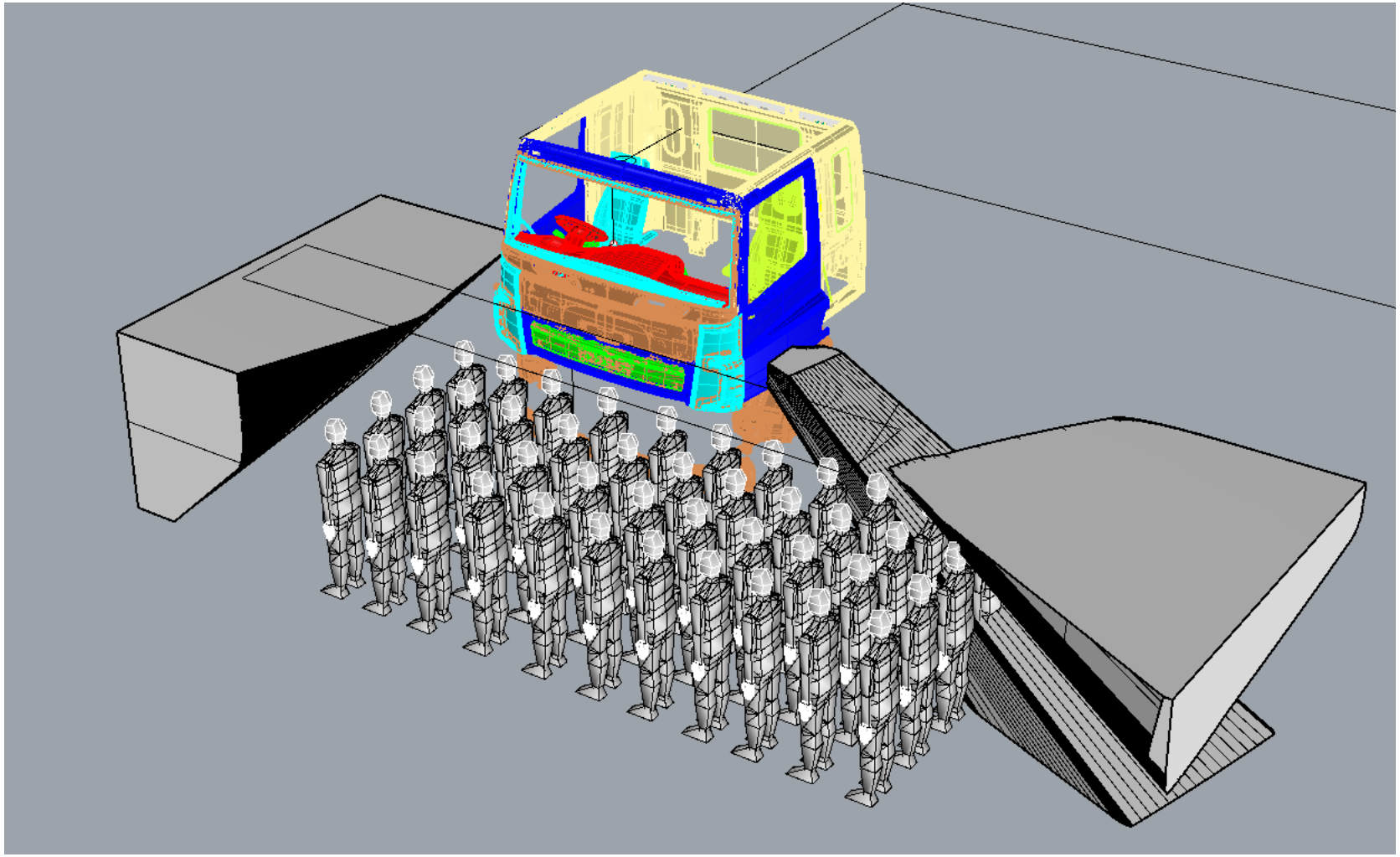
- All of these VRUS are partially visible to the driver of this vehicle. At the edge of the Class VI mirror zone
- Some only have a very small section of the head visible



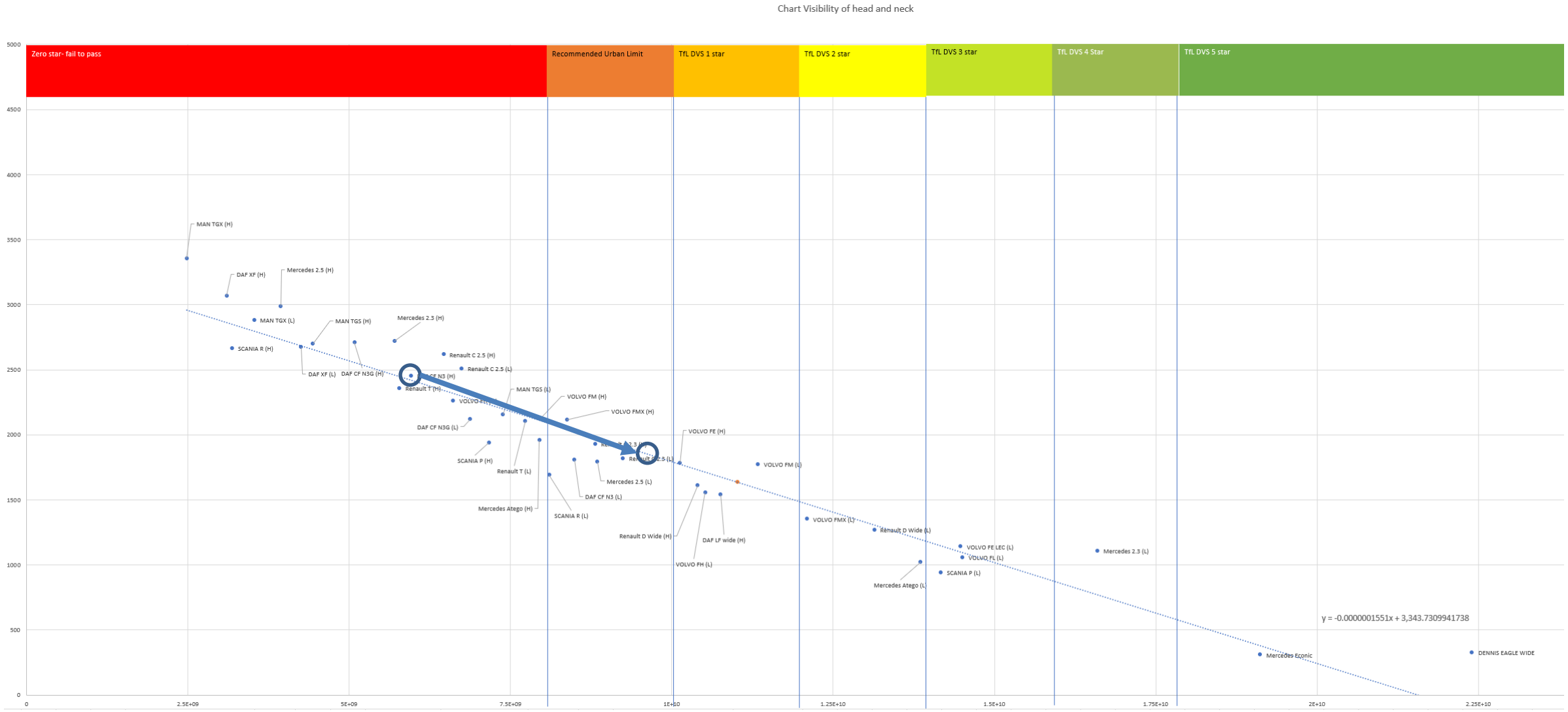


Analysis of Cat A – ACEA proposal (8.5m3) DAF CF (highest)

- If the driver does not use the class VI mirror all of these VRUs are not visible to the front



Analysis of Cat A – ACEA proposal (8.5m³) DAF CF CAB



LOUGHBOROUGH
DESIGN SCHOOL

Summary and LDS position

- It has been shown that a combined approach can lead to vehicle designs which potentially pass the ACEA proposed limits for a differentiated DVS approach but with **inherent blind spots** to the front of the vehicle

- The UK accident database, STATS 19, was used to perform an analysis of the accident scenarios in the UK for collisions with HGVs in the TfL DVS project[1]

- This analysis highlighted that the most common pedestrian accident type was vehicles pulling away from a stand still, and colliding with pedestrians walking in front of the vehicle.

- The results reported today have illustrated that it is possible for vehicles to be improved in terms of direct vision performance to pass the ACEA proposed limits, with no real improvement to the direct vision to the front of the cab

1. https://repository.lboro.ac.uk/articles/report/The_definition_production_and_validation_of_the_direct_vision_standard_DVS_for_HGVS_Final_Report_for_TfL_review/9353513

Summary and LDS position

- The EU parliament and Council stated the following after the vote on GSR requirements in February of 2019

- *"Vehicles of categories M2, M3, N2 and N3 shall be designed and constructed 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** of and to the side of the driver, while taking into account the specificities of different categories of vehicles."*

- The results in this presentation highlight that the ACEA proposed values rely upon **indirect vision through mirrors**, and allow blind spots to exist to the front and side of the vehicles. We therefore do not see the ACEA proposal as meeting the EU stated aim.

Summary and LDS position

- We oppose the ACEA values.
- A hybrid approach which requires a minimum Direct Vision performance to each side of the vehicle has been proposed in the Task Force meetings and we are willing to explore this compromise.
- Our default position is that all vehicles should meet the requirements that have been previously been stated in 15th UNECE VRU PROXI working group meeting, and that a separated approach is required to improve safety in urban environments of the UNECE/EU nations.