


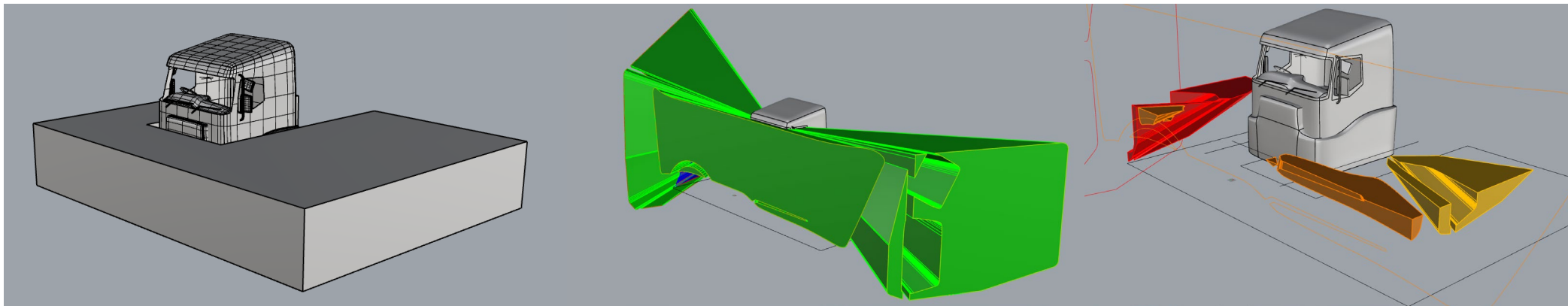
127TH UNECE GRSG: THE UK'S PROPOSED AMENDMENT TO UNECE REGULATION 167

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- The UK is proposing an amendment to UNECE 167
 - The following presentation summarises the evidence gathered for this amendment and the work that has been done to provide a solution
 - First, we will describe how UNECE 167 was defined to provide context

THE PROCESS USED IN UNECE 167

- The process used to measure direct vision in UNECE 167 comprises two separate approaches for quantifying blind spot size
- The first method measures the literal volume of space that is visible to a driver by looking through the windows from a standardised eye point
- This method is highly accurate and allows engineers to see the benefits of design changes made
- The images below show the method in action, with a volume placed around the vehicle which relates to the coverage of close proximity mirrors
- The more of this assessment volume that is visible to the driver the better the result is, and the driver has to rely less on the use of multiple mirrors to notice VRUs in close proximity to the cab
- BUT this method is difficult to relate to the real world. For example, a volumetric score of 10m^3 is difficult to relate to the real world problem



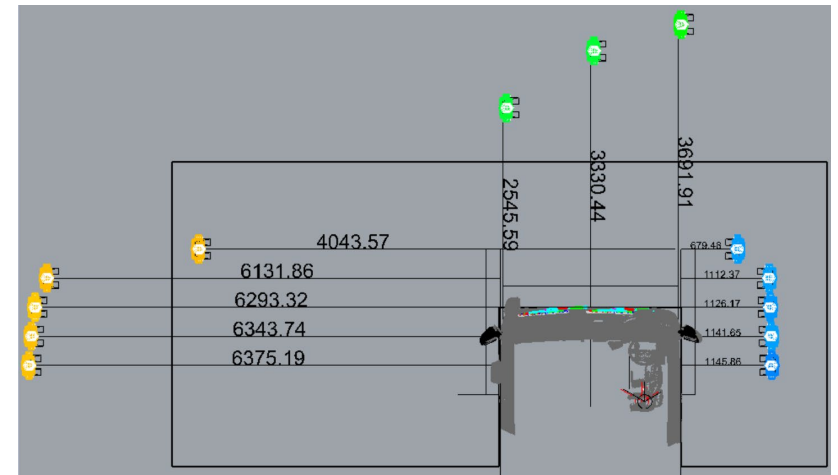
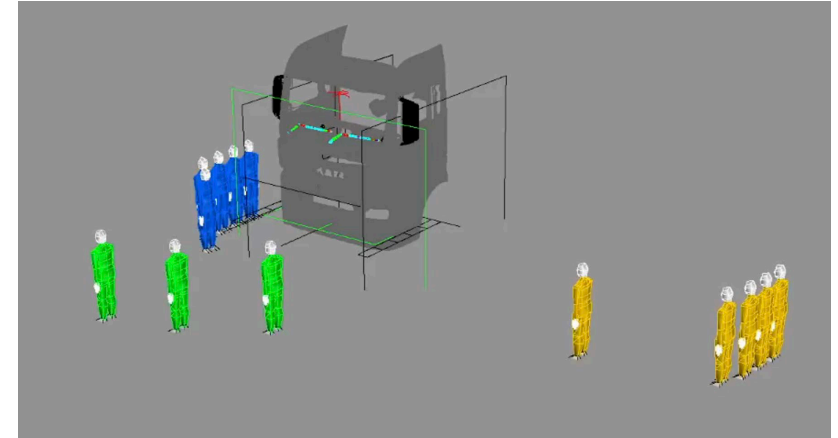
Assessment volume the cab

The volume of space visible to driver through the window

The amount of the assessment volume that can be seen by the driver

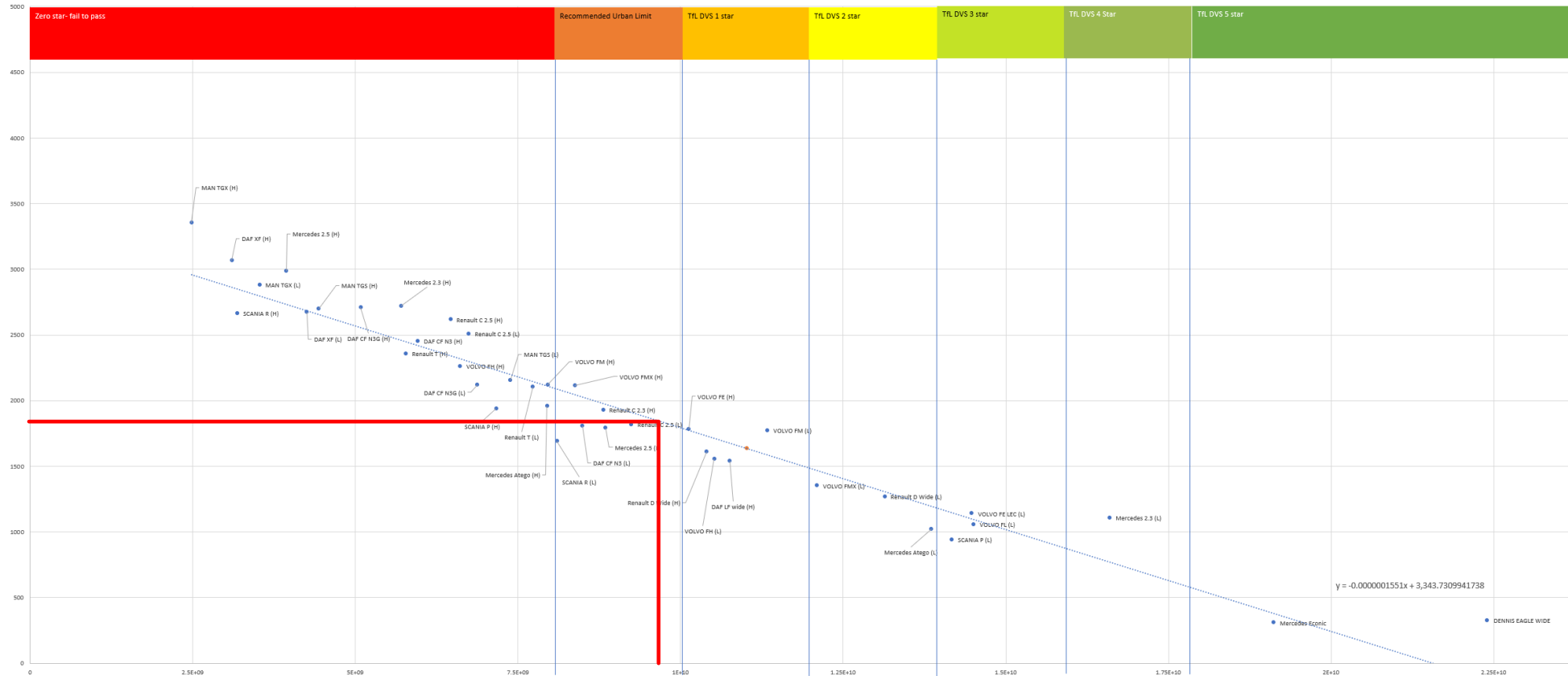
HOW THE VOLUMETRIC SCORES WERE QUANTIFIED IN REAL WORLD TERMS

- The second method provides a quantification of blind spot size in a manner that is easier to relate the accident types that UNECE 167 is trying to reduce
- As per the diagram, an array of VRU simulations is arranged around the vehicle using a consistent method. Each VRU is then moved away from the side of the truck in one axis only
- Half of the head of the VRU must then be be visible to the driver
- The distance that the VRUs are away from the HGV defines the size of the blind spot
- This method is less accurate than the volumetric approach but is easier to relate to the real world problem of HGVs colliding with VRUs that cant be seen directly
- The image shows that for some vehicle designs the VRU distance to the front can be over 2.5m to the front and 4m to the passenger side (UK truck shown with Right hand drive)
- This highlights the size of the direct vision blind spots



EXAMPLE VRU DISTANCES FOR VEHICLES IN THE STAR BOUNDARY CATEGORIES

Chart Visibility of head and neck



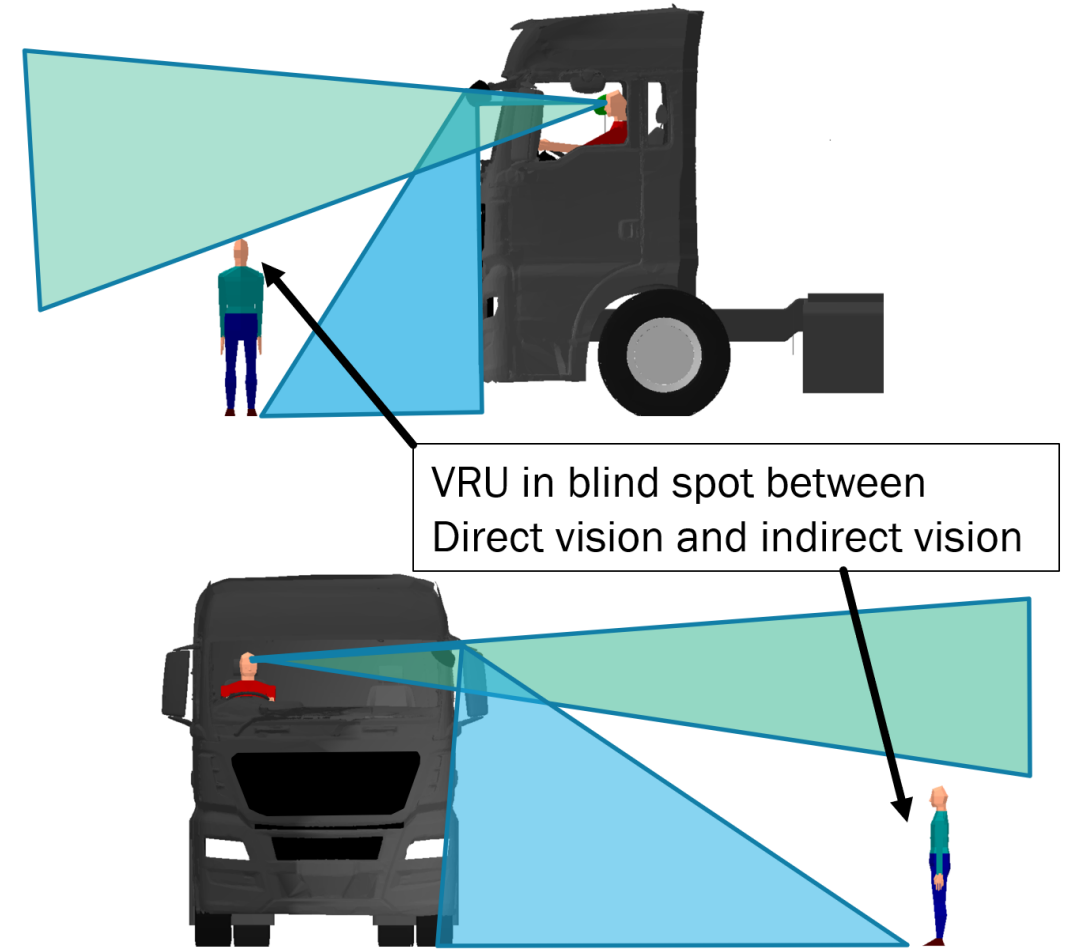
- The Volumetric score and the average VRU distance are correlated to allow a minimum volume requirement to be defined by a minimum VRU distance

EXAMPLE VRU DISTANCES FOR VEHICLES IN THE STAR BOUNDARY CATEGORIES

- KEY FACT FOR THE REQUIREMENT OF AN AMENDMENT
- The frontal volume requirements are defined by the distance at which VRUs are visible to the driver

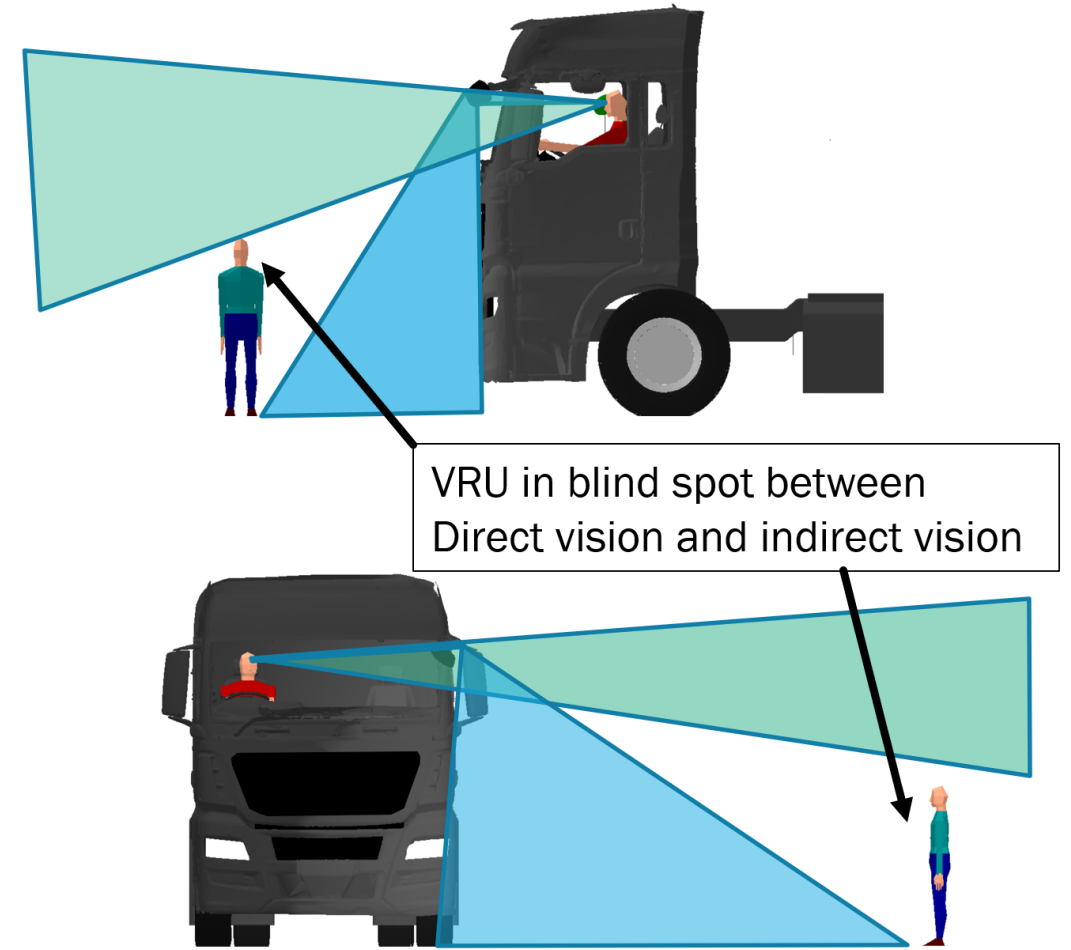
SETTING THE DVS MINIMUM REQUIREMENT

- By plotting the VRU distance against the Volume we gain a tool which allows us to specify a Volumetric limit, using a certain VRU distance
- The minimum requirement has been defined such that it should not be possible for a VRU to be hidden from the driver by being inside a blind spot between direct vision and indirect vision
- See the figure



SETTING THE DVS MINIMUM REQUIREMENT

- In order to address the range of performance in vehicles that operate in different ways, three performance levels were defined
- **Level 1 vehicles are for urban use and have the most stringent requirements**
- **Level 2 vehicles are construction vehicles which have certain height requirements for use in rough terrain**
- **Level 3 vehicles are Long Haul vehicles which are less often used in urban environments**
- These three levels were defined by specific VRU distances
- Level 1 vehicles are required to allow VRUs to be seen by a driver when they are closer to the vehicle than Level 2 and 3 vehicles and so the blind spots are smaller in level 1 vehicles



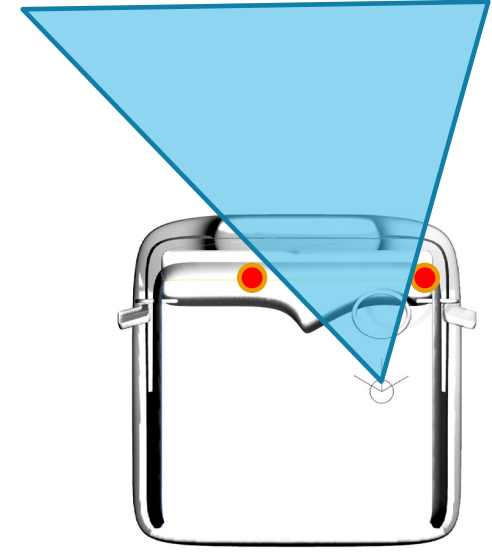
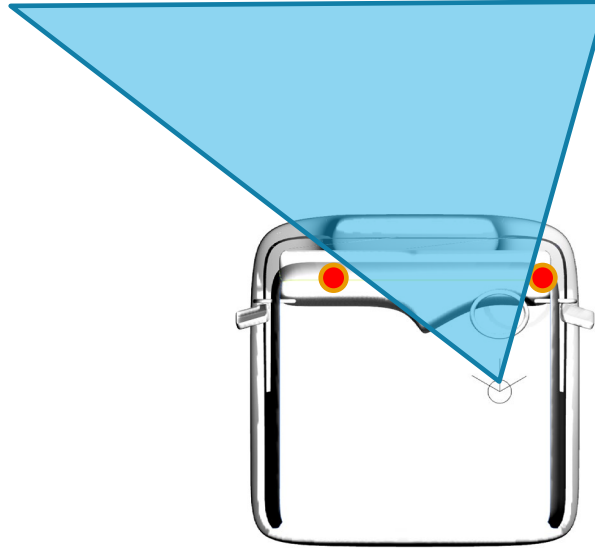
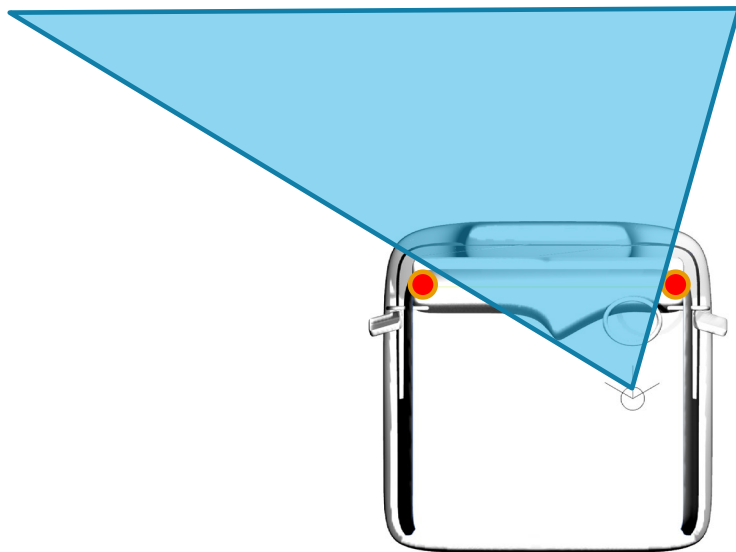
SETTING THE DVS MINIMUM REQUIREMENT

- The Series 00 version of UNECE 167 defined the volume scores required by specific VRU distance values and then **the link to the VRU distances was broken, only the volume scores were required to meet the requirements**
- Further work which was done to improve the technology neutrality of the standard **highlighted that breaking this link with the VRU distances causes problems.**
- For context, the most common accident type to the front of the vehicle in the UK STATS 19 data was a vehicle pulling away from crossing and not seeing a VRU directly in front, **in the UK mostly elderly people are killed in this way**
- There are two main ways identified in which breaking the link with VRU distance causes problems as discussed below.

PROPORTIONAL FRONT VOLUME BY A-PILLAR WIDTH

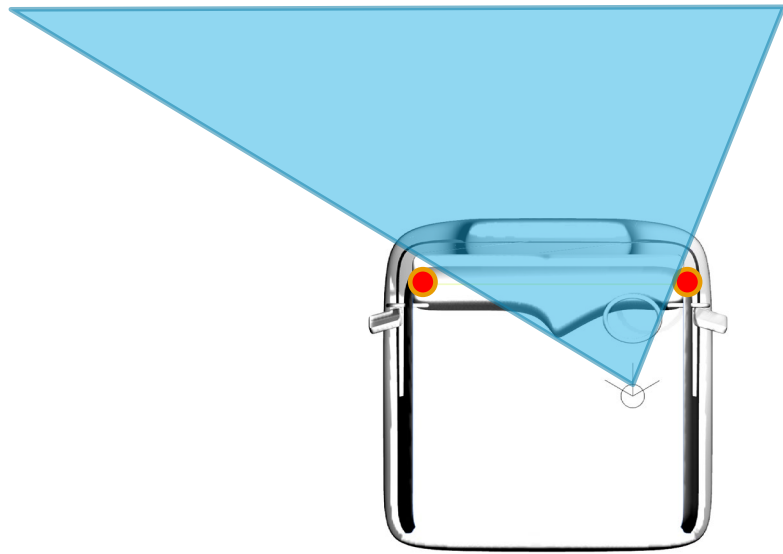
- One issue was highlighted by ACEA in the VRU proxi meetings
- The issue was that the measurement of frontal volume in the series 00 version of UNECE 167 was defined by the visible volume between the A-pillars
- This was seen as not technology Neutral as it penalised potential vehicle designs where the inter A-pillar distance is reduced
- This has been addressed with a suitable amendment
- However, this did highlight a further issue

Decreasing inter A-pillar distance

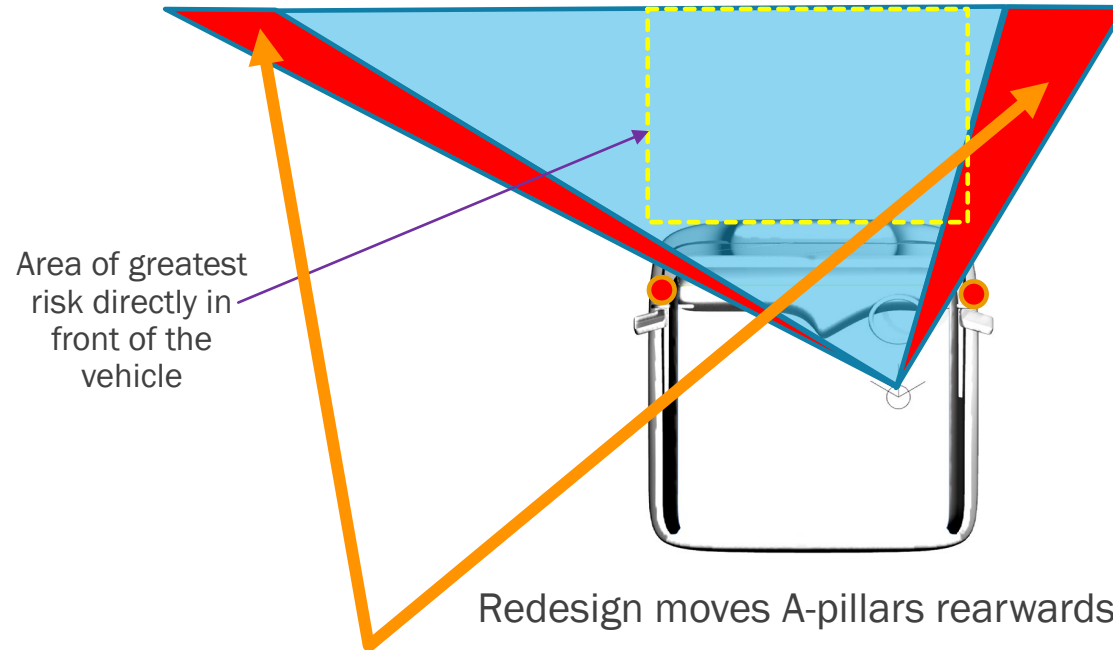


IMPROVING VOLUME SCORE WITHOUT IMPROVING DIRECT VISION OF AREA OF GREATEST RISK

- If manufacturers choose to move the A-pillars rearwards towards the driver compared to the original sample they will be able to gain volume without improving the view of the area of greatest risk
- i.e. the design could do nothing to improve the visibility of VRUs directly in front of the vehicle in the area of greatest risk and still meet frontal minimum requirements



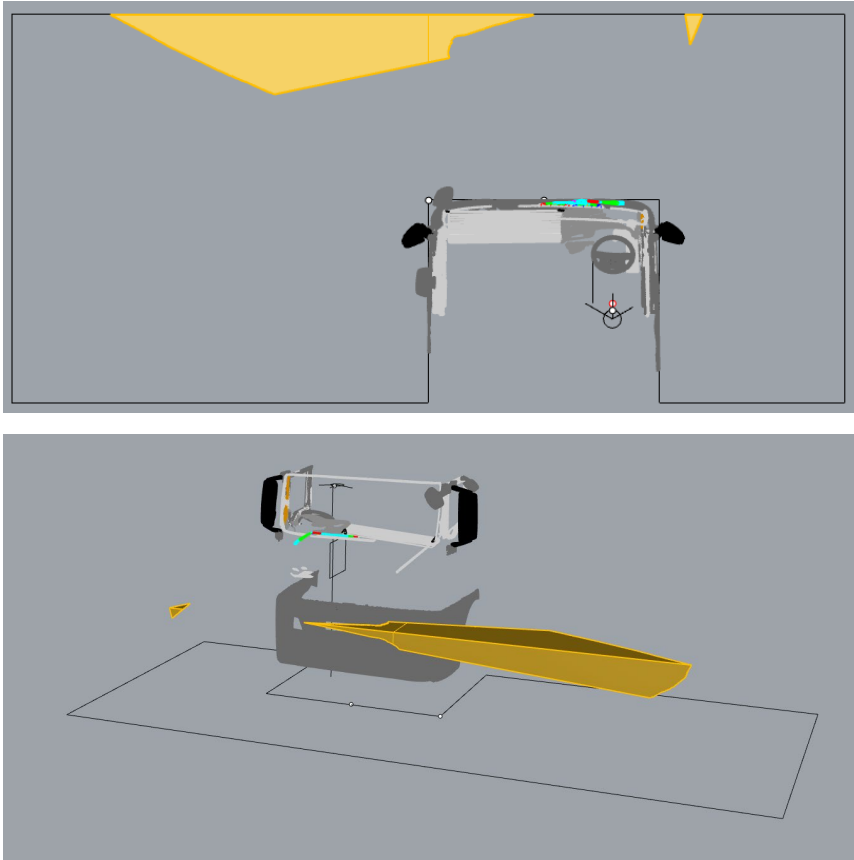
Original vehicle design



Red areas show volume gained outside of area of greatest risk for frontal collisions, **potentially allowing a vehicle to pass the minimum requirements without improving direct vision directly in front of the vehicle in the area of greatest risk.**

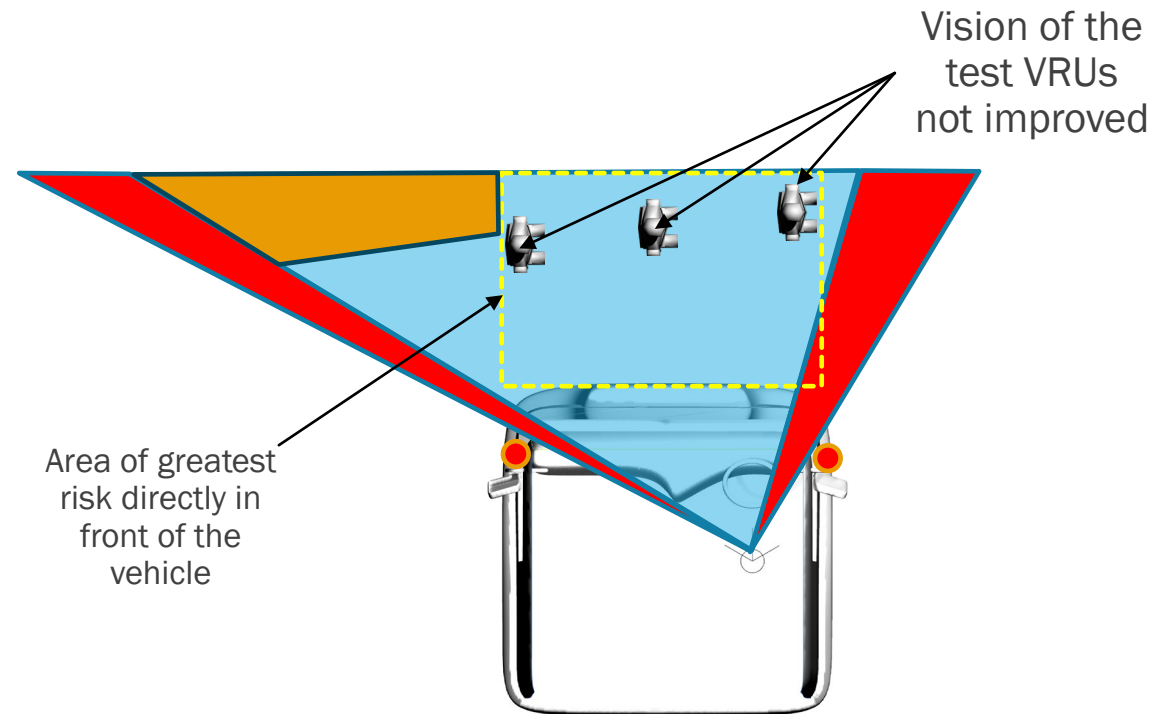
IMPROVING VOLUME SCORE WITHOUT IMPROVING DIRECT VISION OF AREA OF GREATEST RISK

- In addition, further volume can be gained by lowering the passenger side dash board area, but the volume gained is also outside of the area of greatest risk. This approach has been suggested by ACEA



This is the worst performing HGV in the sample used. It can achieve the frontal volume requirements by lowering the passenger side dashboard without improving the direct vision of the three test Vulnerable Road Users at all

It has an average front VRU distance of over 2.8m, so a large direct vision blind spot in front of the vehicle

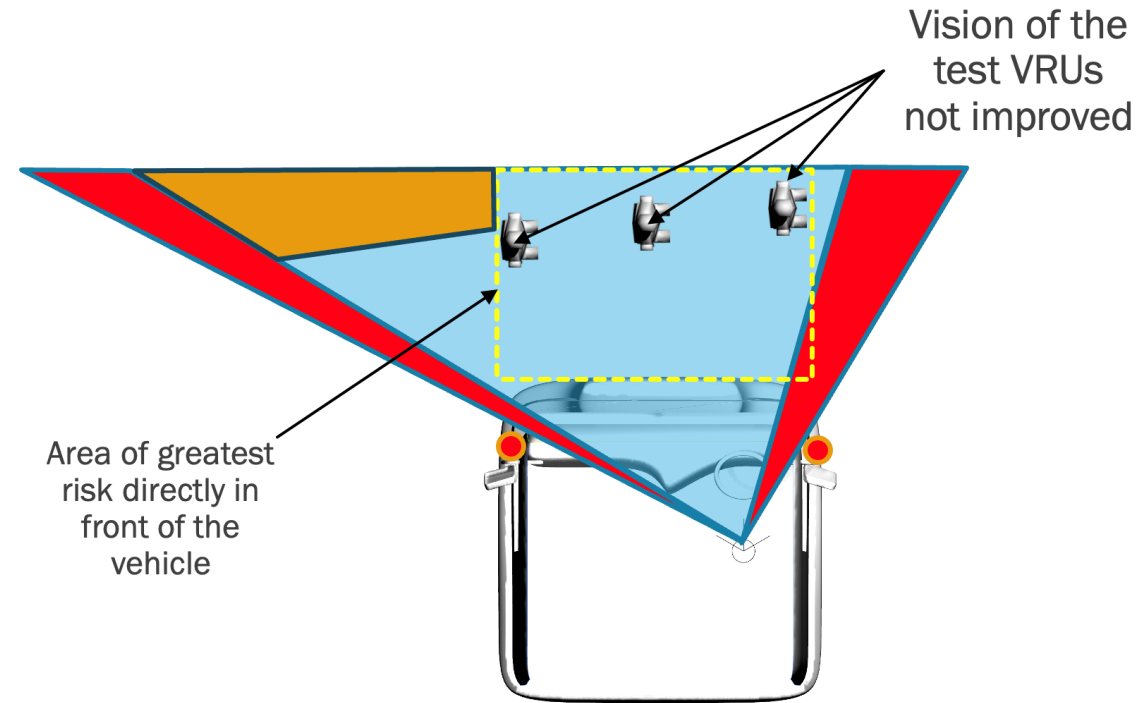



Redesigned dashboard on the passenger side

Orange areas show volume gained outside of area of greatest risk for frontal collisions, **potentially allowing a vehicle to pass the minimum requirements without improving direct vision directly in front of the vehicle in the area of greatest risk.**

IMPROVING VOLUME SCORE WITHOUT IMPROVING DIRECT VISION OF AREA OF GREATEST RISK

- To summarise, there are two ways identified in which frontal volume score can be improved in future designs
- Moving the A-pillars rearwards with respect to the eye position is a change that is less likely to happen due to potential difficulties in then meeting UNECE R29
- However, lowering the passenger side dashboard has been suggested as a change by ACEA in UNECE VRU proxi meetings and is likely
- Given that the frontal volume minimum requirements in the Series 00 version are defined by the visibility of the three VRU simulations to the front of the vehicle, **and yet changes can be made which allow volume to be gained which doesn't improve visibility of the 3 VRUs**, we are proposing an amendment

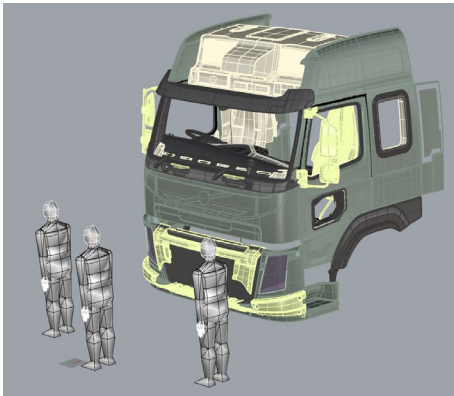


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- We therefore designed a new method to ensure that the intent of the standard is met (to allow the VRUs in front of the vehicle to be seen) as per the content in the next three slides.

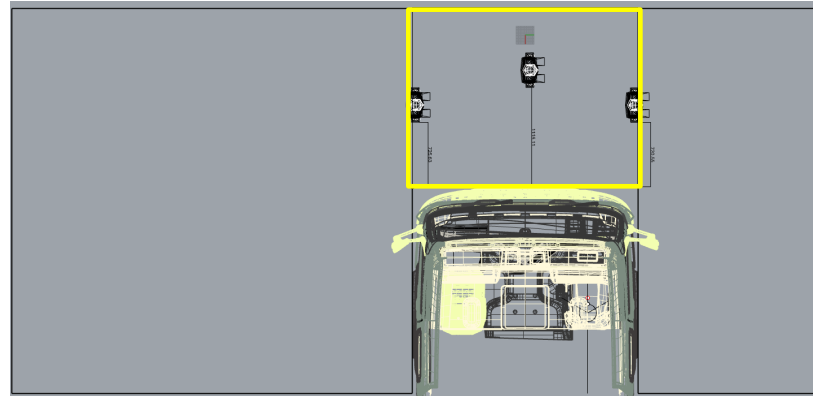
HOW CAN WE ENSURE EQUIVALENCE BETWEEN THE TWO METHODS?

The premise is as follows;

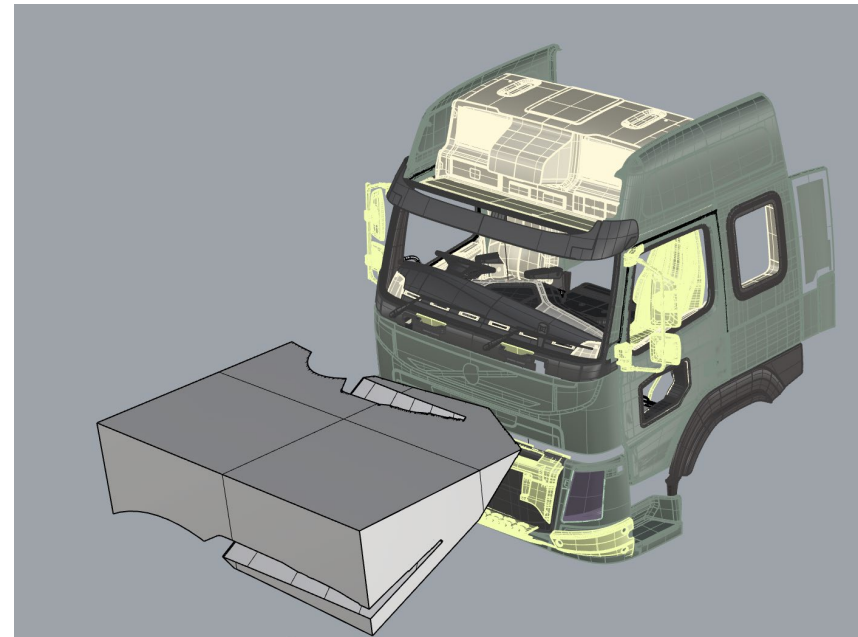
- The volume approach is still preferred by all parties as it is an accurate method that can be performed in CAD during design development
- So the question is what volume is equivalent to the need to see three VRUs directly in front of the vehicle?
- We needed a way to define a frontal volume
- We have taken **the lateral extents** of the vehicle to define the volume directly in front of the vehicle as this is the area that contains the three VRUs for the Series 00 method. **Subsection Frontal Visible Volume (SFVV)**
- Therefore, plotting the VRU distance against the SFVV Volume gives a trend line that can be used to calculate the volume that should be seen at a certain VRU distance, in the same way as the method used to define the volume requirement for the series 00 version



Three VRUs in front of the cab as defined in Series 00



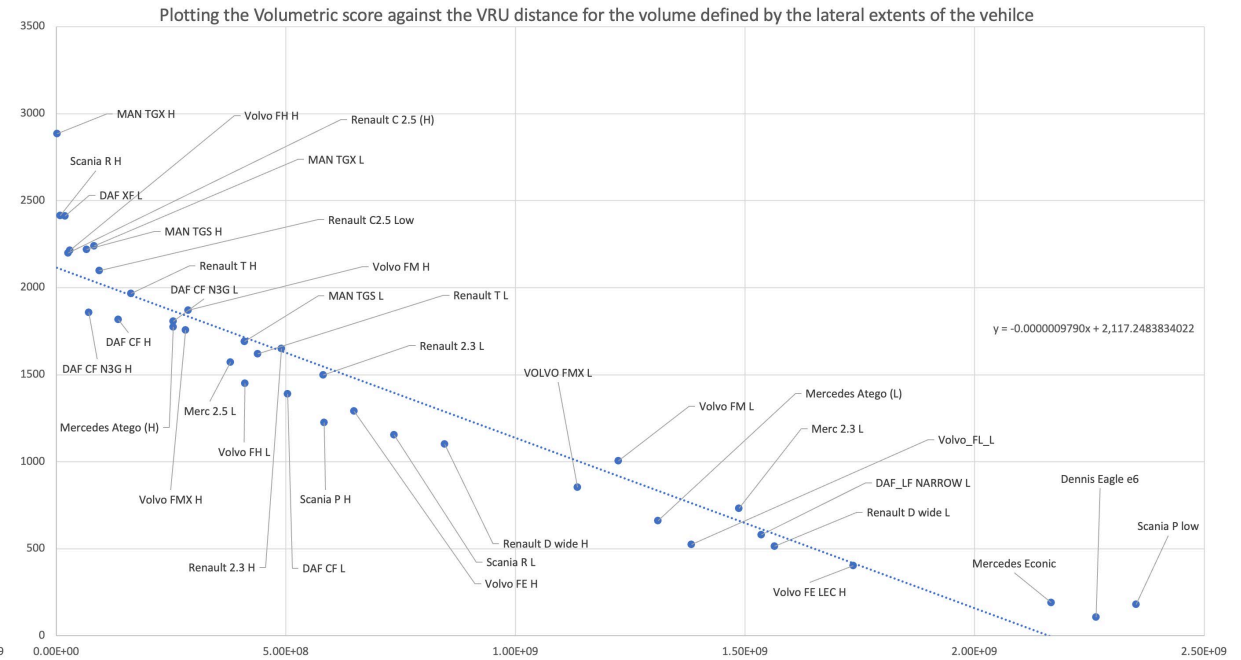
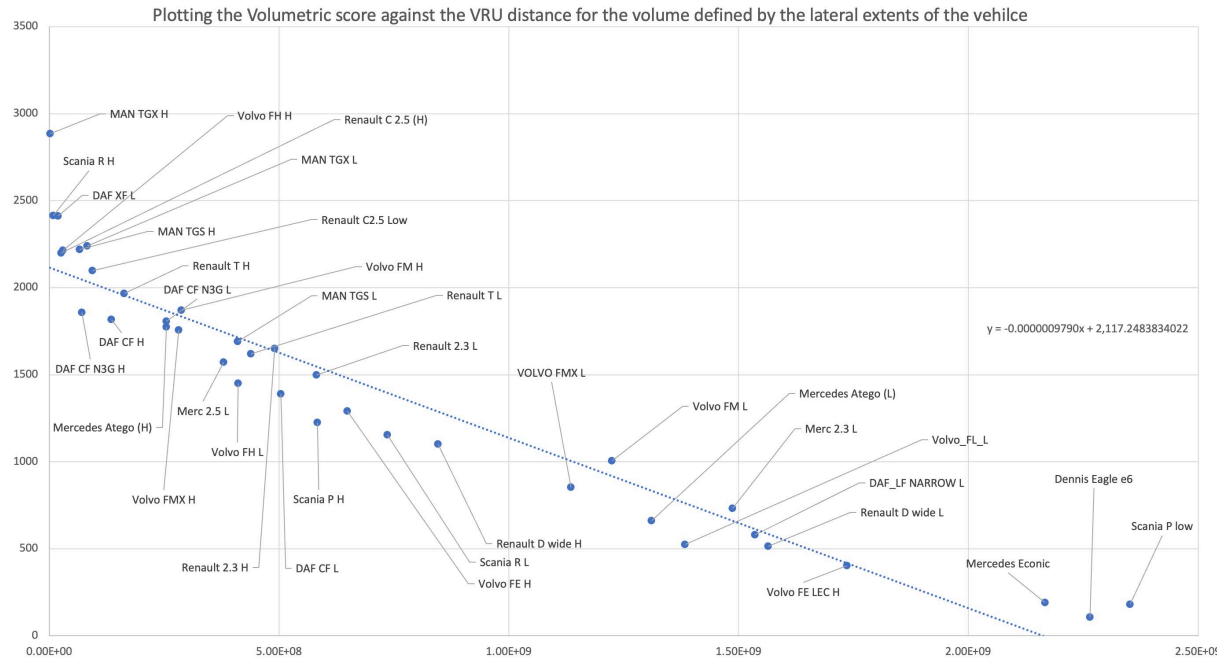
Plan view of the area within which the VRUs are contained, therefore VRU distance should correlate well with volume as per the previous uses of this method



Volume that is visible between the lateral extents of the vehicle

HOW CAN WE ENSURE EQUIVALENCE BETWEEN THE TWO METHODS?

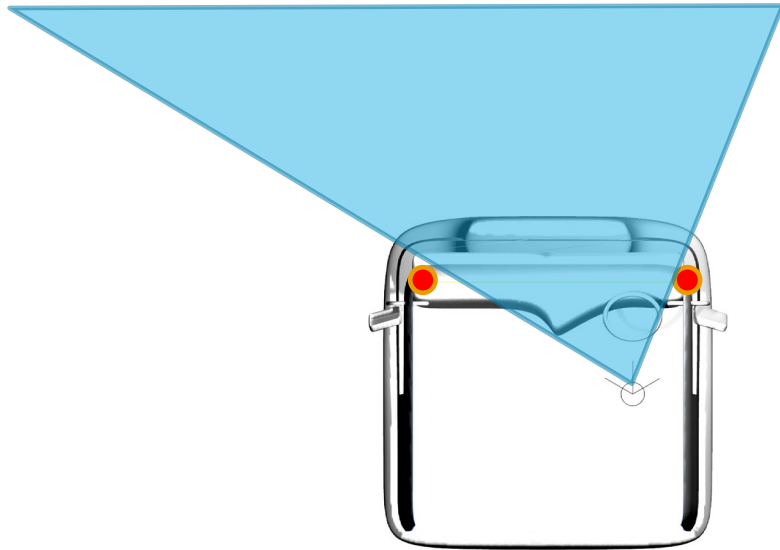
- We have performed this process for 36 vehicles with the following results
- Level 1 vehicles (urban) would need to be able to see **0.48m³** in the SFVV area (average VRU distance 1653mm)
- Level 2 (construction) and 3 (long haul) vehicles would need to be able to see **0.169m³** in the SFVV area (average VRU distance 1958mm)



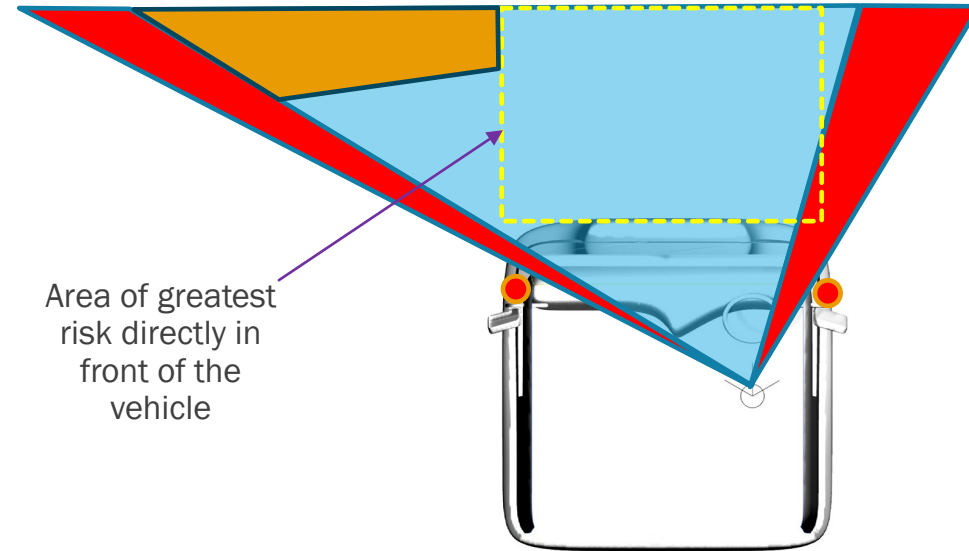
Average VRU DIST	VOLUME	1958 for level 2 and 3	1653 for level 1	Average VRU DIST	VOLUME	1958 for level 2 and 3	1653 for level 1
CALC 1653	4.80E+08 or 0.48m ³			CALC 1958	1.69E+08 or 0.48m ³		

ADDRESSING THE CONCERNS

- By requiring a design to allow visibility of the **Subsection Frontal Visible Volume (SFVV)** we can avoid the issue shown below.



Original vehicle design



Area of greatest risk directly in front of the vehicle

Redesign moves A-pillars rearwards

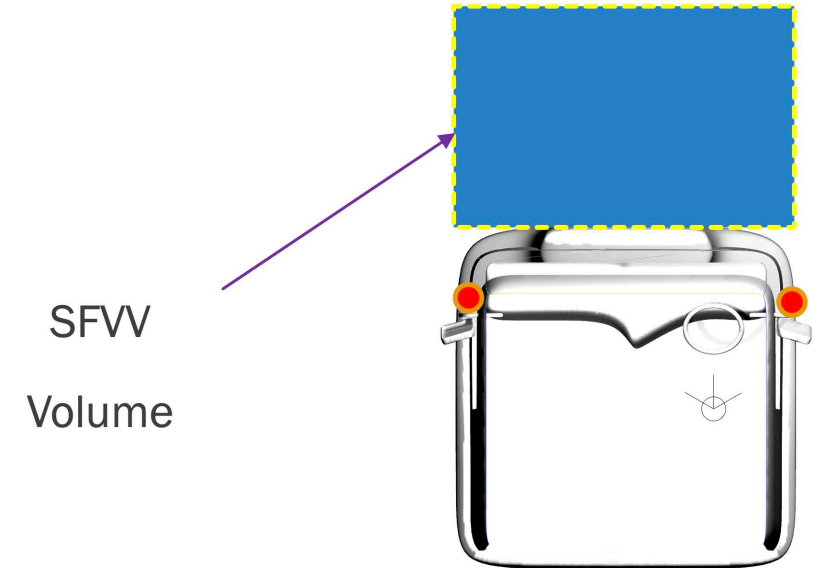
Red areas show volume gained outside of area of greatest risk for frontal collisions, potentially allowing a vehicle to pass the minimum requirements without improving direct vision directly in front of the vehicle.

SUMMARY

- The volume limit for the front of the vehicle was literally defined by the distance at which Vulnerable Road user Simulations are visible to the driver
- We have shown that it is possible for the series 00 version to allow volume to be gained in locations outside the area of greatest risk where those VRUs are not visible
- **This does not make sense and the amendment is required in our view.**
- An additional issue was correctly raised by ACEA, that the SFVV requirements should also be reduced for vehicles with reduced inter A-pillar Distance (IAPD)

THE NEED FOR A TECH NEUTRAL SFVV

- It has been highlighted that the approach taken to ensure that frontal volume is technology neutral for reduced A-pillar width, needs to be replicated for the SFVV volume
- i.e. the SFVV volume is defined by vehicle width but there is less volume to see for narrower vehicles with the same minimum volume requirement
- A narrower 2.3m cab currently has the same volume requirement as the 2.5m cab in the current version
- This needs to be corrected
- This slides below present a solution this problem



PROPOSED SOLUTION

- For a Level 1 vehicle with a cab width of 2.5m we expect to see 0.48m³ of SFVV volume and 1.8m³ for the frontal volume as a minimum requirement as defined in the proposed amendment. This is taken from the table in the Tech Neutral Amendment of UNECE 167
 - The SFVV value is therefore 26% of the frontal volume for level 1 vehicles (urban)
 - For a vehicle with a cab width narrower than 2.5m the method defined in the previous amendment to address Technology Neutrality can be used
 - This method allows the volume requirements to the front to be reduced proportionally for reduced inter A-pillar Distance (IAPD)
 - To find the SFVV volume requirements you take 26% of the volume found by the IAPD equation
 - For level 2 and 3 vehicles the requirement is 1m³ for the full frontal volume, and 0.163m³ for the SFVV
 - Therefore the SFVV volume is 16.3% of the total frontal volume.

PROPOSED SOLUTION

- This method uses the work already established to be able to determine the volume requirements to the front for vehicles with reduced Inter A-Pillar Distance (IAPD)
- This proposal is assuming linearity of the proportion of SFVV to frontal volume, and so we did some testing to see if this was the case.

SUMMARY

- The volume limit for the front of the vehicle was literally defined by the distance at which Vulnerable Road user Simulations are visible to the driver
- We have shown that it is possible for the series 00 version to allow volume to be gained in locations outside the area of greatest risk where those VRUs are not visible
- **This does not make sense and the amendment is required in our view.**
- We have also produced a solution for the Technology Neutrality of the SFVV requirements
- These results have been expressed in the amendment

Project information

Thank you for your attention, are there any questions?

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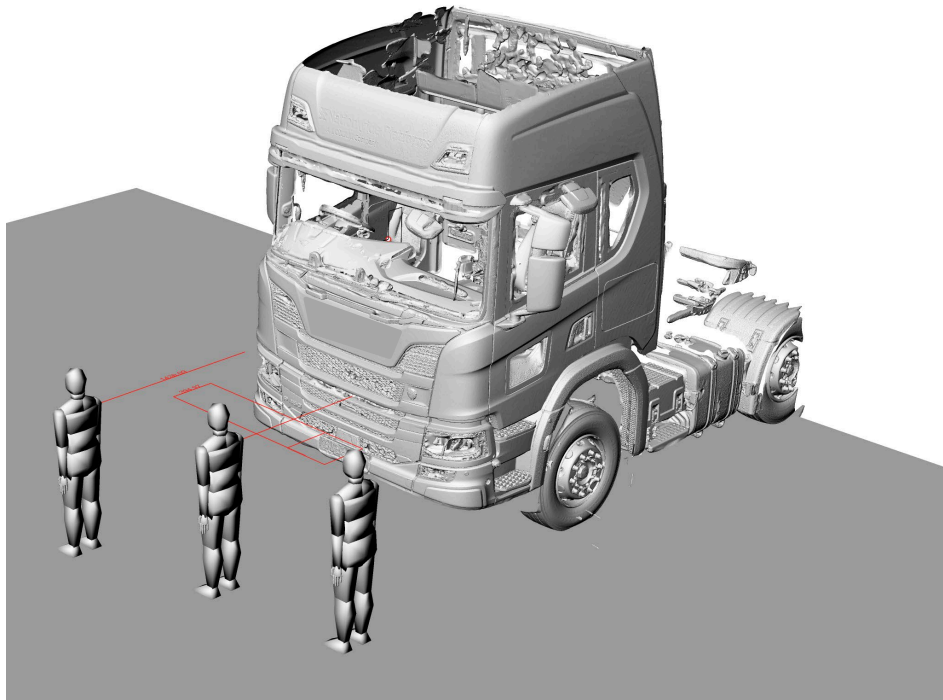
Loughborough Design School

Loughborough University

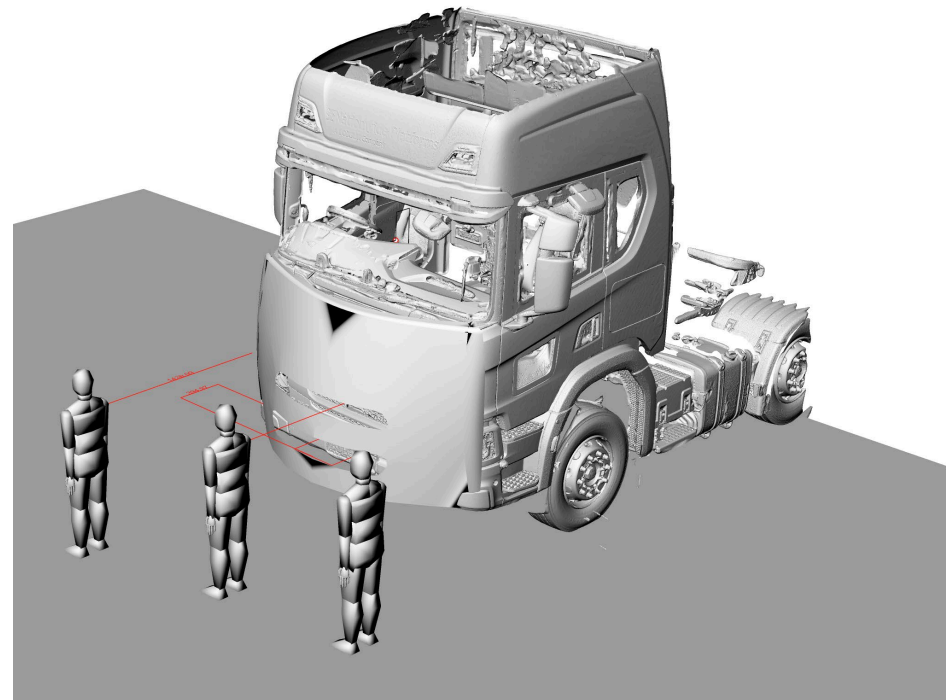
United Kingdom of Great Britain and Northern Ireland

EXTRA CONTENT – EXTENDED FRONT BENEFITS FOR VRU VISIBILITY

- One issue that has been raised is follows
- “Vehicle manufacturers may increase the aforementioned volume only by extending the front of the vehicle. In the EU legal framework, this may even lead to classification as an elongated cab and benefits from further advantages without having to improve visibility from VRU’s.”
- Previous work for VRU Proxi meetings highlighted that elongated cabs inherently reduce the size of the direct vision blind spot
- Here we are using our 3D scan data of a typical HGV.



Typical HGV

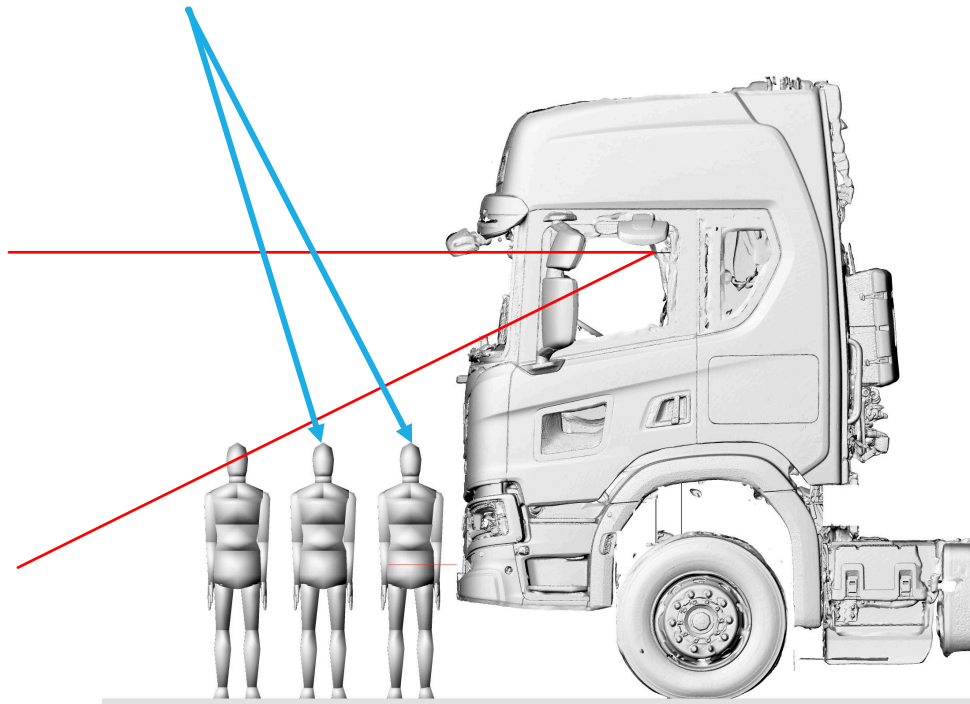


Typical HGV with 400mm extended front end

EXTRA CONTENT – EXTENDED FRONT BENEFITS FOR VRU VISIBILITY

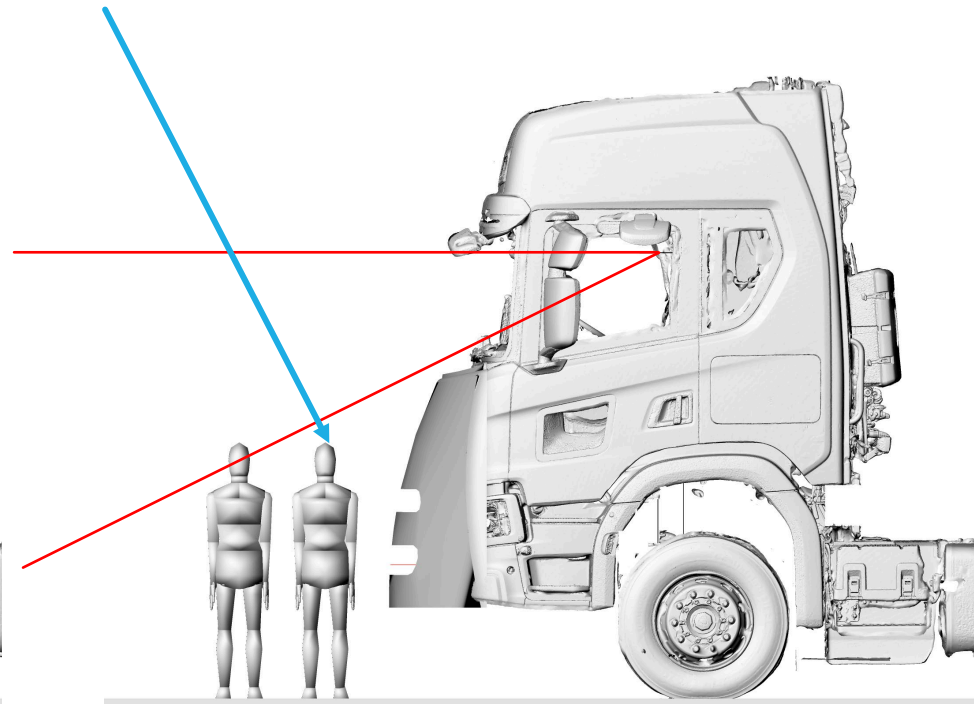
- Elongated cabs effectively push VRUs further away from the eye point
- In the example below a cab elongated by 400mm will allow one VRU to be hidden in the front blind spot
- The standard version allows 2 VRUs to be hidden in the front blind spot
- Therefore elongated cab design reduced the blind spot size in comparison to non-elongated vehicles.

2 VRU simulations in blind spot



Typical HGV

1 VRU simulation in blind spot



Typical HGV with 400mm extended front end