33RD UNECE VRU PROXI GROUP MEETING: TECHNOLOGY NEUTRAL SFVV

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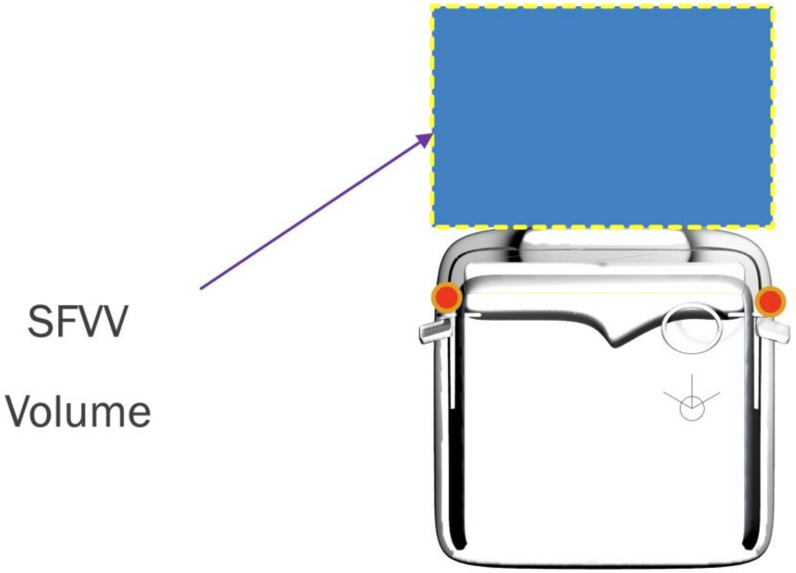
VRU-Proxi-33-07

CONTENT

- Proposal
- Testing the proposal

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 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
- 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 presentation presents an option for solving this issue.



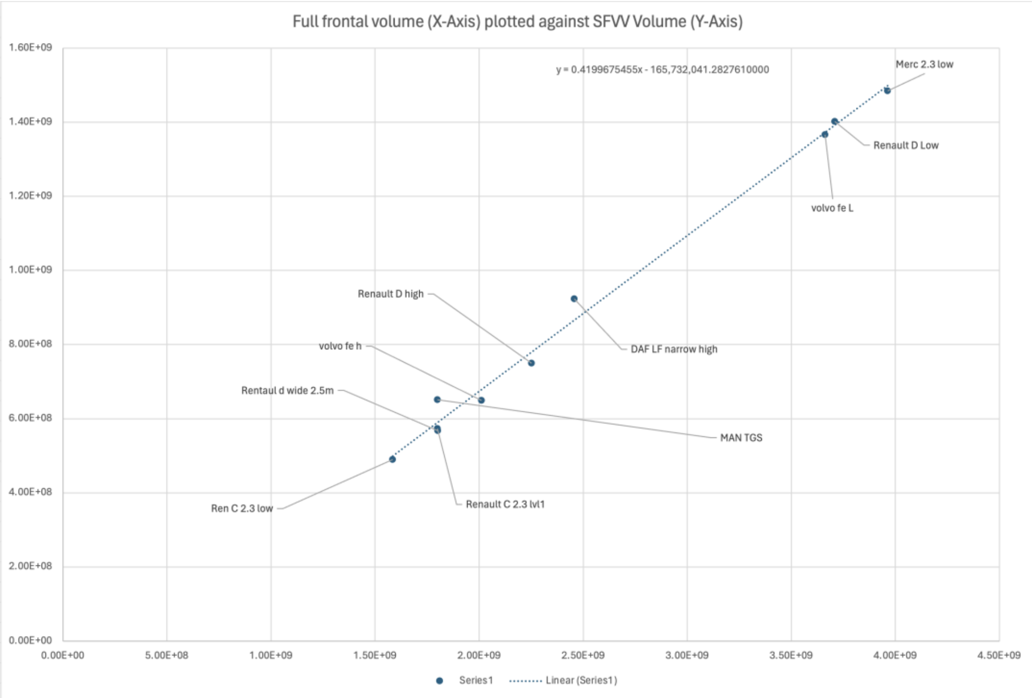
PROPOSAL

- Our proposal is as follows
  - For a Level 1 vehicle with a cab width of 2.5m we expect to see 0.47m^3 of SFVV volume and 1.8m^3 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 26.1% of the frontal volume for level 1 vehicles (urban)
  - For a vehicle with a cab width narrower than 2.5m the IAPD can be measured and the frontal volume calculated.
  - To find the SFVV volume requirements you take 26.1% of the volume found by the IAPD equation
  - For level 2 and 3 vehicles the requirements is 1m^3 for the full frontal volume, and 0.163m^3 for the SFVV
  - Therefore the SFVV volume is 16.3% of the total frontal volume.

- 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.

CHECKING LINEARITY OF SFVV TO FULL FRONTAL VOLUME

- The graph shows the Subsection Frontal Visible Volume (SFVV) plotted against the frontal volume for 10 different 2.3m wide cabs
- The correlation is 0.996
- Therefore we are assuming Linearity
- We then checked some real world cases to see that percentage of the full volume the SFVV provides.

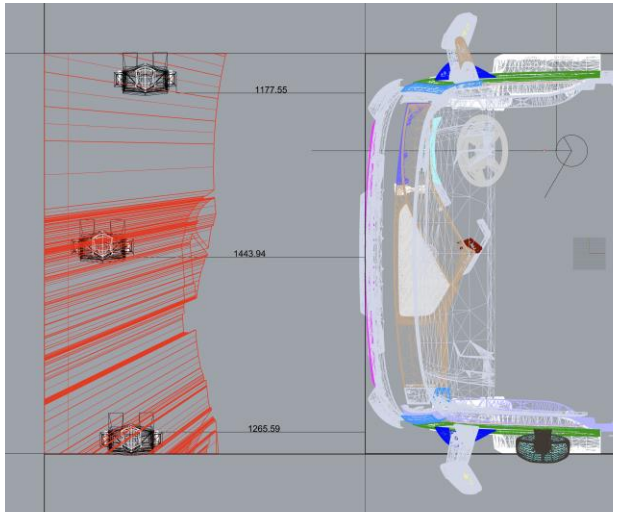


TESTING REAL VEHICLES TO SEE SFVV % OF FRONTAL VOLUME

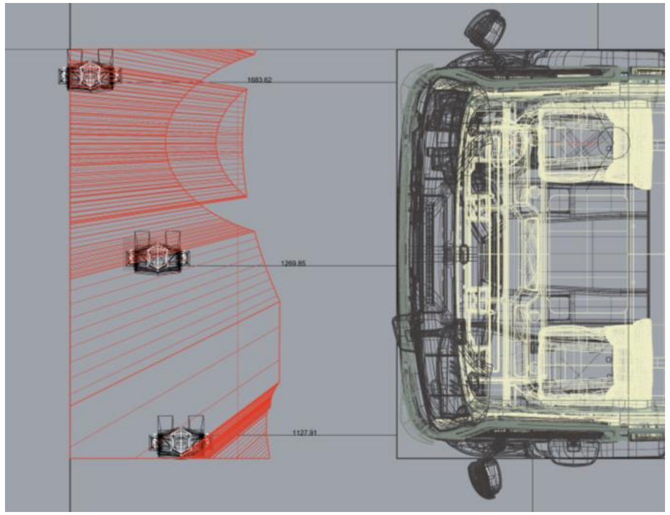
- We have selected a number of vehicles and found the exact mounting height of the cab at which the minimum requirement for for level 1 volume is met (1.8m^3)
- We then found the volume of the SFVV to compare to the proposed 26.1% of the total volume discussed above
- In each case the SFVV volume was 32% of the frontal volume
- But 26.1% is set as a minimum requirement which relates to the average VRU distance of 1653mm for level 1 vehicles.
- Each of the three vehicles tested over performed in the VRU distance test.

	2.3m cabs SFVV % of front vol		
VEHILCE	FRONT VOL	SFVV	% of SFVV
Ren C 2.3 low	1.58E+09	4.90E+08	31%
Renault C 2.3 LVL1	1.80E+09	573287529	32%
Renault D wide LVL1	1.80E+09	567452057	32%
MERC 2.3 AT LVL1	1.80E+09	574169357	32%
VOLVO FE H	2.01E+09	649661555	32%
Renault D high	2.25E+09	749510693	33%
DAF LF narrow high	2.46E+09	923771833	38%
VOLVO FE L	3.66E+09	1.37E+09	37%
Renault D Low	3.71E+09	1.40E+09	38%
Merc 2.3 low	3.96E+09	1.48E+09	37%

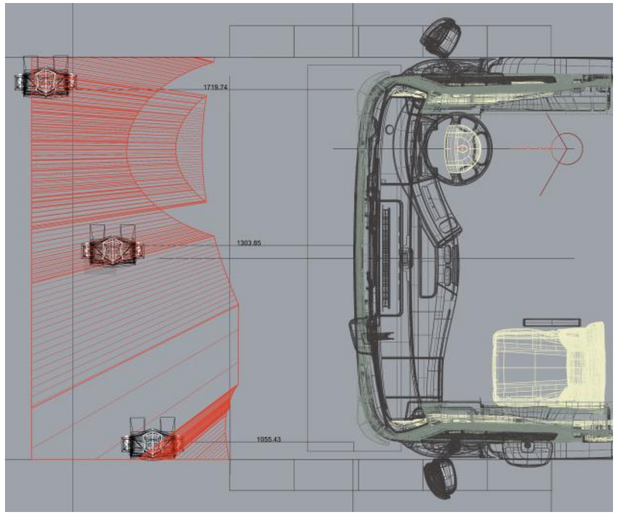
TESTING REAL VEHICLES TO SEE SFVV % OF FRONTAL VOLUME



Merc 2.3 cab



Renault D wide cab



Renault C 2.3 cab

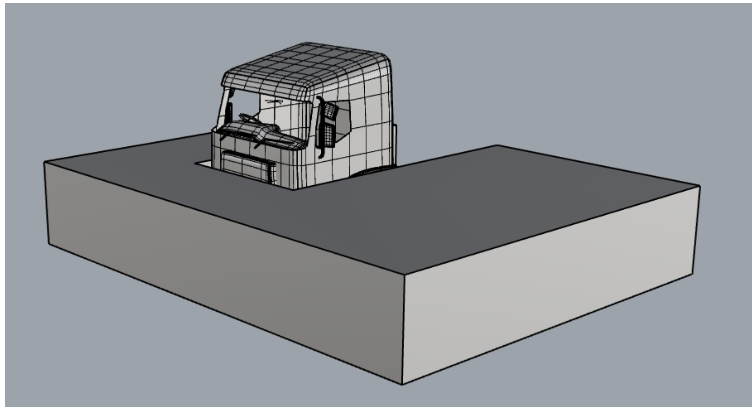
- Mercedes 2.3m cab had an average frontal VRU distance of 1295mm which is 78% of 1653mm
- Renault D wide cab had an average frontal VRU distance of 1360mm which is 82% of 1653mm
- Renault C 2.3m cab had an average frontal VRU distance of 1359mm which is 82% of 1653mm
- Therefore, each is overperforming by a similar amount
- If we reduce the 32% of SFVV from frontal volume by the overperformance amount we get 26% for the Renault D and C and 25% for the Mercedes
- Therefore, we are happy with the 26.1% estimate of SFVV volume from full frontal volume.

DAY 2 CONTENT

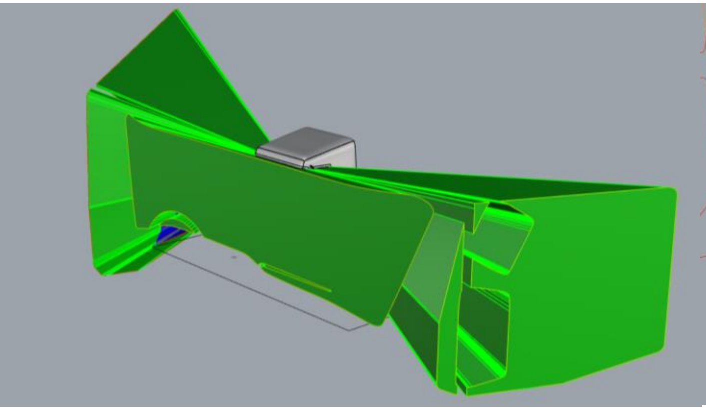
- At the request of the chair, a description of why is an amendment required for UNECE 167 and the results of the extra requested analysis from yesterday afternoon.

THE PROCESS USED IN UNECE 167

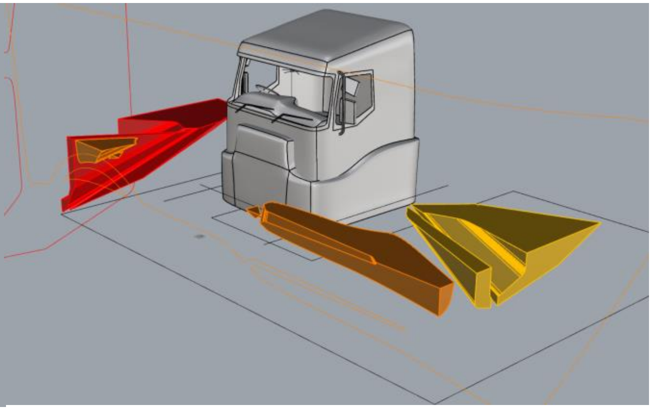
- The process used to measure direct vision in UNECE 167 comprises two separate approaches for quantifying what a driver can see from the vehicle cab
- The first method measures the literal volume of space that is visible to a driver by looking through the windows
- This method is highly accurate and 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. A volumetric score of $10m^3$ is difficult to relate to the real world problem



Assessment volume the cab



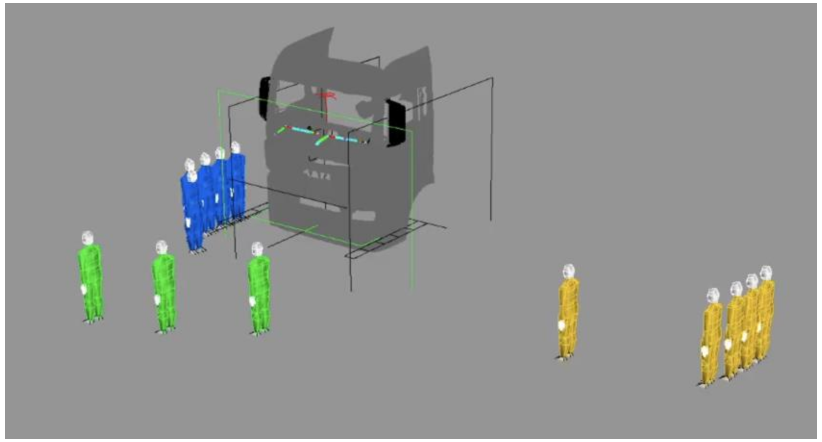
The volume of space visible to driver through the window

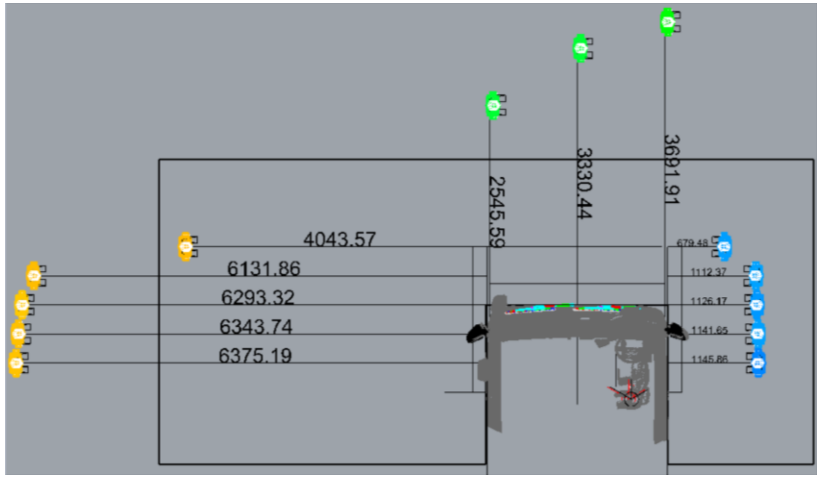


The amount of the assessment volume that can be seen by the driver

HOW THE VOLUMETRIC SCORES WERE QUANTIFIED IN REAL WORLD TERMS

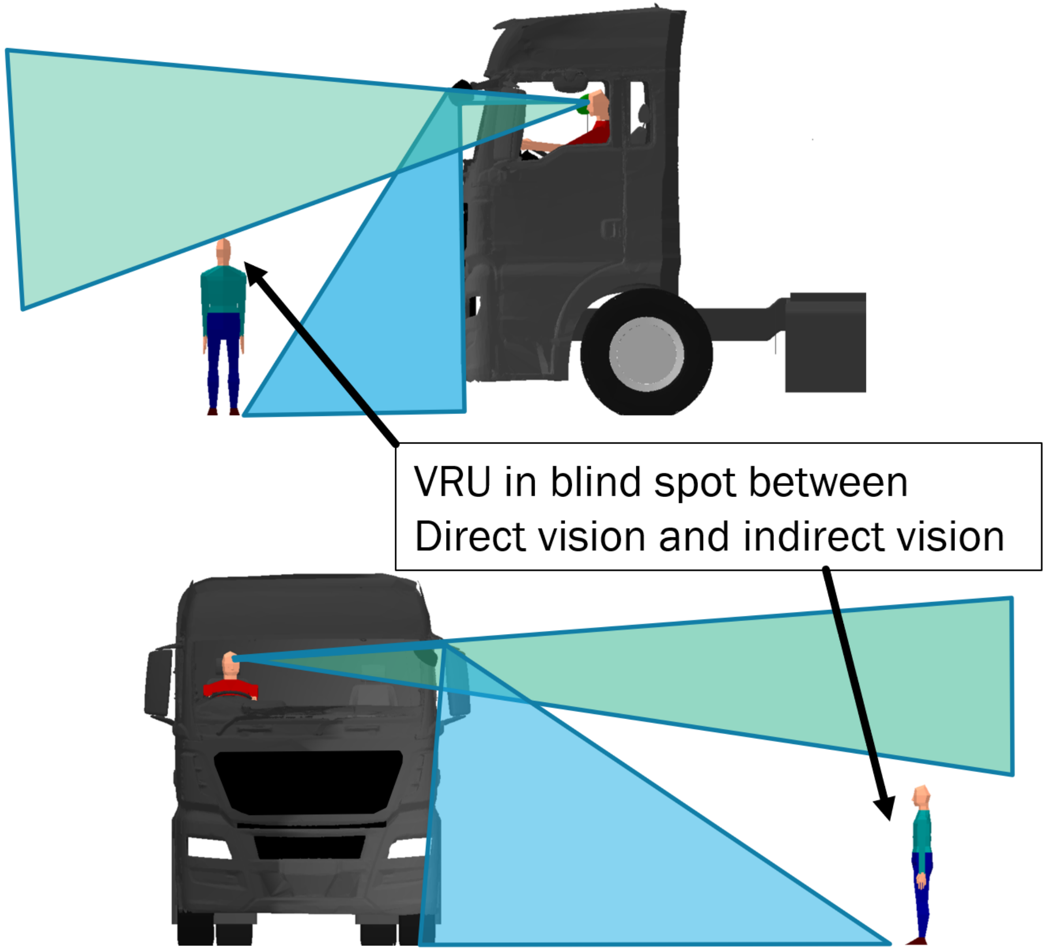
- The second method provides a quantification of blind spot size in a manner that is easier to relate the accident types that UNECE 167 is trying to reduce
- As per the diagram, an array of VRU simulations is arranged around the vehicle using a consistent method. Each VRU is then moved away from the side of the truck in one axis only
- The VRU must then 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





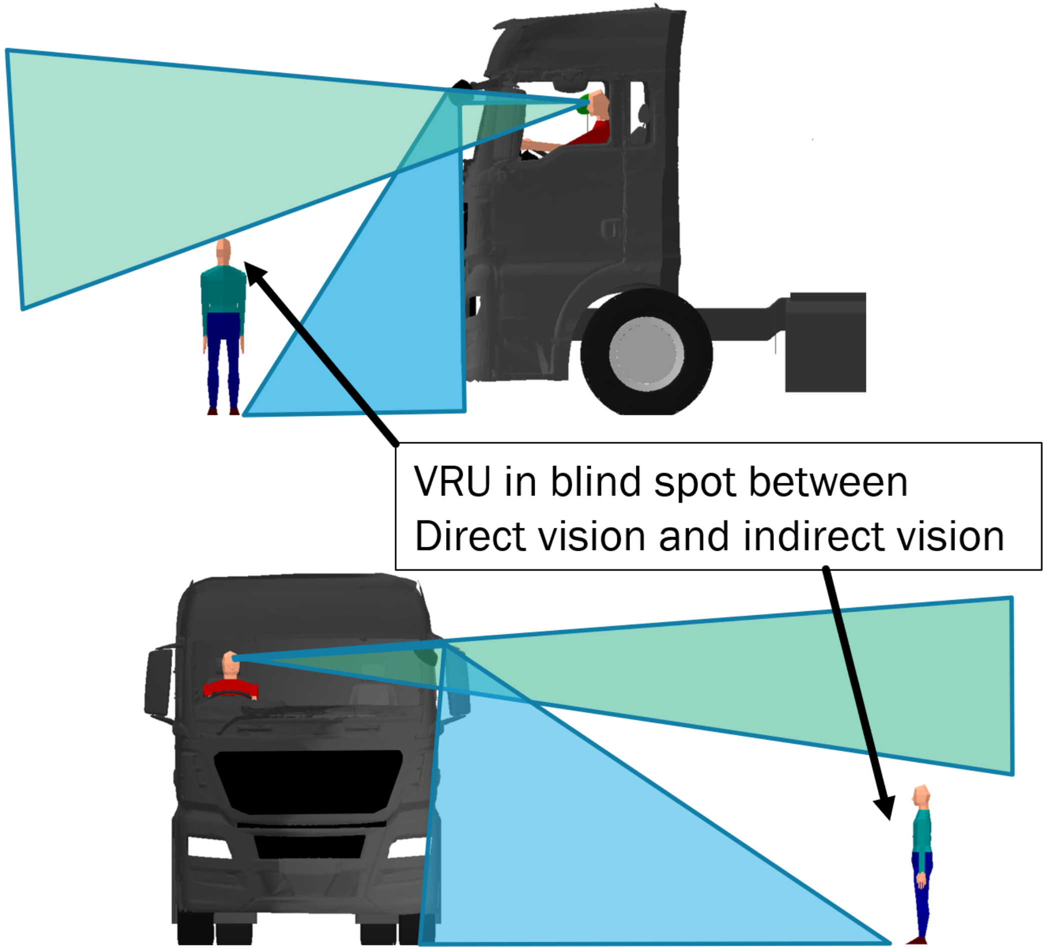
SETTING THE DVS MINIMUM REQUIREMENT

- The performance of the existing vehicle designs in 2018 was worse than anticipated
- A minimum requirement was required
- The minimum requirement was that no vehicle should allow VRUs to be in a blind spot between direct vision through windows and indirect vision through mirrors
- This requirement was a compromise due to the poor performance of many designs
- ANY YET more than half of the vehicles tested were not able to meet this minimum requirement

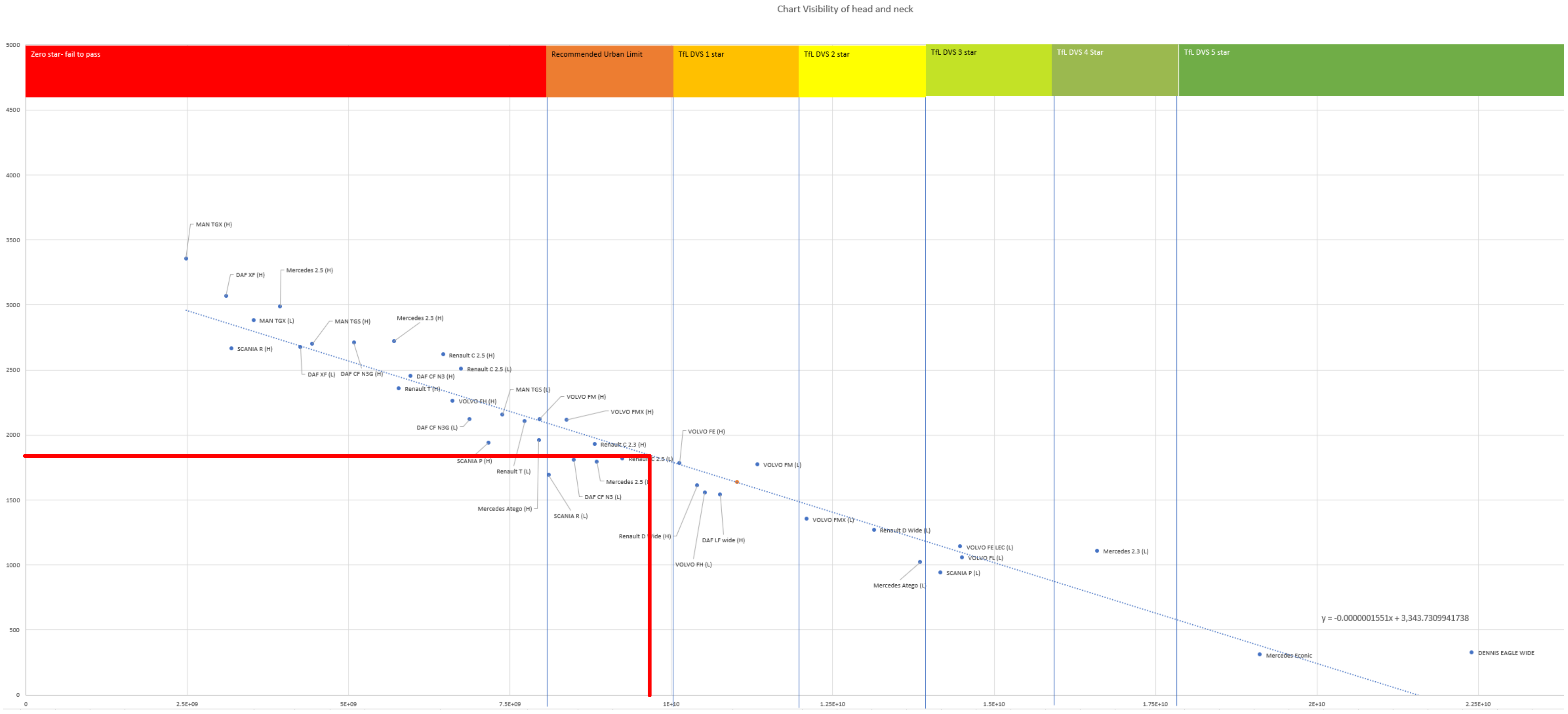


SETTING THE DVS MINIMUM REQUIREMENT

- 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



EXAMPLE VRU DISTANCES FOR VEHICLES IN THE STAR BOUNDARY CATEGORIES (NEW VERSION, HEAD & NECK ONLY VISIBLE) TFL VERSION



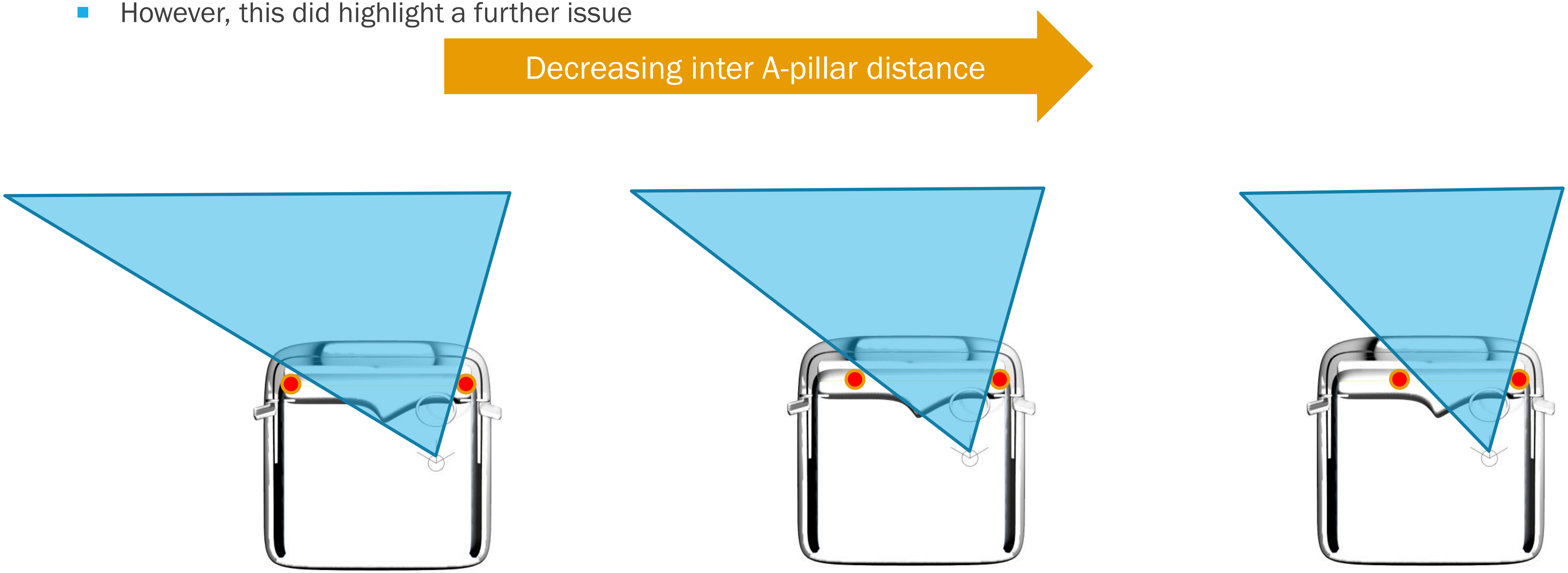
- The Volumetric score and the average VRU distance are correlated to allow a minimum volume requirement to be defined by a minimum VRU distance requirement

SETTING THE DVS MINIMUM REQUIREMENT

- The Series 00 version of the 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.

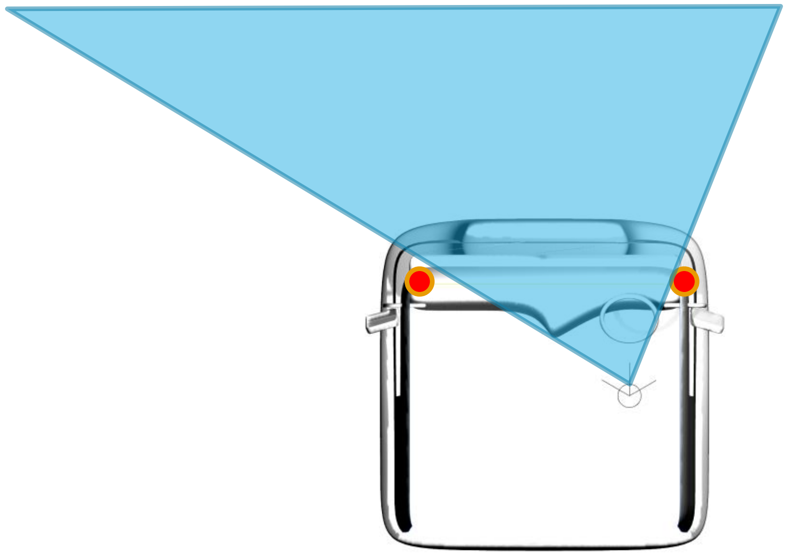
PROPORTIONAL FRONT VOLUME BY A-PILLAR WIDTH

- 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

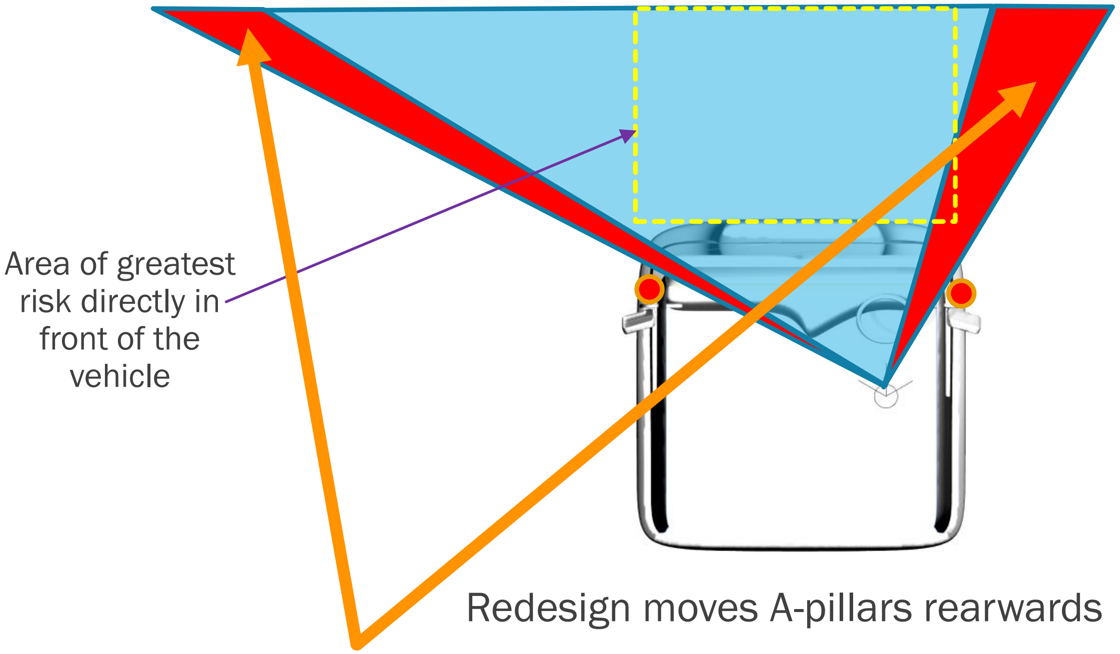


IMPROVING VOLUME SCORE WITHOUT IMPROVING DIRECT VISION OF AREA OF GREATEST RISK

- If manufacturers choose to move the A-pillars rearwards towards the driver compared to the original sample they will 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

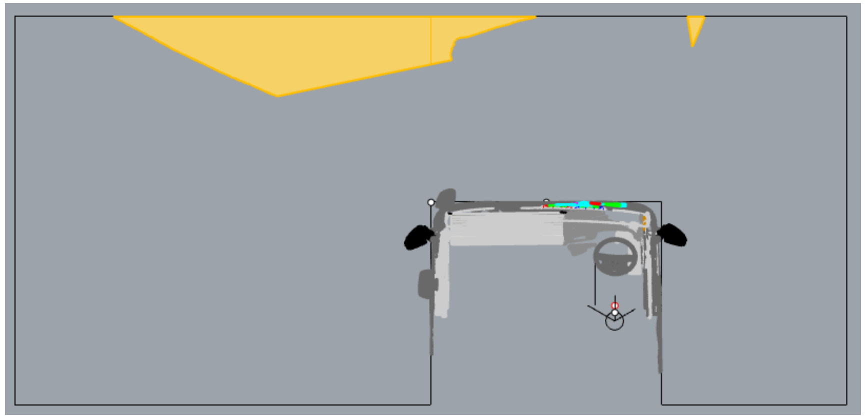


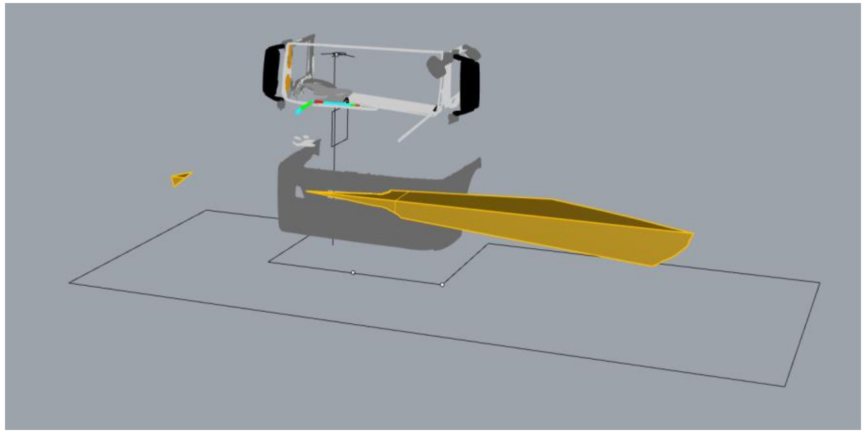
Redesign moves A-pillars rearwards

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 in the area of greatest risk.**

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

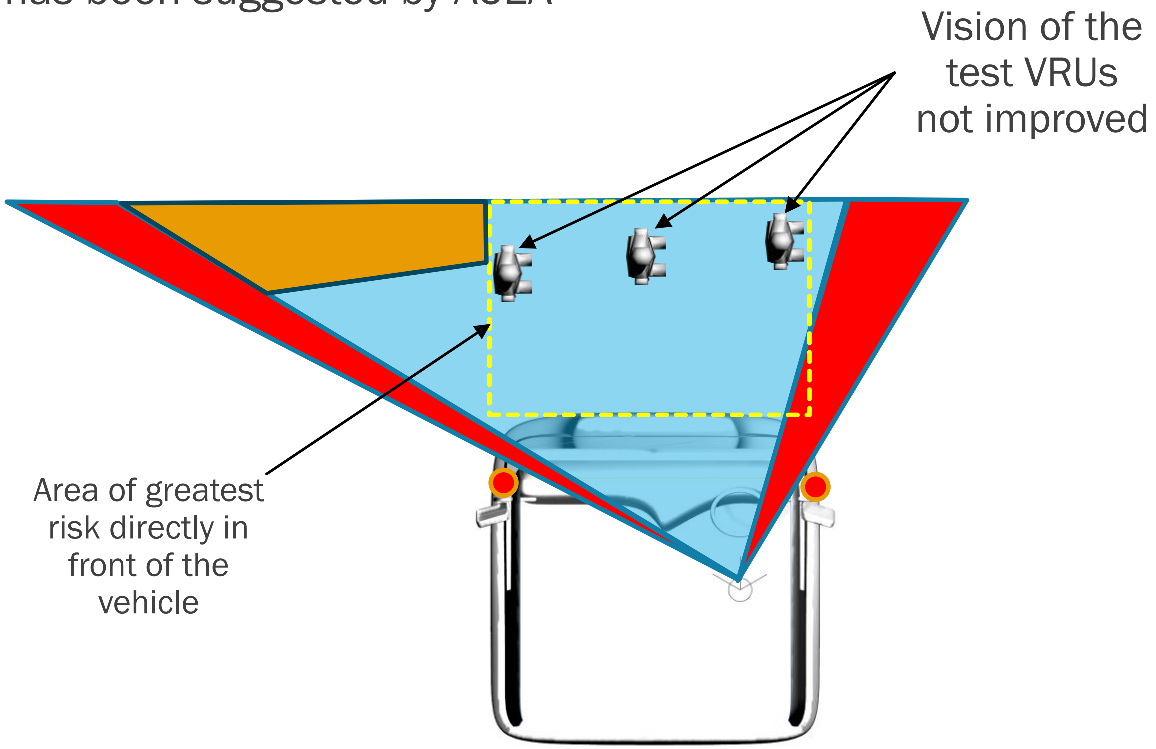
- In addition, further volume can be gained by lowering the passenger side dash board area, but this volume is also outside of the area of greatest risk. This approach has been suggested by ACEA





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



Redesigned dashboard on the passenger side

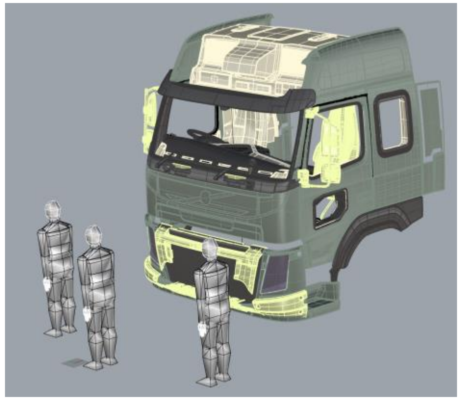
Orange areas show volume gained outside of area of greatest risk for frontal collisions, **potentially allowing a vehicle to pass the minimum requirements without improving direct vision directly in front of the vehicle in the area of greatest risk.**

- 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 sides.

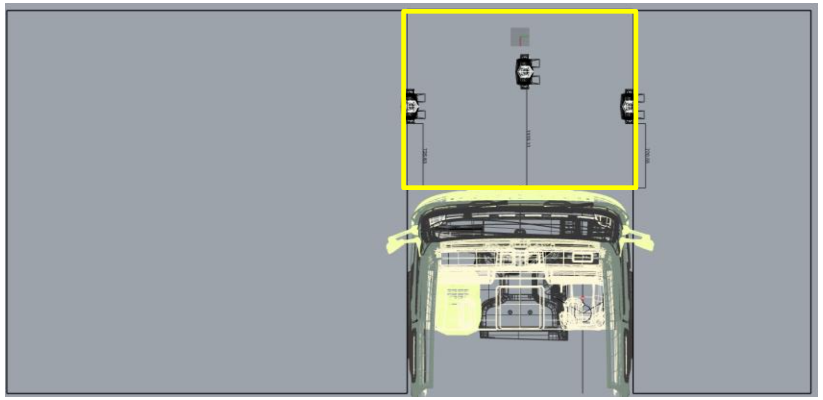
HOW CAN WE ENSURE EQUIVALENCE BETWEEN THE TWO METHODS?

The premise is as follows;

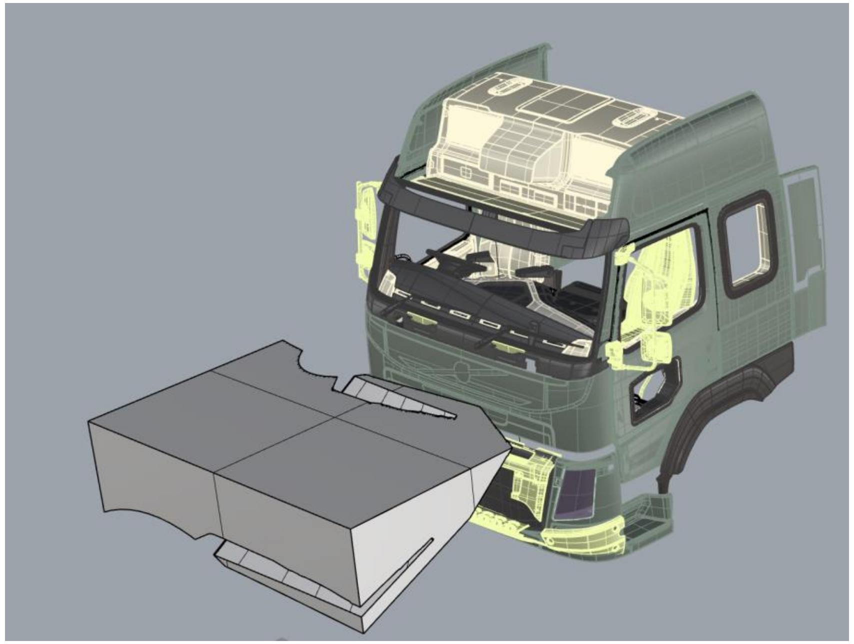
- The volume approach is still preferred
- What volume is equivalent to the need to see three VRUs directly in front of the vehicle?
- We needed a way to define a frontal volume
- We have taken the lateral extents of the vehicle to define the volume directly in front of the vehicle as this is the area that contains the three VRUs for the Series 00 method. Subsection Frontal Visible Volume (SFVV)
- Therefore, plotting the VRU distance against the 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, but for a subsection of the frontal volume



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



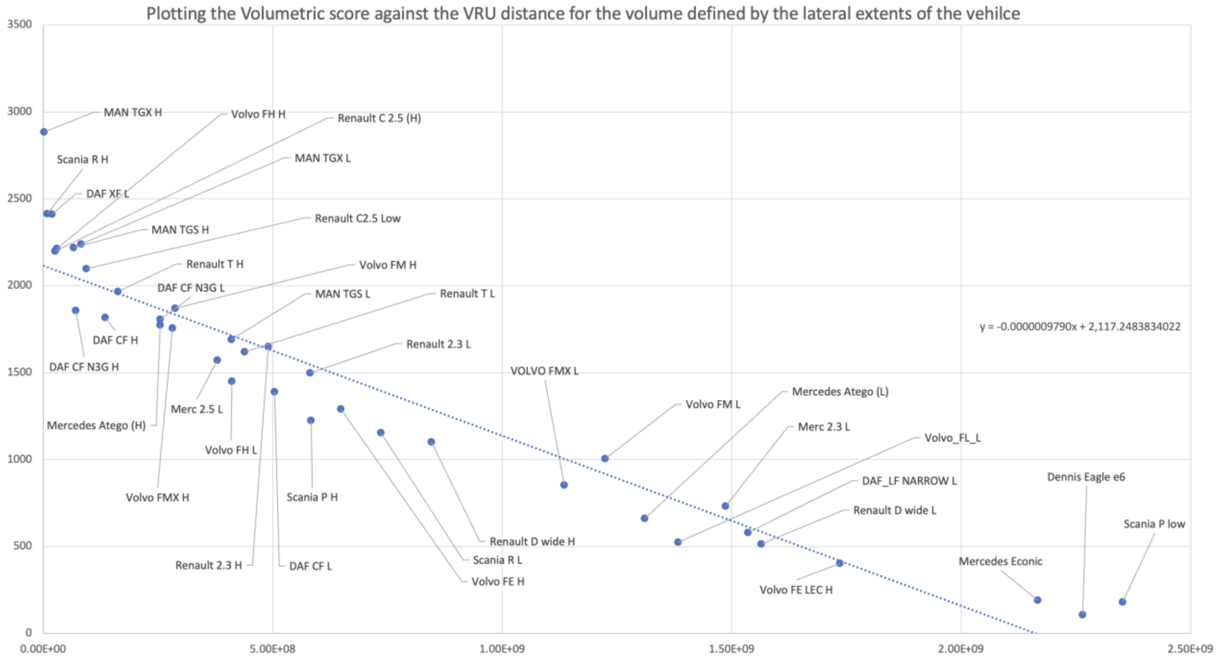
Plan view of the area within which the VRUs are contained, therefore VRU distance should corelate well with volume as per the previous uses of this method



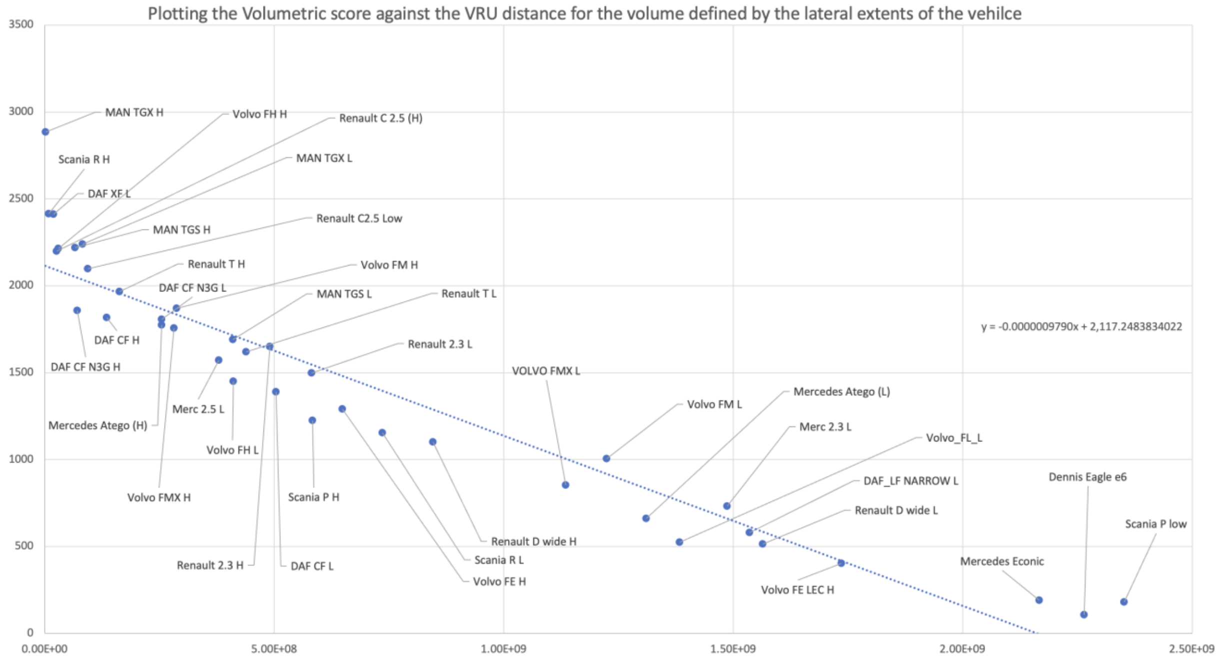
Volume that is visible between the lateral extents of the vehicle

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 **0.48m^3** in the SFVV area (average VRU distance 1653mm)
- Level 2 (construction) and 3 (long haul) vehicles would need to be able to see **0.169m^3** in the SFVV area (average VRU distance 1958mm)



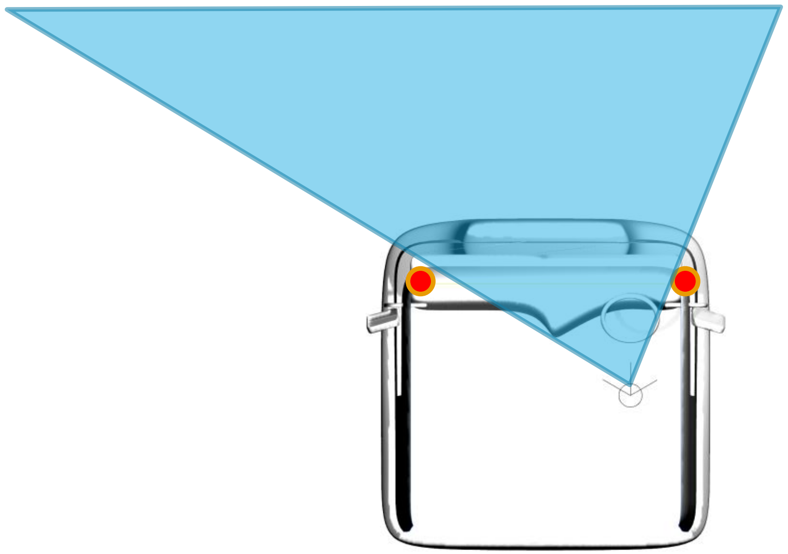
	Average VRU DIST	VOLUME		
CALC	1653	4.80E+08	or 0.48m3	1958 for level 2 and 3 1653 for level 1



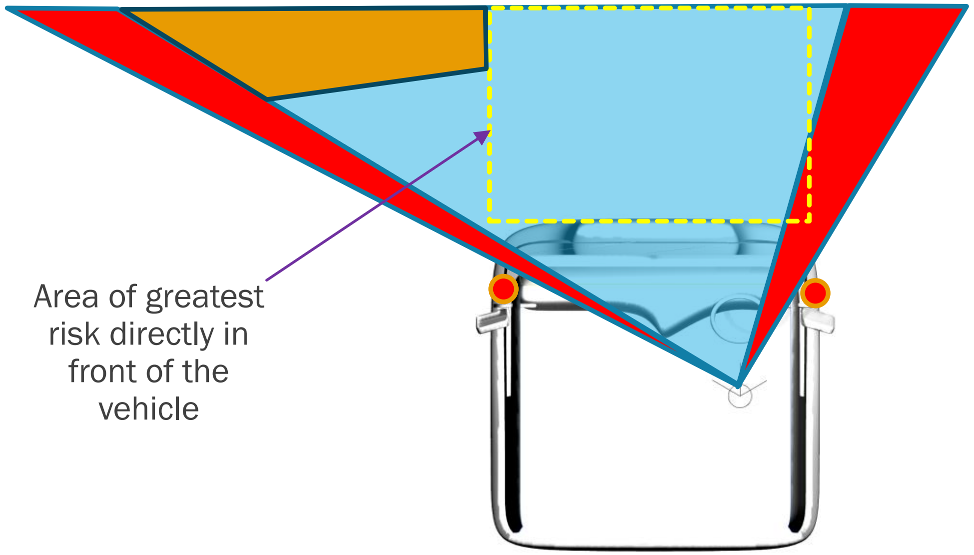
	Average VRU DIST	VOLUME		
CALC	1958	1.69E+08	or 0.48m3	1958 for level 2 and 3 1653 for level 1

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



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.

RESPONSE TO DAY 1 QUESTIONS

- Day 1 questions
- 1. Are there vehicles which can meet the minimum frontal requirement without passing the SFVV
- 2. Do we have a linear relationship between SFVV and Frontal volume for the whole sample

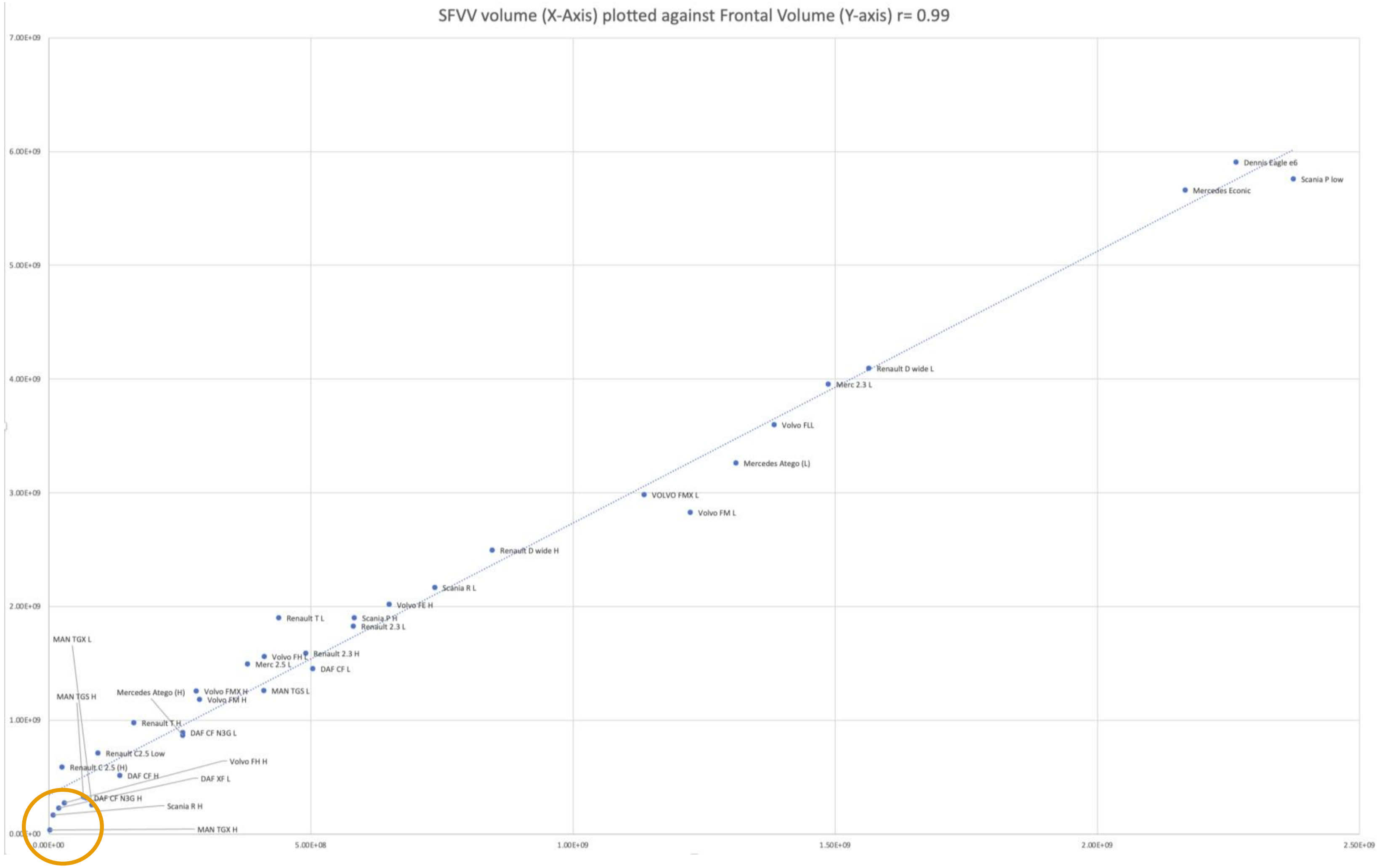
ARE THERE VEHICLES WHICH CAN MEET THE MINIMUM FRONTAL REQUIREMENT WITHOUT PASSING THE SFVV?

- We have examined five vehicles in the time available yesterday afternoon
- LEVEL 2/3: MAN TGX when set at a height which allows $1m^3$ to the front to be visible has a SFVV volume of $0.078m^3$ and so fails the requirement of $0.163m^3$
  - The data indicates that this would case for a number of other level 2 and 3 vehicles, as corroborated by manufacturers comments
- LEVEL 1: we also reviewed the Volvo FL, Volvo FM, DAF CF and DAF LF. With these vehicles, either they could not be mounted at a height (within their specific range between minimum and maximum mounting heights) which allowed the minimum required volume to be achieved or they passed the SFVV values
- Even if all current LEVEL 1 vehicles could meet the SFVV requirements by definition of meeting the frontal volume requirements, this may not be the case for future vehicle designs or designs imported from other markets
- For example, we have performed recent work with the Transport Canada examining North American HGV designs and some of these would be able to pass Front volume requirements without passing SFVV values due to the engine forward of cab designs
- The aim is to set a minimum level of performance based upon the agreed VRU distances and so we recommend the approach be applied in an equal manner across the three vehicle levels

DO WE HAVE A LINEAR RELATIONSHIP BETWEEN SFVV AND FRONTAL VOLUME FOR THE WHOLE SAMPLE?

- Do we have a linear relationship between SFVV and Frontal volume for the whole sample?

- Yes, as the graph shows the relationship is linear and has a correlation coefficient of 0.992
- As discussed yesterday the worst performing vehicles with close to zero frontal volume affect the correlation
- See Orange circle



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.

Project information

Thank you for your attention, are there any questions?

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