August 28, 2019

National Highway Traffic Safety Administration
1200 New Jersey Avenue SE
Washington, DC 20590

Re: Docket Comments: National Highway Traffic Safety Administration
Docket Number NHTSA-2019-0036
Advanced Notice of Proposed Rulemaking
Removing Regulatory Barriers for Vehicles with Automated Driving Systems (ADS)

The Volvo Group is a global manufacturer of trucks, buses, construction equipment and marine and industrial engines. Volvo Group develops, manufactures, and sells heavy-duty trucks, buses and motor coaches and their powertrains in the U.S. under the brand names of Volvo Trucks, Mack Trucks, Volvo Bus, Nova Bus, and Prevost. The Volvo Group has been manufacturing in the U.S. since 1900 and directly employs nearly 15,000 Americans. Our major facilities are in North Carolina, Pennsylvania, Virginia, Maryland, and New York. We have invested nearly $2 billion in our nine manufacturing facilities since 2002 and spend more than $250 million in R&D in the U.S. every year. The Volvo Group respectfully submits the following comments to NHTSA's Advanced Notice of Proposed Rulemaking (ANPRM) for the various proposed FMVSS compliance demonstration techniques for highly automated vehicles which lack traditional vehicle controls, (hereafter "ADS ANPRM" or "ANRPM").

INTRODUCTION

Volvo Group has long been a leader in developing and implementing safety technologies on motor vehicles. Along with Environmental Care and Quality, Safety is a core value of Volvo. Safety is deeply rooted in our culture and heritage with an approach of "Safety by Design" where we continue to develop and provide safety features to our customers in advance of regulations.

As a general matter, Volvo Group agrees with NHTSA that automated vehicles present a significant potential to address societal challenges regarding safety, mobility and energy efficiency and supports NHTSA's approach to advocate for their safe introduction to the market. We agree with NHTSA's assessment that ADS vehicles have the potential to save tens of thousands of lives on US highways annually. ADS vehicles have added potential benefits for congestion mitigation and increased transport efficiency, resulting in an overall reduction of vehicle-miles-traveled (VMT), criteria pollutants, and greenhouse gases. ADS vehicles also have the potential to enable transportation for those unable to afford or use traditional transportation solutions.

Volvo Group believes that the safe introduction of automated heavy-duty vehicles will begin in limited access areas with no exposure to vulnerable road users. Since 2018 Volvo has successfully tested Level 4 autonomous Volvo trucks at the Brønnøy Kalk mine in Norway, transporting limestone along a fivekilometer stretch of tunnels and mine roadway[1]. This is Volvo Trucks' first autonomous solution in real operation, where it is greatly improving the mine's productivity and safety.

For on-road trucks Volvo sees potential for a safe next step in the evolution of advanced automated driving systems in the use-case of semi-confined L4 operation in ports, manufacturing facilities and similar logistics operations. Volvo is in the process of developing a fully autonomous, driverless L4 solution for this application called Vera. Vera is an electric, autonomous and connected vehicle that can operate safely with zero exhaust emissions. It is controlled and monitored via a control tower, and designed for repetitive assignments in logistics centers, factories and ports. Vera is suited to transport goods over short distances with high precision. Volvo has been collaborating with DFDS Logistics at a port terminal facility in Gothenburg Sweden to implement several Vera vehicles as part of a connected system monitored from a control tower. The aim is to establish a seamless flow of goods responsive to demands for greater efficiency and flexibility. Several Vera vehicles are intended to operate on pre-defined public roads in an industrial area.[2]

As a next step Volvo foresees automated driving evolving into limited operational design domain (ODD) L4 highway operation for goods movement between logistics hubs.

All of the applications mentioned and other potential automated commercial vehicle applications lend themselves to certain types of commercial vehicle work, but not all. Society will still need drivers to handle various elements of commercial vehicle transportation.

SUPPORT FOR NHTSA'S APPROACH AND REGULATORY AUTHORITY

As stated, Volvo Group agrees with NHTSA's approach to foster the safe introduction of automated vehicles. Furthermore, Volvo agrees that on-road vehicle safety is within NHTSA's purview and statutory mandate. Volvo supports the continuation of the self-certification framework, and supports that NHTSA have preemption over US states for vehicle design regulatory standards for ADS. This will provide regulatory certainty for new product development, maintain the current national safety assurance paradigm, and preclude the risk for a patchwork of state regulations that will serve only to delay implementation of this critical safety technology by increasing product costs.

Regarding certification, NHTSA stated in the ADS ANPRM, "… some ADS-DVs are equipped with manual controls, and thus NHTSA can conduct compliance verification testing of those vehicles using current test procedures". Volvo fully agrees with this statement and asserts that if an L4 ADS equipped vehicle has traditional manual controls and conventional seating, then the vehicle can be certified to the current FMVSS requirements irrespective of human or ADS control. Volvo also agrees that forcing manual controls on an L5 vehicle for the sole purpose of enabling certification to the current FMVSS requirements results in unnecessary design complexity, regulatory expense and risk.

COMMENTS ON INDIVIDUAL COMPLIANCE VERIFICATION APPROACHES

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[1] https://www.volvotrucks.com/en-en/news/press-releases/2018/nov/pressrelease-181120.html

[2] https://www.volvotrucks.com/en-en/about-us/automation/vera.html

Volvo’s responses to selected questions provided in the ANPRM can be found below.

A. Normal ADS Operation

Question 1: What are the possible advantages and disadvantages of each approach?

Question 2: Discuss whether each approach fits the requirements and criteria of the Safety Act and enables effective enforcement of the FMVSSs

Question 13: Are there specific challenges that will be encountered with this kind of approach (Normal ADS-DV operation) for vehicle compliance verification? Please be specific and explain each challenge.

For this approach the ADS would be in control of the vehicle during compliance testing with all of its operational restrictions and decision-making capabilities in place. This would require an engineer performing the compliance test to input an appropriate destination using the same input method used to direct the ADS-DV in normal operation. The crash prevention FMVSS generally have test procedures meant to test vehicle systems under unsafe or nearly unsafe driving scenarios. This is particularly true for FMVSS121 – Air Brake Systems, and the FMVSS136 - Electronic Stability Control Systems (ESC) for Heavy Vehicles.

Our opinion is that it would be very difficult to replicate the test scenarios in the compliance test procedures with this approach since the ADS vehicle would likely be programmed to avoid the unsafe condition rather than enter it. Therefore, Volvo does not support this approach.

For example, FMVSS121 mandates a maximum stopping distance test where a heavy duty vehicle is stopped with a full brake pedal application from 60 mph. It is difficult to imagine how a test engineer could ‘trick’ a vehicle into this scenario to set up a full brake application without invoking some other crash avoidance maneuver. If it is possible it would most likely not be a reproducible, objective test, and therefore may not meet the criteria in the Safety Act. FMVSS121 contains other examples that present challenges for Normal ADS-DV Operation approach. The standard contains stability requirements in S5.3.6.1 that require a full-treadle brake application for the duration of a stop initiated at “30 mph or 75 percent of the maximum drive-through speed, whichever is less, on a 500-foot radius curved roadway with a wet level surface having a peak friction coefficient of 0.5.” This level of precise control is not foreseen for normal ADS-DV operation and it is again very difficult to imagine some test scenario to initiate the maneuver. FMVSS121 also contains emergency braking requirements that require that the vehicle stop within a certain distance for an induced air system failure. It is likely that the ADS will be programmed to fall back to some minimal risk condition for any brake system failure which would likely invalidate the test.

The compliance tests found in FMVSS136 present similar challenges to this compliance verification approach. In the standard a vehicle is forced into an unstable condition in a J-turn maneuver while trying to maintain an unstable test speed. It is likely that the vehicle will be programmed to recognize that it is entering into an unsafe condition and will reduce speed below the speed directed by the FMVSS136 test procedure. In addition, the reference speed is set at the point corresponding to an ESC brake application constituting a 5 psi drop in pressure. It is hard to envision how this reference speed could be set and maintained for the Normal ADS-DV approach in a practicable and reproducible manner.

Question 3: Can more than one of the approaches be used to verify compliance?

One danger of using more than one compliance verification approach would be the possibility of a manufacturer certifying under one approach and NHTSA verifying compliance with another. This in effect would induce a manufacturer to certify to all compliance approaches listed to assure compliance. This would introduce some amount of unnecessary economic burden to ensure compliance and therefore it could violate the Safety Act criteria of practicableness.

Question 7: Should NHTSA consider an approach to establish new definitions that apply only to ADSDVs without traditional manual controls?

Yes NHTSA should consider it, but should be aware of the possibility for tradeoffs between safety and practicality in crafting new ADS specific requirements.

Question 8: For compliance testing methods involving adjusting current test procedures to allow alternative methods of controlling the test vehicle during the test (normal ADS-DV function, TMPE, TMEC), or to allow the use of a surrogate vehicle:

> *a. How could NHTSA ensure that the test vehicle's performance using the compliance method is an accurate proxy for the ADS-DV's performance during normal operation?*
>
> *b. If NHTSA were to incorporate the test method into its test procedures, would NHTSA need to adjust the performance requirements for each standard (in addition to the test procedures) to adequately maintain the focus on safety for an ADS-DV?*

The purpose of FMVSS121 is "to insure safe braking performance under normal and emergency conditions." The purpose of FMVSS136 is "to reduce crashes caused by rollover or by directional loss-of-control." The purpose of these two standards is to assure the adequate performance of the braking and stability control systems, not the adequate performance of the ADS system. It is important to note here that the ADS system replaces the driver. There is no testing of the driver during normal compliance testing. In the Normal ADS DV Operation approach the ADS 'driver' function is used, but an attempt is made to force the vehicle into a compliance maneuver to test the braking system. Because the ADS-DV control introduces an unknown into the test, it introduces the risks for the standard to not meet the Safety Act requirements for repeatability and reproducibility.

Question 14: Will all ADS-DVs without traditional manual controls be capable of receiving and acting upon simple commands not consisting of a street address based destination, such as "drive forward or backwards a distance of 10 feet and stop"; "shift from park to drive and accelerate to 25 mph"; "drive up onto a car hauler truck trailer"; etc.? Please explain projected challenges for ADS-DVs without traditional manual controls to complete discrete driving commands and tasks.

Volvo foresees that there will be a need for remote control for cases in logistics and manufacturing and when there is a breakdown on the road and the vehicle has stopped e.g. on the shoulder of the highway. This in order to remotely maneuver it from a potentially dangerous place to a less critical position. In this case the remote control may take the vehicle to an exit road.

Question 15: How would NHTSA ensure that the performance of the ADS-DV during testing is consistent with how the vehicle would perform during actual normal use?

Volvo is asserting that this not consistently possible for an ADS-DV for the case of trying to perform a compliance test using the approach of Normal ADS-DV operation. Also, the FMVSS (121 and 136 in particular) use tests that are practicable and objective to set a safety performance level; they approximate a realistic, worst-case scenario to ensure that the system will perform well during actual normal use.

B. <u>Test Mode with Pre-Programmed Execution (TMPE):</u>

The TMPE approach proposes a set of tests in a pre-programmed “compliance test library” which the manufacturer programs into the ADS-DV for a test engineers access by some special means. This approach requires a manufacturer, who has programmed an ADS always to use the best tactical approach and use an appropriate speed for all situations, to override this logic and direct the vehicle into potentially unsafe situations. This will require a special set of tests to be programmed into the ADS-DV only for compliance testing that will give no added value to the vehicle’s normal operation.

Question 1: What are the possible advantages and disadvantages of this approach?

If the approach is feasible, a big advantage is that the current set of compliance tests could be run as is with little or no modification. Some disadvantages are 1) those pre-programmed test scenarios could be invoked in error or even under malfeasance and 2) it is difficult imagine that an ADS can be programed to realize or be assured that it has the correct physical roadway/infrastructure to allow the test to be run. For example, how would the vehicle 'know' that it has enough track to run an FMVSS121 stopping distance test, or how would it 'know' that the proper lane markings are present for an FMVSS136 ESC J-turn test? Also, it is difficult to imagine how the preliminary reference speed for FMVSS136 would be obtained. In this test the preliminary reference speed is calibrated by subjecting the vehicle to two series of test runs using the J-Turn test maneuver at increasing entrance speeds. One series uses clockwise steering, and the other series uses counterclockwise steering. The entrance speed of a test run is the 0.5 second average of the raw speed data prior to any ESC system activation of the service brakes and rounded to the nearest 1.0 mph. It would seem that many logistic and safety challenges would be introduced when attempting this test using the TMPE approach. For these reasons Volvo does not support this approach.

Question 2: Discuss whether each approach fits the requirements and criteria of the Safety Act.

The Safety Act criteria for an FMVSS are that regulatory requirements must be:

1) Practicable (technologically and economically)
2) Objective (measurement based & reproducible results)
3) Reasonable, practicable and appropriate for the type of vehicle

This approach may fail the requirement for practicability because it introduces workload and cost only to be able to run a compliance test by virtue of the extra programming needed to recognize the proper test set up, and run the compliance test. Also, the approach may be considered unreasonable because it forces manufacturers to pre-program a scenario that the vehicle itself does not recognize and would never encounter during its self-driving experience.

Question 8: For compliance testing methods involving adjusting current test procedures to allow alternative methods of controlling the test vehicle during the test (normal ADS-DV function, TMPE, TMEC), or to allow the use of a surrogate vehicle:

a. How could NHTSA ensure that the test vehicle's performance using the compliance method is an accurate proxy for the ADS-DV's performance during normal operation?

b. If NHTSA were to incorporate the test method into its test procedures, would NHTSA need to adjust the performance requirements for each standard (in addition to the test procedures) to adequately maintain the focus on safety for an ADS-DV?

Volvo does not support adjustment of the current FMVSS performance criteria. This has the potential to introduce an unintended consequence of setting new, lower level of safety performance in the market. If new requirements or adjusted requirements are considered, they should be developed to meet or exceed the same level of safety of the current FMVSS, and under the requirements of the Safety Act.

Question 18: Is it practical to expect that an ADS-DV without any traditional manually-operated controls can be safely and efficiently operated within the confines of a test track with only a preprogrammed test menu (i.e., without some form of external controller or other means of vehicle control input)?

The FMVSS121 and FMVSS136 maneuvers can only be performed at a limited number of particular test tracks in the US. The pre-programmed mode of test for braking (stopping distance, emergency braking, ESC …) would need to be specific for each test track. Most of these tracks have features that are outside the normal ODD of the ADS-DV which can cause performance issues. This would invalidate the test or make safe operation difficult.

Question 22: How could vehicle-based electronically accessible libraries for conducting FMVSS testing be developed in a way that would allow NHTSA to access the system for compliance testing but not allow unauthorized access that could present a security or safety risk to an ADS-DV?

It is important to note that cybersecurity can be an issue here. Given a hacker base that is continually evolving, how can a manufacturer permanently assure that the library of test maneuvers cannot be accessed and used for malfeasance?

C. Test Mode with External Control (TMEC):

Question 1: What are the possible advantages and disadvantages of each approach?

Volvo supports this approach. The main advantage of this approach is that it allows the certification test to be run as it is currently defined in the FMVSS. The main disadvantage is that remote operation must be programmed into the ADS irrespective of a manufacturer's plans to use the method of control. This begs the question of how L5 ADS vehicles will be moved in cases of logistics and manufacturing. It is Volvo's view that the industry will 'grow' into autonomous applications that require less human control. In the near to mid-term industry will build the ADS on top of traditional vehicle controls, so these vehicles could be certified to the FMVSS using the traditional controls with a human driver. Eventually, there will be true L5 vehicles lacking traditional controls. It is likely that these vehicles will require some method of remote operation for logistics and manufacturing, so the TMEC approach would be good as a compliance approach in the long term.

Question 2: Discuss whether each approach fits the requirements and criteria of the Safety Act and enables effective enforcement of the FMVSSs

TMEC meets the practicable and objective criteria of the Safety Act if a given manufacturer is already designing for remote operation, because the compliance tests can be performed per the existing test procedure as if a human were operating the vehicle. If no remote operation control is available, the vehicle will need to have traditional controls and therefore can be tested using a human driver to the current FMVSS.

Question 6: What other potential revisions or additions to terms, in addition to 'driver', are necessary for crash avoidance standards that NHTSA should consider defining or modifying to better communicate how the agency intends to conduct compliance verification of ADS vehicle?

It may be necessary to add definitions and sections to FMVSS121 and FMVSS136 for "certification using remote operation". This may be needed to address concerns with low speed vehicles and path keeping during remote operation certification. For FMVSS136 some consideration may be needed for the low speed threshold to account for automated vehicles only meant to operate a very low speeds. (In the FMVSS136 test the lowest preliminary reference speed must be at least 20mph).

Question 8: For compliance testing methods involving adjusting current test procedures to allow alternative methods of controlling the test vehicle during the test (normal ADS-DV function, TMPE, TMEC), or to allow the use of a surrogate vehicle:

a. How could NHTSA ensure that the test vehicle's performance using the compliance method is an accurate proxy for the ADS-DV's performance during normal operation?

Again, the purpose of FMVSS121 is "to insure safe braking performance under normal and emergency conditions." The purpose of FMVSS136 is "to reduce crashes caused by rollover or by directional loss-of-control." The purpose of these two standards is to assure the adequate performance of the braking and stability control systems, not the adequate performance of the ADS system. It is important to note here that the ADS system replaces the driver. There is no testing of the driver during normal compliance testing. If the vehicle state variables (speed, acceleration, lateral acceleration, heading, steering angle …) during a test match a normal human-driven test, (that is they meet the regulated test criteria), then the test should be an exact proxy and valid.

Question 25: Is it reasonable to assume a common (universal) interface, translator, and/or communication protocol between an external controller and any ADS-DV will be developed?

It is possible that a universal standard would eventually be developed but most likely not in the first many years of ADS vehicle development and deployment.

Question 29: Are there other considerations NHTSA should be aware of when contemplating the viability of using an external controller-based vehicle certification?

Training will be needed to qualify remote operators, including NHTSA test engineers. Also for off-board remote operators, the question of how they are getting feedback from the vehicle needs to be explored. Possibilities for this include virtual reality or even physically looking at the vehicle.

D. <u>Simulation</u>

Question 1: What are the possible advantages and disadvantages of each approach?

Question 2: Discuss whether each approach fits the requirements and criteria of the Safety Act and enables effective enforcement of the FMVSSs

The main advantage for manufacturers to use simulation is to enhance or reduce physical tests in vehicle development. As NHTSA notes in the ANPRM, simulation is generally software based or hardware-in-the-loop based, and must be validated or calibrated by performing actual, physical testing. Simulation will be used extensively in the development of ADS vehicles but the method will not supplant the need for physical testing. If NHTSA were to use simulation as a compliance verification technique, NHTSA would need many vehicle and component based parameters, and access to proprietary control algorithms. For a manufacturer, these parameters and code are available during vehicle development and used for simulation. It would be very difficult for NHTSA to independently develop an accurate simulation model in a cost-effective and timely manner. If the FMVSS were updated to use simulation in conjunction with physical testing, such revisions would have to comply with the current Safety Act criteria and should be developed to meet or exceed the level of safety provided by the current FMVSS.

E. Technical Documentation for System Design and/or Performance Approach:

Question 1: What are the possible advantages and disadvantages of each approach?

Question 2: Discuss whether each approach fits the requirements and criteria of the Safety Act and enables effective enforcement of the FMVSSs

For the Technical Documentation approach, technical design documentation (e.g., a system function description and logic and/or schematic diagrams) would be provided to NHTSA to permit an assessment of FMVSS compliance. FMVSS121 and FMVSS136 are currently written to be performance-based, objective tests. Manufacturers incorporate these tests into a larger set of tests that are part of a design verification and validation (V&V) program. Another part of the vehicle design and input into the V&V program are the types of documentation that NHTSA lists as candidates for technical documentation (e.g., a system function description and logic and/or schematic diagrams). It is not clear how NHTSA would use such documentation to verify whether or not a vehicle or vehicle system performs in an adequately safe manner. It is also not clear how this information would be used as part of a NHTSA safety investigation. How would NHTSA judge the adequacy of the system presented?

Volvo agrees with the current NHTSA approach of developing objective, repeatable, and reproducible test procedures used by both manufacturers and the agency, ensuring the same test results regardless of who executes the test, or when and where the test is executed. It is not clear how the Technical Documentation compliance verification approach would give the same level of objectivity.

F. Use of Surrogate Vehicle with Human Controls:

Question 1: What are the possible advantages and disadvantages of each approach?

Question 2: Discuss whether each approach fits the requirements and criteria of the Safety Act and enables effective enforcement of the FMVSSs

In this approach a vehicle manufacturer would demonstrate that all relevant aspects of the surrogate vehicle are identical to those of the ADS vehicle without traditional manual controls and then complete compliance verification using that surrogate vehicle. Because of the inherent differences between the two vehicles, particularly the safety system control inputs, it is difficult to imagine how the two vehicles could be demonstrated to be equivalent for safety performance evaluation. How would the test or vehicle be calibrated such that the same performance of the brake system is obtained for both vehicles if the braking system being tested is only developed for one of them? This would introduce some uncertainty as to whether or not the same level of safety is being demonstrated. Also, this alternative requires a manufacturer to build a separate set of vehicles only for the purpose of certification, and to perform comparative testing with the two sets of vehicles. This need would generate a large and unnecessary expense.

CONCLUSION

The Volvo Group appreciates the opportunity to comment on this significant rulemaking activity and recognizes the effort NHTSA is putting forth to understand and eliminate barriers to the adoption of ADS vehicles. ADS vehicles have the potential to significantly improve safety on our nation's highways while improving the efficiency, effectiveness and availability of transportation. As a heavy duty vehicle manufacturer who is developing ADS technology, we look forward to working with NHTSA, other DOT Agencies, and other stakeholders on the safe introduction of ADS equipped vehicles. If you have any questions, please contact Robert Fasnacht at 336-392-9153 or robert.fasnacht@volvo.com.