July 25, 2019

The Honorable Heidi King
Deputy Administrator
National Highway Traffic Safety Administration
1200 New Jersey Avenue SE
Washington, DC 20590

Re: Request for Comments Concerning Removing Regulatory Barriers for Vehicles with Automated Driving Systems, Docket No. NHTSA-2019-0036

Dear Deputy Administrator King,

The Texas Innovation Alliance (Alliance) respectfully submits comments to the National Highway Traffic Safety Administration (NHTSA) as the agency seeks to address regulatory barriers for vehicles with automated driving systems (ADS). As a state facing rapid growth, rising congestion, and over 3,500 traffic fatalities every year, Texas has a keen interest in advancing ADS technologies. The Alliance welcomes the opportunity to offer input and supports the agency's leadership to develop a regulatory environment that encourages the safe testing and deployment of technologies with significant potential to improve the safety, mobility, and economic vitality of the United States.

The Alliance is a partnership network of over 40 cities, transportation agencies, and research institutions who are committed to developing shared solutions to the most pressing mobility challenges in the state. Charged with preparing the transportation system to meet the future mobility needs of Texas residents and businesses, the Alliance seeks to safely integrate and take full advantage of the latest technology advancements. Drawing on practical experience and research expertise from the Texas Department of Transportation (TxDOT) and Southwest Research Institute (SwRI), the Alliance offers input in response to questions outlined in the request for comments as well as encourages NHTSA to:

> **Complement Physical Tests with Non-Physical Requirements**. There is value to utilizing physical and non-physical requirements to fully evaluate the safety of ADS-DV's. Physical tests provide the most realistic representation of how the vehicle would perform during normal use and enable the agency to identify defects that are not readily captured through simulation or documents. Non-physical requirements enable the agency to assess the safety of the software updates that are pushed more frequently; however, a process should consider the cost and training requirements to the agency.

Anticipate the Shift to a Software-Centric Paradigm. In testing ADS-DV's, the agency should develop capabilities to evaluate vehicle safety as transportation transitions from a hardware-centric to a software-centric model. As software updates are being pushed remotely on a regular basis, how will the agency test a vehicle for compliance when the vehicle is continuously changing? Currently, the aptitude of human operators is verified through written and demonstrated driving tests; similar protocols are needed to verify software has the same or higher capabilities.

Develop a Common Operational Design Domain (ODD) Framework. A main component to developing a comprehensive approach to testing ADS-DV will be acknowledging the lack of existing standardization in framing of ODDs. For NHTSA to develop a common testing protocol, there will need to be a common ODD framework. This will allow for clarity and consensus in the design and development of ADS to ensure safe operation of ADS-DVs. NHTSA can work with industry leaders and public agencies to determine what this framework should be.

As we usher in new mobility solutions, the Alliance believes incremental steps are needed to support safe testing while NHTSA continues working with public and private stakeholders to gather additional data and insights. We appreciate NHTSA's proactive approach to soliciting input from public, industry, and research perspectives. The Alliance shares a vision where automated vehicles are an opportunity to reimagine commercial mobility and looks forward to continued engagement with NHTSA to build a safer future for all.

Regards,

Darran Anderson
Executive Sponsor
Texas Innovation Alliance
Director, Strategy and Innovation
Texas Department of Transportation

Alliance Working Group
City of Arlington | City of Frisco | Houston METRO | North Central Texas Council of Governments | Texas Department of Transportation | Texas Southern University | University of Texas at Austin Center for Transportation Research

If you have any questions regarding this submission, please feel free to contact Kristie Chin, PhD, at kristie.chin@utexas.edu.

Approach A: Normal ADS-DV Operation

13. Are there specific challenges that will be encountered with this kind of approach for vehicle compliance verification? Please be specific and explain each challenge.

We agree that this approach to NHTSA safety testing is likely the closest representation of how vehicles will behave and perform during normal use. In order to make this approach adequately robust, there are a range of challenges that will need to be overcome. AVs on the market today largely require significant human inputs to start routes, navigate obstacles, and interact with passengers. As the technology evolves in the AV market for vehicles that lack traditional manual controls but retain typical seating configurations, it is expected that this level of required human inputs will decrease. This is ideal for AV operations but will make testing more difficult. For NHTSA to test all safety features and operational scenarios, it will be necessary for these vehicles to have significant testing capabilities. AV manufacturers will need to provide a form of override control and/or external control device to allow proper testing of the vehicles. In our experience with EasyMile EZ-10 vehicles and drive.ai vehicles, so much of the technology, software, and hardware are deemed proprietary, it is unclear how NHTSA testers would be able to access sufficient external control to complete the testing. Additionally, since the vehicles are carefully programmed for their routes, it is unclear how test routes would be created and used by NHTSA.

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?

NHTSA should take this opportunity to be proactive and establish clear requirements for testing protocols to be put in place by the vehicle manufacturers. All vehicles should be required to have a testing ODD that contains situations capable of testing all FMVSSs. The testing ODD should also contain all situations in which the vehicles are expected to operate in real-world ODDs. Within the test ODD, NHTSA staff should be able to program a variety of routes and destinations to allow a sufficiently wide range of testing. A pre-programmed test route would yield only a simulated and controlled experience, which may not adequately capture all safety scenarios. There should also be requirements for routine updates to the test ODD to account for software and technology updates.

Approach B: Test Mode with Pre-Programmed Execution (TMPE)

16. How could engineers responsible for performing FMVSS compliance assessments of an ADS-DV without manual controls be expected to access and interface with the compliance test library menu?

While vehicle manufacturers will need to play a significant role in providing access for safety testing, the Alliance wishes to highlight the importance of a standardized approach to providing this access for a range of functions. In addition to safety and compliance testing, access will be needed by fleet managers for daily operations and their own safety protocols. It is important to note that the ability of a fleet operator to perform certain daily tests for checkout of a given vehicle's systems and sensor calibration would be a very important aspect of operating a large fleet of vehicles, especially when they are being dispatched into operation without an operator or attendant onboard (L4 unmanned operation).

20. How much variation in test results across various test locations (i.e., proving grounds) is expected to result from testing an ADS-DV equipped with the same FMVSS compliance library at different locations? Could the ability to satisfy FMVSS performance requirements depend on the location the tests are performed?

The compliance library should be developed such that there is minimal variance across test locations. In particular, it should include road weather conditions and control for other environmental factors. To guarantee confidence in results, the compliance library should provide results that can be readily compared with one another.

Approach C: Test Mode with External Control (TMEC)

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?

Yes, the Alliance believes it is very important to have a consistent and common interface developed for uniform testing and operations across all vehicles.

26. What is the most viable method for securely interfacing an external controller with the ADSDV (e.g., wireless or physical access)?

The Alliance recommends that a physical control is required by NHTSA for increased security with physical interface with these vehicles. Some AV manufacturers already make use of such an external, physical control, and this approach should be adopted across the board with a universal interface. This will provide a higher level of security and protection from external hacking.

27. Could a means of formal control be developed 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?

The ability to safely operate a vehicle remotely, especially from an operations control center, is an important and practical capability that can be facilitated by the ADS-DV manufacturers as a fleet-operations capability that is consistent with the NHTSA request.

Related safety standards may evolve from this basic remote operator functionality which would be very useful in managing daily AV fleet operations—especially for failed vehicle recovery and unusual operating conditions that cause an individual ADS-DV to come to a stop (e.g., a blocked travel lane due to another stalled vehicle).

28. Is it reasonable to assume any geofence-based operating restrictions could be suspended while an external controller intended to assess FMVSS compliance is connected to the ADSDV?

The Alliance recommends that geofenced operating restrictions are able to be suspended, with appropriate security protocols in place, to allow complete and robust FMVSS safety testing and compliance.

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

Security of the vehicle should be of utmost concern when allowing for any external operations. A rigorous testing protocol and security clearance process should be created by NHTSA whereby vehicle manufacturers can grant NHTSA authority to conduct tests. As an external controller may also be used in other situations, such as loading and unloading a vehicle or moving it from storage to its route, there will need to be a method for differentiating between testing operations and routine operations.

Approach D: Simulation

30. How can simulations be used to assess FMVSS compliance?

Simulation is an appropriate tool for assessing FMVSS compliance for structured scenarios, and can be used to test extreme events where risks of live tests are too great. High risk scenarios need to be scripted, repeatable and standardized, just like normal operations scenarios, to ensure common testing.

As ADS-equipped vehicles develop over time, experience of existing ADS will be transferred to new models or sent as updates to all ADS vehicles. Artificial intelligence and its machine learning will experience variability in decision-making and the live experiences it encounters. Testing will need to occur regularly to account for these changes, and to a common expected standard. Those test standards will grow to exceed our expectations of human drivers, especially since we have expected norms humans bring to their driving that will need to be tested against ADS, such as moral decision-making. To appropriately test to standard and regularly, only by running millions of simulations can NHTSA expect an outcome with an acceptable degree of confidence and reduce the anomalies caused by variability of AI decision-making.

However, it is not a practicable approach for the agency to consider implementing at scale nationwide. NHTSA may want to consider centralization of testing and certification so that common repeatable conditions can be tested for all vehicles in both live and simulated scenarios. NHTSA should look to other industries that are further along in simulations testing such as the aerospace industry, which is already heavily autonomous, and the defense industry, which has an extensive live and simulated test environment, to identify lessons learned in certifying and regulating.

31. Are there objective, practicable ways for the agency to validate simulation models to ensure their accuracy and repeatability?

The agency could have a leadership role in identifying a common set of scenarios where simulation would be appropriate and establishing their associated vehicle-specific parameters and environmental characteristics for development. Perhaps there needs to be core safety modules related to ADS-DV's, where the agency can verify those modules are valid and reasonably replicate real live scenarios. Further research regarding the feasibility of working with vehicle manufacturers to develop an application programming interface (API) designed to allow a common set of scenarios and operating conditions is needed to assess the viability of simulation as a safety evaluation mechanism.

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

34. How can the documentation-focused approach ensure compliance with FMVSS, considering it neither verifies that the vehicles on the road match the documentation nor confirms that the vehicles on the road comply with the FMVSSs?

The documentation-focused approach could be used for some of the FMVSS standards, particularly verification of certain components and their functionality. However, this method presents some challenges when the human operator is removed. Without a human operator, how do you assure that a component can and will be engaged using the ADS software?

Given the intellectual property concerns pertaining to the source code developed for ADS systems, manufacturers will be likely very reluctant (if at all) to provide code in any detail enough to verify compliance. Further, it assumes the testing agency will have the ability and resources to evaluate the code. Seeing as every code will be different, evaluation will be incredibly resource-intensive for both manufacturers and testing facility. The cost and complexity of reviewing test code is much more expensive than existing test methods.

Further complicating matters is the complexity that is machine learning. How do you document the thought process of the human brain? Learning algorithms are similarly incredibly difficult to document. In many cases, due to machine learning, there is no guarantee of a desired outcome. Only by running millions of simulations can a person expect an outcome with an acceptable degree of confidence.

Approach F: Use of Surrogate Vehicle with Human Controls

39. If results from FMVSS compliance tests of a conventional vehicle performed by its manufacturer differ from the results of NHTSA tests of an equivalent ADS-DV (particularly if the conventional vehicle complies with the agency's standards, but the ADS-DV does not), can the conflicting results be reconciled? If so, how?

The ability to operate a surrogate vehicle that is identical in its ADS functionality and performance could have a strong benefit to fleet operations of ADS-DVs for purposes of either failure management and/or hosting of empty vehicles through the system.

Conceptually, conditions will occasionally occur when a portion of the system becomes inoperable due to issues with communications system failures (e.g., GPS signal compromise, etc.), issues that take a portion of the system out of the ADS-DVs ODD (e.g., a construction zone that has not been provided for in the most recent vehicle mapping update) or other such anomalies to fleet operations. Under those circumstances, the provision of continued failure-mode operations using a surrogate vehicle to which the trailing ADS-DVs could be "virtually coupled" would be an important feature. Creating a platoon of vehicles that could progress through the system under manual operation of a leading surrogate vehicle would be of great value when a high ridership demand condition must continue to be served while system failure recovery is underway.