Automotive Safety Council

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Removing Regulatory Barriers for Vehicles with Automated Driving Systems

Subject: **Advance notice of proposed rulemaking (ANPRM).**

The Automotive Safety Council (ASC), is an industry association of 48 of the world's leading suppliers of Active, Passive, Autonomous, Interior, Pedestrian and Child Safety Systems to the automobile industry. The mission of the ASC is to reduce highway casualties and injuries by providing the motoring public with reliable and effective safety systems, components and services, and to promote public education on the proper use and benefits of their restraint systems.

The ASC is providing comments to the recently published ANPRM document requesting comments pertaining to Removing Regulatory Barriers for Vehicles with Automated Driving Systems. The ASC appreciates the opportunity to comment on this topic.

General Comments

The Automotive Safety Council (ASC) is encouraged by the fact that the agency is again addressing the topic of removing regulatory barriers for vehicles with automated driving systems. The ASC believes it is essential that regulations are adapted to allow automated driving vehicles to be deployed in a timely, but safest manner. All manufacturers need to understand how AV's will be evaluated and approved for public road use.

The ASC will be addressing FMVSS 111, 126 and 135 in our response. The following is a summary of each regulation addressed and then followed by specific responses to the ANPRM requests.

<u>FMVSS 111</u>

- The objective of FMVSS 111 is to set minimum standards for vehicle rear visibility. The latest revisions to FMVSS 111 per the Cameron Gulbransen Kids Transportation Safety Act of 2007 require an expanded rear field of view, to improve driver visibility behind the vehicle and reduce deaths and injuries resulting from back over crashes.
- Currently this is evaluated by placing several vertical cylinders in a defined pattern behind the test vehicle and determining whether they can be seen by a typical driver with suitably adjusted mirrors and a rear-view camera system. In the case of an ADS-DV, the vehicle mirrors, display and driver will be replaced by a sensor system and automated driving hardware and algorithms. Therefore, it may not be possible to directly replicate the existing tests during normal ADS-DV operation or using test modes with pre-programmed execution or external controls.
- However, simulation, documentation review and data from a surrogate vehicle may be suitable to evaluate an ADS-DV's sensor's detection capabilities, and therefore compliance to FMVSS 111:
- Simulation may be used to evaluate an ADS-DV's ability to detect defined targets located in designated positions. However, it does require that the sensor's performance is correctly modeled in terms of field of view, range and resolution, and the test area and environmental elements would also need to be simulated. This would require degree of cooperation between NHTSA and the relevant vehicle manufacturer (e.g., developing an accepted model).
- Simulation can help in detecting the limits of system performance, and enables testing to be carried out more quickly, especially if changes are made in the ADS-DV system.
- Documentation review can be used to evaluate basic information about sensor performance including range, resolution and field of view, but is unlikely to provide sufficient information about system level performance once the sensors / cameras are installed in the ADS-DV.
- The use of a surrogate vehicle with human controls could also be considered for verification testing, especially if the ADS-DV is a retrofitted production vehicle. For example, if the performance parameters and mounting locations of the surrogate vehicle's sensors are identical to those of the ADS-DV's, it may be possible to demonstrate that the designated test targets can be detected by the ADS-DVs sensor system.

<u>FMVSS 126</u>

Electronic Stability Control (ESC) has been found to reduce some multi-vehicle crashes and proven to be effective in preventing single-vehicle loss-of-control, run-off-the road crashes which are a significant portion of rollover crashes. ASC feels it's imperative the agency retains the requirement that all vehicle's must be equipped with an ESC system and meet the safety intent of the regulations set forth in FMVSS126 for all levels of automation.

It is expected that automated driving vehicles will reduce the number of crashes caused by human error, but situations will still arise that will require stability control systems to keep the vehicle stable in emergency situations such as winter ice patches or emergency collision avoidance.

ESC systems monitor the steering wheel input and compares the intended direction of the human driver to the actual vehicle behavior. If the intended direction deviates from the actual direction, ESC will try to maintain stability by applying the appropriate brake pressure to individual wheels in combination with reduced engine torque to reduce speed and create correction yaw moments which are intended to keep the vehicle in control and on the road. The same principle will benefit ADS DV systems in unexpected emergency situations but will require new test procedures written for systems without a human driver and manual controls (i.e. steering wheel).

The current ESC Regulation FMVSS126 test procedures assumes a steering wheel exists and requires a robotic machine attached to the steering wheel to provide repeatable test results. For automated driving systems that don't have a human driver and manual controls, ASC feels the most practical test method would be using a pre-programed script utilizing the ADS-DV steering system in a special test mode for use on a dedicated proving ground. It may be required to install a temporary manual control to assist the test personal to navigate the vehicle on the proving ground in preparation for the sine steer with dwell tests. It may be that this pre-programmed script could be embedded in the vehicle itself (as with a TMPE method), but it is also possible to consider a pre-programmed script which could be injected through the same interface as is used for the manual control (TMEC with provision for automation). In either scenario, this method would replace the need of a steering robot and provide similar repeatability.

ASC feels that simulation tools for systems design are essential in developing and validating ESC capabilities, but do not feel these methods should be used as final validation methods.

<u>FMVSS 135</u>

Approaches to revising test provisions for Federal Motor Vehicle Safety Standard (FMVSS) 135

- Among the key factors that need to be considered during the revision of FMVSS 135 are the following: repeatability of results, compliance with specification intent, correlation with a conventional vehicle, feasibility of methods, cost and effort to produce acceptable results and minimizing adaptation of vehicle for test execution.
- The ASC wishes to highlight the inherent connection between FMVSS 135 and FMVSS 105. While the procedures and performance criteria of FMVSS 105 are different in several ways from those of FMVSS 135, the barriers to ADS-DV validation are substantially similar such that any comments to the validation of ADS-DV to FMVSS 135 will also apply to vehicles which fall within the scope of FMVSS 105.

<u>Specific responses to NHTSA ANPRM:</u>

The agency requests comment on the following approaches: (1) Normal ADS-DV operation; (2) Test Mode with Pre-Programmed Execution (TMPE); (3) Test Mode with External Control (TMEC); (4) Simulation; (5) Technical Documentation for System Design and/or Performance Approach; and (6) Use of Surrogate Vehicle with Human Controls. The agency also requests comment on whether any additional alternatives are possible. In addition to answers to the questions that appear after the discussion of each approach, NHTSA requests that commenters answer these questions for each of the approaches:

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

(1) Normal ADS-DV operation:

<u>FMVSS126</u>

- The ESC sine steer with dwell test is a limit handling maneuver that is not considered normal operation for ADS-DV systems. There are many real-world situations that can lead to the need of an ESC activation and creating a scenario test based on normal ADS-DV operations would be difficult to define consistently for all potential crash scenarios.

<u>FMVSS 135</u>

- ASC does not view Normal ADS-DV operations as an appropriate approach for FMVSS 135. NHTSA must consider:
    - The preparation of the vehicle, which is an essential part of the current test procedure. Here we would call the Agency's attention to the brake burnish sequence as an example. There are additional factors, such as the test surface, which also play a pivotal role in the final result.
    - The challenges posed by seeking to recreate the brake performance test and maneuvers on public roads in real world conditions. Vehicles are not likely to recreate the procedure requirements as part of normal every-day travel and seeking to induce the maneuvers in the presence of other road users could pose a notable risk to the occupants and other individuals. ASC notes that some of the maneuvers require induced system failures such as a failed brake circuit.
- Consequently, ASC strongly cautions against the adoption of normal ADS-DV operations as a means of validation for FMVSS 135.

(2) Test Mode with Pre-Programmed Execution (TMPE)

<u>FMVSS126</u>

- A dedicated software test program is recommended for the ESC sine steer with dwell procedure as defined today in FMVSS126.
- Temporary installation of driver controls may be needed to assist the staging of the vehicle prior to the high dynamic maneuvers
- The OEM's could provide a test mode providing access with test diagnostic tools**.**

<u>FMVSS 135</u>

- The ASC also wishes to register some concerns with the use of TMPE. Although it may be possible to establish a user interface for which NHTSA would be the sole authorized user, there are inherent risks and notable cybersecurity concerns associated with such approach. Steps would need to be taken to guard against unauthorized use. This issue would be perhaps best addressed by the vehicle manufacturers who are responsible for the overall vehicle cybersecurity strategy.
- There are also issues relevant to the maneuvers necessary for FMVSS 135. We would call NHTSA's attention to the brake burnish sequence (S7.1) and the sequence of maneuvers from S7.13-7.16. These sequences require vehicle reorientation between stops in the sequence. In order to be successful, the pre-set catalog of maneuvers would have to be extremely detailed and it would have to be customized for the test track at which the work was being done.

- Some of the maneuvers listed under FMVSS 135 further require the use of an external signal (such as a check on the brake temperature). Therefore, there would still be a need for an outside input to be provided to the ADS-DV vehicle.

- ASC also envisions further complications relative to the need for vehicle directional control while the vehicle is implementing the brake stop maneuvers. FMVSS 135 has the requirement that the vehicle is able to remain within a 3.5 m lane through the duration of the stop (S6.5.4.2). However, with a conventional vehicle, a steering correction against any brake lateral pull is permitted (S6.5.3.3). Especially in the example of the hydraulic circuit failure test maneuver (S7.10) in a vehicle with a diagonal split brake system, this counter steering action from the test driver is needed. Additional functionality may be needed to meet this requirement if there is no driver input.

(3) Test Mode with External Control (TMEC)

<u>FMVSS126</u>

- The current test procedure requires a steering robot installed on the steering wheel. Adding (mechanically linked) manual steering controls wherein a human fully replaces the steering robot would be costly, complicated and time consuming since the vehicles are already equipped with electronic steering controls that can be used for a pre-programmed test script. Additionally, results would not be as consistent from a human driver as with an automated control. However, it may be feasible to embed a pre-programmed test script into an external controller rather than into the vehicle software. This external controller will be necessary for maneuver preparations. Therefore, this could be an approach in between TMPE and TMEC which addresses some of the challenges of both.

<u>FMVSS 135</u>

- Of the options presented in the NHTSA ANPRM, the ASC views the TMEC approach as the most feasible in connection to FMVSS 135. Again, the active involvement of the vehicle manufacturer would be essential here in order to create an external HMI controller device that would enable an interface with the vehicle. Each vehicle would require a unique structure of internal signals, which may be used to inject specific maneuver request details. Although it may not be possible to have one common device and interface for all vehicle manufacturers in the first few years of deployment, it could be possible to develop a common front end (test driver interface) with unique back end signal mapping which could be tailored to the vehicle under test. This will certainly require some cooperation from the vehicle manufacturers to build up the proper interface for each vehicle and to override the normal ODD restrictions.
- The implementation of an external driver control interface would address some of the barriers associated with the TMPE method. A TMEC method would also allow for certain aspects of the maneuvers, which depend upon test driver actions, to continue to rely on the test driver. For example, lane keeping during the execution of a hydraulic circuit failure test. While there may be cybersecurity concerns with having an access point for an external interface, in most cases, these are concerns which will already exist and require solutions.

(4) Simulation

FMVSS126

- Simulation tools are very helpful in developing robust ESC systems, but the sine steer with dwell procedure creates a very high dynamic response that can cause wheel lift and departs from the normal linear performance of vehicle dynamics resulting in unreliable simulations. Tire and suspension modeling at these high dynamics create unpredictable responses that can only be effectively evaluated at a dedicated proving ground with real vehicle setups. Simulation methods also bring up challenges on how models are shared, and substantial efforts may be required to correlate simulation to actual vehicle results.

FMVSS 135

- Simulation cannot fully address the challenges inherent in FMVSS 135 and assume the same role as real world testing. Factors that would be difficult to address in model validation include:
  - The slip behavior between the tire and the road;
  - Lining friction behavior with temperature and pressure;
  - Thermal capacity and cooling behaviors to properly simulate fade performance; and
  - Suspension stiffness and the weight transfer response of the vehicle during a brake apply.
- Overall, ASC does not envision a simulation option that would be appropriate and reflective of the intent of the standard without an intense degree of cooperation between NHTSA and the relevant vehicle manufacturer.

(5) Technical Documentation for System Design and/or Performance Approach

FMVSS126

- Currently, suppliers provide technical documentation to support OEM submission to NHSTA. ASC does not see any changes to how this is currently conducted

FMVSS 135

- Suppliers do not have direct responsibility for the contents of any technical documentation, which might be shared between a particular vehicle manufacturer and NHTSA in order to demonstrate vehicle compliance to a federal regulation. As such, suppliers view the question of what can be demonstrated by technical documentation to be a topic strictly between the vehicle manufacturers and NHTSA and would not seek to provide an opinion.

6. **Use of Surrogate Vehicle with Human Controls**

FMVSS 135

- The criteria for what is an appropriate surrogate vehicle is again a topic for dialogue between the vehicle manufacturer and NHTSA. Certainly, in the cases where the vehicle manufacturer and NHTSA can reach such an agreement, the technical barriers for this method are not as significant as some of the other proposed methods.

3. Can more than one of these approaches be specified by the agency as alternative ways for the agency to determine compliance with the same requirement in the same FMVSS? If so, please describe how this

could be done consistent with the Vehicle Safety Act, using one or more specific FMVSS requirements as illustrative examples. If more than one approach could be specified for the same requirement in the same FMVSS, do commenters believe that the agency, in assessing compliance with the same requirement in the same FMVSS, choose one approach for one vehicle model, but another approach for a different model? If so, explain why.

<u>FMVSS126</u>

- ASC feels the Test Mode with Pre-Programmed Execution (TMPE) is the most practical way to conduct the ESC sine steer with dwell procedure, but alternative ways are still possible but with more effort.

<u>FMVSS 135</u>

- NHTSA may consider a combination of approaches to determine compliance with the same requirement within FMVSS 135. Simulation has some limitations due to model accuracy and the ability to correlate to real world results, however if considering combinations of approaches, the limitations of simulations might be overcome with demonstrated correlations with either a surrogate vehicle with human controls or a surrogate ADS-DV vehicle which has been subjected to a physical test, such as by the TMEC method. This will come back to a question of, what are the criteria for a valid surrogate vehicle, which is a topic for discussion between the vehicle manufacturers and NHTSA. There is also a precedent concerning FMVSS 126 understeer control for some aspects of a regulation to be demonstrated by technical documentation while others are demonstrated through a physical test by NHTSA.

4. If only one of these approaches can be used to enforce a particular FMVSS requirement, what factors should be considered in selecting that approach? What policy or other considerations should guide the agency in choosing one alternative approach versus another for determining the compliance of a particular vehicle or item of equipment?

<u>FMVSS 135</u>

- Among the key factors that need to be considered during the revision of FMVSS 135 are the following: repeatability of results, compliance with specification intent, correlation with a conventional vehicle, feasibility of methods, cost and effort to produce acceptable results, minimizing adaptation of vehicle for test execution and the principle of technology neutrality.

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 vehicles?

<u>FMVSS 135</u>

- General revisions for FMVSS 135
    - Force to the brake control
        - It should be considered that in most cases the limitation of wheel slip is the strictest test criteria and the 500 N pedal force limitation does not affect the stopping distance result (maneuvers S7.5, S7.6, S7.7, S7.8, S7.9, S7.10). In these cases, ignoring the pedal force limitation will be mainly irrelevant to vehicle performance results.
    - Maneuvers S7.13-7.16 procedures are dependent upon the pedal force achieved in S7.5, so in this case NHTSA must define a new target application level not dependent upon pedal force.

    - Maneuver S7.11 generally is restricted by pedal force on conventional vehicles, which lack a source of secondary brake power / power support. Expectation will be that if pedal force is no longer a limitation, an ADS-DV will be more capable than certain conventional vehicles because of the presence of power brake redundancy.
    - NHTSA may need to consider the methods by which failures are induced in an ADS-DV and whether the failure mechanism represents the goals of the test maneuver given variations in vehicle design.
    - In S5.3.1 labeled Foot Control, NHTSA should consider, if the requirement for a foot control must be maintained for a non-ADS-DV vehicle, how to modify or clarify this requirement for an ADS-DV vehicle without driver controls.

- Maneuver details that may need to be considered for FMVSS 135:
    - S6.31b may require a provision from the manufacturer to disable the RBS system for validation testing if there is no user interface available to do so.
    - S6.5.2: Changes are required in the test vehicle to override ADS system operational design domain rules.
    - S6.5.3.2: Changes are required in the test vehicle to override ADS system operational design domain rules.
    - S6.5.4.1 Counter steer input discussed within text above
    - S6.5.5 If requirements will still remain for the vehicle to be placed in a "neutral gear", it will be necessary for the manufacturer to provide some interfacing control to allow the test operator to make this gear selection, presuming the vehicle intended for public sale has no such transmission control mechanism.
    - S7.1.2 Burnish: Limitations to automated operation discussed above and include considerations for braking to a deceleration target, which may require a special control in the TPME method.
    - S7.2; S7.4: These sections are likely irrelevant for and ADS-DV, as such a vehicle should always be equipped with ABS.
    - S7.13-7.16: The criticality of time and temperature for this sequence makes automation with TMPE quite difficult.

7. Should NHTSA consider an approach to establish new definitions that apply only to ADS-DVs without traditional manual controls?

<u>FMVSS 135</u>

- ASC believes that it is appropriate to maintain requirements which test the vehicle in the most similar way possible to the manner in which conventional vehicles are validated when the intent of the regulation in question is still valid.

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:

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?

FMVSS 135

- NHTSA may need to consider the methods by which failures are induced in an ADS-DV and whether the failure mechanism represents the goals of the test maneuver given variations in vehicle design.

9. For compliance testing methods that replace physical tests with non-physical requirements (simulation, documentation):

a. If the test method is used to determine compliance with a real-world test, how can NHTSA validate the accuracy of a simulation or documentation?

FMVSS 135

Each aspect of a simulation model must be shown to be correlating with a real-world test result at the most representative level possible. Only when each aspect of the simulation has been demonstrated to reliably correlate with real world results can the simulation be used as a proxy for real world testing.

b. If NHTSA must run real-world tests to validate a simulation or documentation, what is the advantage of non-physical requirements over these other compliance methods?

FMVSS 135

ASC sees no inherent advantage to an exclusive simulation approach without testing. ASC sees that many aspects of the regulation, especially secondary requirement not related to vehicle performance such as verifying the volume of the brake fluid reservoir, could be demonstrated through design documentation effectively.

10. Would non-physical requirements simply replicate the existing physical tests in a virtual world? If not, what would be the nature of the non-physical requirements (that is, what performance metrics would these requirements use, and how would NHTSA measure them)? Are there ways that NHTSA could amend the FMVSSs to remove barriers to ADS-DVs that would not require using the compliance test methods described in below?

a. Are there any barriers in the FMVSS or NHTSA's test procedures that could be addressed by altering or removing references to manual controls in the test procedures without substantively changing the FMVSS performance requirement?

FMVSS 135

- See question (6) above

b. Are there any changes that NHTSA could make to the FMVSS test procedures that could incorporate basic ADS capabilities to demonstrate performance, such as using an ADS-DV's capability to recognize and obey a stop sign to test service brake performance?

FMVSS 126

- New test procedures may need to be considered for current active safety tests
- § Support case-by-case review of FMVSS
- If NHTSA is able to work with manufacturers to address test process challenges, new procedures do not necessarily need to replace existing tests, rather, supplement for ADS-DV

FMVSS 135

- See question (7) above

A. Normal ADS-DV Operation

To better understand the "Normal ADS-DV Operation" approach and its possible applications, the agency asks the following questions.
Questions specific to this testing method (general questions precede this section):

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.

FMVSS 135

- See question (1) above

B. Test Mode with Pre-Programmed Execution (TMPE)

Questions specific to this testing method (general questions precede this section):

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 pre-programmed test menu (i.e., without some form of external controller or other means of vehicle control input)?

FMVSS 135

- See question (1) above

21. Is it reasonable to assume any geofence-based operating restrictions could be suspended while the ADS-DV is operating in a "test mode" intended to assess FMVSS compliance?

FMVSS 135

- ASC believes it is reasonable to modify operating restrictions. Some can be suspended, and others may be retained with alterations. ASC presents as an example the need for lane-keeping during the FMVSS 135 braking maneuvers. Test case specific programming of the operating restrictions will be necessary.

C. Test Mode with External Control (TMEC)

Questions specific to this testing method (general questions precede this section):

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?

FMVSS 135

- See question (1) above

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 ADS-DV?

FMVSS 135

- Same comment as question 21 regarding TMPE method

D. Simulation
Questions specific to this testing method (general questions precede this section):

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

FMVSS 135

- See question (1) above

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

FMVSS 135

- See question (9) above

32. Is it feasible to perform hardware-in-the-loop simulations to conduct FMVSS compliance verification testing for current FMVSS?

FMVSS 135

- ASC has some reservations about the feasibility of simulation in general. Refer to the response in question 4 above.

33. Is it feasible to perform software-in-the-loop simulations to conduct FMVSS compliance verification testing?

FMVSS 135

- ASC believes that SIL would be more difficult. Application-specific control logic would be necessary. The number of elements which must be correlated with a physical test increase. ASC offers as an example the fluid flow restrictions within the brake hydraulics, which would be incorporated in a HIL set-up, but would need to be modeled and verified in a SIL set-up.

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

Questions specific to this testing method (general questions precede this section):

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?

FMVSS 135

- See question (1) above.

F. Use of Surrogate Vehicle with Human Controls

Questions specific to this testing method (general questions precede this section):

37. To what extent could equivalence of the vehicle components used for conventional and ADS-DVs be demonstrated to assure that surrogate vehicle performance would be indicative of that of a surrogate ADS-DV?

FMVSS 135

- See question (1) above.

In conclusion, the ASC welcomes this opportunity to comment on Removing Regulatory Barriers for Vehicles with Automated Driving Systems. We welcome any invitation to visit the NHTSA office for a detailed discussion of these comments should the need arise.

Sincerely,

Douglas P. Campbell
President
Automotive Safety Council