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Subject: **Framework for Automated Driving System Safety**
Docket No. NHTSA-2020-0106

Docket Management Facility, M–30
U.S. Department of Transportation
West Building, Ground Floor,
Room W12–140,
1200 New Jersey Avenue SE
Washington, DC 20590.

To Whom It May Concern:

UL appreciates the opportunity to comment on the US Department of Transportation's (DOT) Advance Notice of Proposed Rulemaking (ANPRM) on the Framework for Automated Driving System (ADS) Safety. UL supports DOT's efforts to objectively define, assess, and manage the safety of ADS performance while ensuring the needed flexibility to enable further innovation.

Founded in 1894 in Chicago, Illinois, UL is the world's leading safety, security, and sustainability company. UL's technological and scientific expertise brings clarity to manufacturers as they navigate complex global rules and markets and reassures consumers that the products they purchase are safe and secure. Our nonprofit parent company, Underwriters Laboratories Inc., is dedicated to advancing the UL mission through the discovery and application of scientific knowledge. We conduct rigorous independent research and analyze safety data, convene experts worldwide to address risks, share knowledge through safety education and public outreach initiatives, and develop standards to guide safe, sustainable commercialization of evolving technologies.

UL encourages federal agencies to leverage public-private partnerships in developing public policy by incorporating consensus-based standards, available accreditation schemes, and globally recognized practices to meet its compliance interests. By working with the private sector, government agencies can promote transparency, leverage private sector resources and contribute to economic and job growth. UL is pleased that NHTSA recognizes the value of existing consensus standards and has requested comment on a framework that envisions a relationship to the work done by the private sector. UL applauds DOT's specific reference to UL 4600*, Standard for Safety for the Evaluation of Autonomous Products,* and its notation that, unlike similarly referenced ISO standards, UL 4600 was developed primarily for automated driving systems. To increase overall trust in the marketplace, independent third-party organizations may be leveraged to conduct testing and other services which support confidence in ADS.

Additionally, UL values the partnership on vehicle cybersecurity we have with NHTSA by virtue of the memorandum of understanding (MOU) established between UL Verification Services, Inc. and NHTSA in May 2019. Given the inextricable linkages between safety and security in ADS, this MOU allows for examination of methodologies, tools, and metrics associated with the testing and evaluations of vehicle cybersecurity and serves as a basis for UL and NHTSA to share related test data.

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Please find attached UL's detailed responses to a subset of the questions posed in the ANPRM. As the DOT moves forward with its efforts to objectively define, assess, and manage the safety of ADS performance while ensuring the needed flexibility to enable further innovation with this ANPRM and future rulemaking, UL is eager to share our valuable expertise with DOT. If you have any questions regarding this submission or would like to discuss UL's recommendations further, please do not hesitate to contact Thomas Daley, UL Global Government Affairs, at thomas.daley@ul.com. Thank you for your attention to these comments.

Respectfully,

Mary Joyce
Vice President and General Manager, New Mobility
UL

A. Questions About a Safety Framework

1. Describe your conception of a Federal safety framework for ADS that encompasses the process and engineering measures described in this document and explain your rationale for its design.

UL agrees that a Federal safety framework for ADS based on appropriate process, engineering, and administrative measures is necessary to manage risks associated with public deployment of vehicles equipped with ADS. Key aspects of a robust safety framework would likely include these items:

***Process Measures*:** Conformance with an agreed set of appropriate industry safety standards addressing important aspects of ADS development such as ISO 26262 (Functional Safety), ISO 21488 (SOTIF), and UL 4600 (Safety Case), and others as necessary.

***Engineering Measures*:** Demonstratable minimum level of performance against:

- a suitably comprehensive set of ADS simulation tests utilizing standardized scenarios and associated standardized databases appropriate for the target operational design domains (ODDs);
- a challenging (but limited in scope) physical obstacle course appropriate for the target ODD(s);
- a real-world/random driving test in traffic relevant for each target ODD. This test would be the analog of a state driving license test and a last test to confirm minimum ADS performance in the ODD. It is anticipated that traffic patterns and situations may vary somewhat from test-to-test, as they would in real world situations; and
- operational milestones which are designed to permit ramping of ADS deployment volumes based on a track record of safety success in the ODD.

***Administration Measures*:** A robust safety framework includes measures to objectively review, verify, or otherwise confirm conformance to designated safety processes and performance criteria. Example administrative measures available to NHTSA may include:

- review of process measures for adequacy;
- specification of a minimum set of standardized scenarios and databases for simulation testing of various ODDs with specified minimum performance criteria;
- specification of limited physical test track scenarios and performance criteria;
- specification and administration of ADS real-world tests for various ODDs (ADS “driver’s license test”);
- specification of production deployment in-use milestones and safety criteria; and
- review of in-use safety profile and providing or revoking of permissions to increase deployment volumes.

2. In consideration of optimum use of NHTSA's resources, on which aspects of a manufacturer's comprehensive demonstration of the safety of its ADS should the Agency place a priority and focus its monitoring and safety oversight efforts and why?

UL believes that the selection of appropriate process measures, the development of standardized simulation scenarios and databases, and the determination of minimum performance criteria for

simulation and physical operation are important for the safe widescale deployment of ADS-equipped vehicles on public roads.

3. How would your conception of such a framework ensure that manufacturers assess and assure each core element of safety effectively?

When assessing ADS elements of sensing, perception, planning and control, consider that the performance of individual elements and the level of integration with other elements may vary considerably between different ADS implementations. Process measures are applicable to any implementation; however, it may prove more difficult to specify minimum performance measures for each element separately in a way that would not unnecessarily restrict the specific implementations of the manufacturers. For example, consider an ADS system exactly meeting some minimum specified level of performance for each of the four indicated elements. Then consider a different ADS system with a lower performing sensing element but with a much higher performing perception element. Which system would be safer in operation? Therefore, the safety of the complete system is of primary importance and any intermediate element performance threshold should be carefully considered.

The proposed concept of a safety framework focuses primarily on process measures and ADS system level performance testing, and flexibly accommodates core element performance testing as may be supportive of system level safety. Additionally, the proposed administration measures assure compliance with the process measures and required testing.

4. How would your framework assist NHTSA in engaging with ADS development in a manner that helps address safety, but without unnecessarily hampering innovation

The ADS industry benefits from established safety guidelines and specific safety performance targets and measures. The framework anticipates NHTSA's role in setting objective and consistent guidelines and performance criteria, including working with industry to establish standardized simulation scenarios, databases and performance thresholds, while focusing on end system performance and technology agnostic measures.

5. How could the Agency best assess whether each manufacturer had adequately demonstrated the extent of its ADS' ability to meet each prioritized element of safety?

The agency could assess various agreed or required process outputs and test reports; administer or oversee a final "ADS driver's license test"; and approve and monitor production deployment safety metrics and requests for expansions in deployments.

6. Do you agree or disagree with the core elements (i.e., "sensing," "perception," "planning" and "control") described in this document? Please explain why.

While the stated core elements may be useful for illustrating or understanding the functioning of ADS systems, they may be less useful for setting individual performance targets for the reasons described previously. Also, there may be differing definitions or interpretations of these elements, and perhaps even other safety relevant functions may exist or be developed in the future. For example, mover prediction, pose and localization, and advanced mapping functions may not fit neatly into certain definitions of the stated core elements.

The primary focus of NHTSA's safety performance criteria, thresholds, and other engineering measures should remain at the vehicle level, while requiring the specific internal elements to be developed according to best safety processes with a valid safety case. This frees NHTSA from needing to make assumptions about present and future ADS architectures, and the associated risks of frequent regulatory changes or unnecessarily inhibiting innovation.

8. **At this early point in the development of ADS, how should NHTSA determine whether regulation is actually needed versus theoretically desirable? Can it be done effectively at this early stage and would it yield a safety outcome outweighing the associated risk of delaying or distorting paths of technological development in ways that might result in forgone safety benefits and/or increased costs?**

   The industry and the public will benefit from the establishment of a robust safety framework for the deployment of ADS-equipped vehicles on public roads. This framework should be developed proactively amongst stakeholders rather than reactively in response to adverse events. Certain elements of the framework could be implemented quickly, such as process and performance guidelines and reviews, while other elements such as FMVSS regulations may follow.

9. **If NHTSA were to develop standards before an ADS-equipped vehicle or an ADS that the Agency could test is widely available, how could NHTSA validate the appropriateness of its standards? How would such a standard impact future ADS development and design? How would such standards be consistent with NHTSA's legal obligations?**

   NHTSA can leverage its extensive understanding of traffic laws and existing safety profiles of human controlled vehicles to set initial system level performance expectations and minimum requirements for operating in specific ODDs. Additionally, various existing safety process standards have been developed and can be utilized during the development of ADS-equipped vehicles.

11. **What rule-based and statistical methodologies are best suited for assessing the extent to which an ADS meets the core functions of ADS safety performance? Please explain the basis for your answers. Rule-based assessment involves the definition of a comprehensive set of rules that define precisely what it means to function safely, and which vehicles can be empirically tested against. Statistical approaches track the performance of vehicles over millions of miles of real-world operation and calculate their probability of safe operation as an extrapolation of their observed frequency of safety violations. If there are other types of methodologies that would be suitable, please identify and discuss them. Please explain the basis for your answers.**

    Autonomous vehicle safety methodologies typically include 'rule-based' activities based on identified scenarios which can be evaluated and "statistical' methodologies based on field exposure. These methodologies should be used in combination as both are important.

    Rule-based methodologies are a natural outcome of several safety standards, and are already in development widely across the industry. Statistical approaches are also proposed for safety validation in both ISO 21448 and UL4600, and are a topic of discussion in the industry. However, it is a known challenge to interpret statistical methods sufficiently to justify a specific validation target for a given automated driving system. Various industry efforts regarding a statistical framework

might benefit from NHTSAs guidance and collaboration toward an industry-accepted statistical approach.

B. Questions About NHTSA Research

14. What additional research would best support the creation of a safety framework? In what sequence should the additional research be conducted and why? What tools are necessary to perform such research?

Quantification is a lynchpin of risk evaluation and acceptance. However, the ability to fully and accurately quantify risk at the vehicle level remains elusive. To further the state-of-the-art, and help address the needs of a safety framework, the following research tasks are proposed:

- ***Naturalistic driving studies:*** Evaluation and continued pursuit of naturalistic driving behavior is still very useful, so that the human-driving baseline is well understood for a wide variety of scenarios.
- ***Simulation frameworks for validation:*** AV simulation and the extension of known validation frameworks and acceptance criteria into the virtual/simulated world are additional areas for continued research. We must determine the state-of-the-art methods and frameworks by which simulation is used to create a safety case argument.
- ***Safety validation criteria within new safety standards:*** Both the ISO 21448 and the UL 4600 standards employ quantified, measurable metrics as a part of safety validation and risk acceptance. Research is required to define, quantify, and fully establish the mathematical frameworks that meet these standards, cementing safety argumentation.