National Society of Professional Engineers®

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Dear Dr. Shladover,

The National Society of Professional Engineers (NSPE) is a multidisciplinary engineering society with more than 32,000 members practicing in all technical areas in industry, government, education, private practice, and construction. NSPE values the protection of the public health, safety, and welfare above all other considerations.

This letter is a follow-up to NSPE's participation in the January 19, 2016, meeting in Washington, DC, which focused on proposed autonomous vehicle behavioral competencies. NSPE would like to elaborate further on the proposed California Autonomous Vehicle Deployment Regulations Peer Review Discussion Paper, California PATH Program, University of California, Berkeley.

NSPE commends the state of California and the California Department of Motor Vehicles for taking the initiative on this important matter and believes the draft regulations identify a number of key issues for consideration. At the same time, NSPE would like to offer the following comments for consideration:

p. 1: Definition of Behavioral Competency
The DMV's proposed regulations cover only operations on public roadways. However, the overall transportation system requires a significant amount of travel not on public roads, including private roads, toll roads, private drives, parking lots, intermodal facilities, ferries, parking garages, etc. In fact, most journeys will in fact begin and end on non-public roadways, and often will include intermediate segments that will take the vehicle off public roadways. Consideration should be given to the processes for providing ample advance warning, preparation and controlled return of operations to the vehicle to the human operator.

p. 2: Definition of Dynamic Driving Task
This definition should also include the real-time functions for driving in all weather conditions and for both daytime and nighttime driving conditions, and in particular, the processes and response when driving conditions change during operation, taking the vehicle outside of its approved operating conditions.

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p. 2: Definition of Operational Design Domain
The operational design domains proposed in SAE J3016 are overly broad and do not adequately reflect the myriad of sub-domains a vehicle may be required to enter and exit in the course of a single route within an overall domain (For example, toll roads). Ideally, and ultimately, autonomous vehicles should be capable of safe operations in the full range of domains; initially, a minimum range of operations within the varied requirements of the defined domains should be established.

p. 3, para 3: Functional Safety
The draft addresses behavioral competencies in isolation and functional safety is not included in peer review document. It would be prudent to emphasize that these factors are interdependent.

p. 3, para. 2 & 3: "High Level" Behavioral Competency Definition
The language in this section addresses "typical and limited abnormal" driving conditions along with commonly encountered hazards. This implies a high level, minimum competency, but does not define this standard. If the AV has only 90% of human sensory, cognitive, or analytical ability, is that acceptable?

p. 3, para. 2: Critical Driving Maneuvers
This term is only broadly defined in the draft. These critical driving maneuvers should be better defined and identified for each Area of Operation.

Transparency in the capabilities and limits of the vehicle's ability to execute critical maneuvers will be necessary to ensure public understanding of what to expect under certain scenarios. Such awareness and behavioral competence will be required of both the AV operator and the traditional vehicle operators and pedestrians who will share the road in the real world conditions.

p. 4: 5-10 Second Rule for Operator to Re-engage Control of Vehicle
This rule seems to cover too broad of a range, particularly in light of the statement later in the draft (p. 8, para. 1): "because human factor studies have indicated that in most cases, there is not sufficient time to re-engage the operator to perform obstacle avoidance maneuvers."

p. 5: Self-Diagnostic and Failure Response
Competency 3 should also include detection and response to mechanical failures such as blown tires, broken fan belts, bursting radiator hoses, etc.

p. 6: Discussion Questions
What is meant by "level of depth at which the failure and ODD detection systems can be demonstrated"?

Failure scenarios should be established and tested regardless of the technology that is used and should result in transfer of control to the operator under all scenarios and not a degraded mode of operation. A degraded mode of operation may increase the safety risk to the operator and public.

p. 7: Detection of, and Response to, Vehicular Traffic
Competency 14 addresses merging vehicles ahead, but not beside or behind, which is an often and foreseeable scenario, especially with human-operated vehicles sharing the road with AVs.

Competency 16 addresses the appropriate evasive action. Similar to critical driving maneuvers, "appropriate evasive action" needs to be defined and identified.

p. 8, para 2: Detection of Other Vehicles and Road Users
The proposed regulation attempts the difficult task of setting criteria for objects of a certain size, shape, or mass in the road that may cause the vehicle to lose control. This raises the issue of other things not in the road but below the road's surface, the road such as potholes and trench failures.

p. 8: Non-merging movements
Additional competencies should be required for vehicles entering the road at cross streets and driveways. These are not necessarily "merging" movements. (Note: All driveways are considered intersections from a traffic-management perspective.)

p. 8: 360 degree perspective. There is also the competency for detecting and responding to cars behind the AV and detection of low clearances above the vehicle. Such a competency may not be as relevant to automobiles as they would to larger vehicles, such as trucks.

p. 9: Detection of, and Response to, Other Road Users
"Arterial/Urban" should be checked for Competency 9.

p. 10: Detection of Emergency Vehicles
The draft appears to address detection and response to only stationary emergency vehicles and traffic blockage. Detection and response to the more usual dynamic interaction—meaning an emergency vehicle with lights and sirens that is in transit in traffic lanes—needs to be addressed.

p. 10: Detection of, and Response to, Other Road Users Discussion Questions
These are the most critical questions, particularly as they relate to decisions about what an AV will collide with and how that decision is made when a collision is unavoidable. This raises the classic "trolley car dilemma[1]").

[1] The trolley dilemma is a thought experiment in ethics. The general form of the problem is this: There is a runaway trolley barreling down the railway tracks. Ahead, on the tracks, there are five people tied up and

What is the AV's response if it approaches an accident in which it is not involved?

p. 11: Speed Limits & Traffic Control Devices
Competency 12 requires additional work. It should specifically mention the Manual on Uniform Traffic Control Devices (MUTCD). It should also note pavement marking detection and recognition. A complicating factor is that traffic control devices can vary even within a single state, depending on the jurisdiction, city, or state.

p. 12: Traffic Control Device.
The discussion on traffic control devices needs to consider pavement markings and the lack thereof in most cases. Additionally, the discussion should include construction traffic control, which is also governed by the MUTCD.

p. 13: Navigation & Vehicle Maneuvers
Again, this section deals with maneuvers on public streets but not necessarily the interface and necessary transit between private and public. Clarification is necessary.

p. 14, para. 1: Additional Functionality
The definition of "detection" should be strengthened by making it explicitly state that it is <u>not</u> limited to defined or mapped intersection points. In other words, no sensor should to be in an inactive mode just because there is no identified intersection on the map. (Unlike autonomous vehicles, human operated vehicles cannot be depended upon to enter and exit traffic only where vehicles are authorized to do so.)

This section also raises the question of the map database and its accuracy.

p. 14, para. 1: Work Zone Detection
Every scenario cannot be accounted for; in all work zones the vehicle should automatically default to control by the operator. (This issue was raised and extensively discussed without resolution at the January 19th workshop.)

On the broader issues and questions, the regulation of fully autonomous vehicles is a complex and important issue with national (in fact, global) implications. California has proven to be the leader in the development of smart technologies, with other states often following California's initiative. Other states are likely to do so in the case of autonomous vehicles as well. The opportunities, innovations, and technologies that are rapidly bringing

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unable to move. The trolley is headed straight for them. You are standing some distance off in the train yard, next to a lever. If you pull this lever, the trolley will switch to a different set of tracks. However, you notice that there is one person on the side track. You have two options: (1) Do nothing, and the trolley kills the five people on the main track. (2) Pull the lever, diverting the trolley onto the side track where it will kill one person. Which is the correct choice?

autonomous, or self-driving vehicles, to our roadways has created intense competition, as companies race to be the first to develop and implement autonomous vehicles. The issue is further complicated by the understandable pressure AV manufacturers and developers feel to protect proprietary and competitively sensitive details of the capacities and limits of their product designs. While understandable, these pressures pose significant potential for counterproductive opacity in a process that demands transparency if public health, safety and welfare are to be adequately served, as well as to build public understanding, trust and confidence in the new technology. NSPE urges the California Department of Motor Vehicles to move thoughtfully and carefully on this important issue.

The issues surrounding AVs present immense challenges for both infrastructure managers and policymakers because protecting the public safety in the implementation of this rapidly emerging technology will require immediate action at the national, state, and local levels of government. Timely steps must be taken to prepare for these rapid changes toward society's greater dependence on smart technologies.

The development of autonomous vehicles and their associated systems will, in many ways, have the same if not a more significant impact on the public health, safety, and welfare within the nation's transportation system than the current design of highways, bridges, railroads, subways, rapid-transit systems, and airports. Governments have properly and successfully adopted codes and standards for the design, manufacture, and construction of these systems for the benefit of the public, health, safety, and welfare and must continue to do so in a prudent manner.

Because of AVs' profound impact on the public health, safety, and welfare and the multiple engineering disciplines involved in AV systems, it is the position of the National Society of Professional Engineers that licensed professional engineers, who bear a statutory obligation to place public health, safety and welfare paramount, must play a key role in the design, development testing and certification of autonomous vehicles and AV systems.

The development of autonomous vehicles and associated systems will have a critical effect on public safety. For this reason, NSPE urges the California Department of Motor Vehicles, in its development of regulations related to fully autonomous vehicles and their associated systems, to ensure that its policies recognize and incorporate the key role of licensed professional engineers in the development of AVs and their associated systems. Professional engineers in California and elsewhere already play a critical role in the protection of the public health, safety, and welfare of the traveling public using the nation's infrastructure through state laws, regulations, and policies. Likewise, the design, development, and deployment of autonomous vehicles and their support systems should be treated in the very same manner and should require the participation and involvement of licensed professional engineers to provide the highest level of protection for the benefit of the public health, safety, and welfare.

The National Society of Professional Engineers and the California Society of Professional Engineers stand ready to assist the California Department of Motor Vehicles as it moves forward on this important issue.

Thank you for inviting NSPE to participate in recent key meetings as well as the opportunity to comment on these important public policy issues.

Sincerely,

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NSPE President

TRA:AES/mac
cc: Bernard C. Soriano, Ph.D., Deputy Director, California DMV
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