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August 28, 2019

Ms. Heidi R. King
Deputy Administrator
National Highway Traffic Safety Administration
1200 New Jersey Avenue, SE
Washington, D.C. 20590

Docket Number NHTSA-2019-0036

Submitted via Federal eRulemaking Portal at http://www.regulations.gov

Dear Deputy Administrator King:

Nuro, Inc. (hereafter, "Nuro") is pleased to have the opportunity to comment on the National Highway Traffic Safety Administration's ("NHTSA" or "the Agency") advanced notice of proposed rulemaking on removing regulatory barriers to testing and verifying compliance with the Federal Motor Vehicle Safety Standards (FMVSSs) for Automated Driving System-Dedicated Vehicles (ADS-DVs). Nuro shares the Agency's perspective that ADS technology, properly harnessed, has the potential to provide tremendous benefit to road safety, the economy, and the public at large. We strongly support the Agency's efforts to remove the regulatory barriers that today inhibit the development of these technologies, and to codify testing methodologies that ensure vehicles meet NHTSA's safety standards.

Nuro was founded with the mission to "accelerate the benefits of robotics for everyday life." We are the first company in the nation providing open-to-the-public, on-road goods delivery with unmanned autonomous vehicles. Central to that vision is "R1," a custom robot designed, built, and deployed by Nuro exclusively for the purpose of delivery, and engineered from the ground-up with safety in mind. Unlike traditional passenger vehicles, these light-duty, autonomous, delivery vehicles lack driver or passenger compartments; instead, they feature cargo and service compartments. Passengerless ADS vehicles like Nuro's have the potential to be the safest vehicles on U.S. roads, both for other drivers and pedestrians, because they can avoid the human causes of collisions like distraction, impairment, and speeding; are lighter weight and narrower; operate at lower speeds; and include physical features designed to protect pedestrians and other road users over the goods carried inside.[1] Removing the barriers to introducing these innovations at scale will improve public safety, as well as avoid "unnecessary design restrictions and regulatory expense."[2]

NHTSA's overall approach in the ANPRM

Nuro supports the overall approach that NHTSA describes in this ANPRM in three principal respects:

[1] Our approach to safety and the innovations in vehicle design introduced in Nuro's vehicles are described more fully in our Safety Self-Assessment, *Delivering Safety: Nuro's Approach*, available at nuro.ai/safety.
[2] 84 FR 24433 [hereafter "ANPRM"], 24436 (May 28, 2019).

- **Requires ADS-DVs to achieve the safety purpose of the FMVSS.** NHTSA proposes to test and verify compliance of ADS-DVs based on ensuring that the vehicles are able to meet the safety purpose of each applicable FMVSS at least as well as a human-driven vehicle.[3] By focusing on the safety purpose of each standard, rather than the specific manual controls that have historically been assumed, NHTSA can allow innovations — such as passengerless vehicle designs — that achieve higher levels of safety.

- **Focuses first on base vehicle safety.** Nuro also supports NHTSA's focus in this rulemaking on the applicability of the existing FMVSS.[4] By separating issues related to base vehicle safety (addressed by the FMVSS) from issues related to the ADS itself, NHTSA will be able to gather the most relevant input on this issue, expedite the removal of regulatory barriers to this life-saving technology, and allow for NHTSA's parallel rulemaking efforts on "Safety Principles for Automated Driving Systems" to more directly address novel issues raised specifically by the ADS.

- **Revises testing procedures and manual control requirements in parallel.** Finally, we agree with the Agency that translating the underlying requirements for manual controls into technology-neutral terms that do not assume the presence of a human driver or human occupant is a prerequisite before it will be possible to implement the new testing and verification procedures contemplated by this ANPRM. All three of the contemplated rulemakings in the "removing regulatory barriers" series must be complete before their benefits can take effect.

Technology-neutrality and business-model neutrality

As NHTSA reviews its testing and verification procedures, it is critical that the Agency follow a technology-neutral and business-model neutral approach. The Department of Transportation's most recent ADS guidance rightly laid out that technology neutrality is one of the critical principles to successful regulation of innovation.[5] As Secretary Chao has said, "the Department's approach to new technology is technology neutral-- not top down, command and control. The Department is not in the business of picking winners and losers. Consumers and users ultimately will decide which technology or package of technologies suits them best."[6]

This principle is also enshrined in the Vehicle Safety Act, which requires that "[e]ach standard shall be practicable, meet the need for motor vehicle safety, and be stated in objective terms,"[7] and that the Secretary "consider whether a proposed standard is reasonable, practicable, and appropriate for the particular type of motor vehicle or motor vehicle equipment for which it is prescribed."[8] NHTSA's implementation of neutral standards will enable manufacturers the greatest ability to introduce safety innovations, and avoid the need for the Agency to regularly revisit the standards as technology continues to advance.

In the context of removing regulatory barriers, technology-neutrality and business-model neutrality argue for modifying standards, test procedures, and verification processes to enable a variety of ADS-DVs, ranging from fully passengerless manufacturer-owned fleets of last-mile delivery vehicles to

[3] *Id.* at 24435.
[4] *Id.* at 24437.
[5] US Department of Transportation, *Automated Vehicles 3.0: Preparing for the Future of Transportation*, iv. (2018).
[6] Secretary of Transportation Elaine L. Chao, *AV 3.0 Roll Out* (Oct. 4, 2018), https://www.transportation.gov/briefing-room/av-30-roll-out.
[7] 49 U.S.C. 30111(a).
[8] 49 U.S.C. 30111(b)(3).

personally owned autonomous passenger cars. We encourage NHTSA to offer manufacturers flexibility in how to apply the test procedures, provided that vehicles meet the safety purpose of each relevant standard. The implications of technology neutrality for the Agency's contemplated rulemaking are described in more detail below.

Testing Method options should be available for a range of ADS-DV designs. The Testing Method procedures that NHTSA requires should be practicable in both driverless and passengerless designs, and in designs that are equipped with some manual controls as well as those that lack all manual controls. NHTSA can provide flexibility by allowing manufacturers to choose the verification method that is most relevant to their vehicle design. For example, in a passengerless vehicle like Nuro's with no capacity for human occupants, the use of a surrogate vehicle with human controls would not be practicable (e.g., there is no space for a driver's seat or steering wheel), and so requiring all manufacturers to use this procedure would not be technology neutral. But by allowing manufacturers of passengerless vehicles the option to use an external manual controller or a pre-programmed testing mode, NHTSA can accommodate a range of innovations and avoid favoring a certain technology.

Safety purpose of each standard should consider range of technologies. As the Agency considers the safety purpose of each standard in translating the requirements and the testing and validation procedures, it should consider different kinds of ADS-DVs and how the safety purpose might be applicable to some but not others. For example, rearview mirrors provide information to occupants (both in passenger ADS-DVs and traditional passenger cars) regarding whether it is safe to exit the vehicle, but in a passengerless ADS-DV, there are no occupants and therefore there is no relevant safety purpose. Likewise, the occupant protection standards (200-series) protect human occupants in both passenger ADS-DVs and traditional passenger cars, but serve no safety purpose in a vehicle without human occupants. In cases like this, NHTSA should adjust the text of the applicability section of the standard to exclude those types of ADS-DVs for which the standard serves no relevant safety purpose. If the standard is not applicable to a particular kind of ADS-DV, then NHTSA will also not need to determine how to test compliance with that standard for those vehicles.

As NHTSA considers the safety purpose of each standard, we encourage the Agency to consider four distinct types of light-duty vehicles, and how different FMVSS would be implicated for each:

1) Full-speed driverless, passenger vehicles: These vehicles would carry passengers, but are intended to lack controls for a human driver, such as a steering wheel or pedals. Their seating designs also may differ from current vehicles.
2) Full-speed passengerless light-duty delivery vehicles: These vehicles would have no human occupants. Like the driverless passenger vehicles, they lack controls for a human driver, but they also do not have any seating positions or need to protect those inside the vehicle. Note that while these vehicles would have top speeds greater than 25 mph, they may still have speed limitations (i.e., less than the 50 mph assumed by some standards).
3) Low-speed driverless passenger vehicles: These vehicles may be used in a variety of applications, including passenger shuttles, but are limited to speeds of 25 mph or less and subject to the requirements of the low-speed vehicle class, including FMVSS No. 500.
4) Low-speed passengerless delivery vehicles: These vehicles are similar to their low-speed passenger counterparts, but would have some differences. For example, a vehicle without human occupants would not have a need for passengers to be able to see out of the vehicle through a windshield.

Manufacturer-owned fleet models should be accommodated. The ANPRM notes that it "assumes that

ADS-DVs will be sold or leased to individual owners, similarly to how traditional vehicles are sold."[9] The available evidence of manufacturer business plans indicates this will not be the case. For example, as we have reported to the Agency previously, "the entire fleet [of Nuro R2X vehicles] will be owned and centrally managed by Nuro, rather than sold or leased to customers, providing the opportunity to comprehensively ensure the consistent and safe operation of these vehicles, and to consistently improve performance and service."[10] Similarly, media reporting regarding the business plans of most, if not all, major developers of ADS technology has indicated that vehicles will at least initially be operated in fleets owned by the manufacturer or otherwise not available to the general public. Manufacturer-owned fleets do not pose any issues for certification testing and self-certification, which today is the foundational element of vehicle safety regulation — and we support NHTSA's intentions, announced in AV3.0,[11] to retain the self-certification model.

However, even if fleet ownership were only a minority approach, NHTSA may still wish to develop a process that enables the Agency to test and verify ADS-DVs when required. We encourage NHTSA to develop procedures that work for the full range of potential business models, rather than favoring one particular business model (e.g., dealership sales) over another.

Nuro is open to working with NHTSA to develop procedures for enabling Agency verification that a vehicle is compliant, using vehicles that are representative of the fleet even in cases where vehicles are not sold to the public. For example, one approach could be that NHTSA requests from a manufacturer a list of all VINs produced, and the Agency randomly chooses a vehicle from the list. The manufacturer could then transport that vehicle at the designated proving grounds location within a short time period, i.e., a time period insufficient to allow for alterations that would make the vehicle unrepresentative of the average vehicle. Because these fleet vehicles contain highly sensitive intellectual property, require trained test operators, and the crash avoidance tests are non-destructive, manufacturers and NHTSA can together supervise the vehicle to safeguard the hardware and intellectual property. At the conclusion of the verification, the manufacturer can transport the vehicle back to its facility — especially sensitive IP such as the computer system. With procedures such as these, NHTSA could verify vehicle safety, regardless of the manufacturers' business model, and protect manufacturers' needs for protecting confidentiality.

Test procedures and verification methods should account for ODD limitations. NHTSA indicates in the ANPRM that it is contemplating testing and verification procedures for Level 4 autonomous vehicles (and Level 5 vehicles). Level 4 vehicles are defined in part by their limited Operational Design Domain (ODD). Nuro believes that Level 4 vehicles in limited ODDs will be the first deployments of ADS vehicles, and this has been borne out by experience: the first fully unmanned service open to the general public was Nuro's autonomous delivery service in Scottdale, Arizona with R1, launched in December 2018, and other early autonomous pilots have also been Level 4 deployments, including driverless robotaxi services within a defined geography and low-speed shuttles. For NHTSA's procedures to work on these first AV deployments, they will need to account for the fact that many ADS-DVs will be limited in respects such as speed, mapped areas, and weather conditions. While these ODD restrictions are limitations on the ADS, manufacturers may also design the underlying vehicle that is intended to be equipped with the ADS to have more limited capability than today's general purpose, go-everywhere passenger cars, because there is no need to design a powertrain capable of going 65 mph for a vehicle

[9] ANPRM, *surpa* at 24441, fn. 33.
[10] Nuro Exemption Petition at 3, https://www.regulations.gov/document?D=NHTSA-2019-0017-0002.
[11] *Automated Vehicles 3.0, supra* at 7 ("reliance on a self-certification approach, instead of type approval, more appropriately balances and promotes safety and innovation").

that will never go on high speed roads. This means that NHTSA will need to adjust the FMVSS requirements, test procedures, and verification approaches to be feasible for vehicles with a variety of ODD and vehicle hardware limits.

Testing Methods for verifying compliance with FMVSS

NHTSA outlined in its ANPRM six possible methods for manufacturers and the Agency to verify compliance with the FMVSS when the vehicle does not have manual controls. In order for these compliance methods to work, we assume that NHTSA will have already removed all regulatory barriers, including assumptions of manual controls, terms like "driver" or "driver's seating position," and other assumptions as described below (see "Barriers extend beyond manual controls").

In identifying Testing Methods, we understand NHTSA is seeking methods that will be viable for the full range of potential ADS-DVs, accurately show that vehicle has met the standard, be representative of the overall vehicle production, be conducted safely, be efficient for manufacturers conducting certification testing, and enable NHTSA to verify compliance if necessary. In light of these objectives, we recommend that NHTSA allow manufacturers to choose either or both of options two and three as described in the ANPRM: a manual controller or a pre-programmed test execution mode.

Manual controller: We anticipate that manufacturers will develop some means of manual control for their vehicles, such as teleoperation, short-range remote control, or detachable manual controls inside the vehicle. Based on our understanding of current practice, this is already being done by many in the industry.[12] It is logical to assume this practice will continue for the foreseeable future, because these manual controllers offer manufacturers significant utility in moving vehicles short distances around their facilities, and several companies have written in their Voluntary Safety Self-Assessments that they are using this as a safety backup. However, it is important to note that each manufacturer is designing a controller specific to their vehicle, and no universal controller exists or is likely to emerge.

Manual controllers have several advantages for testing. They are straightforward to apply: they enable the same control of the vehicle's movement as traditional passenger car controls (including to position the vehicle for testing, and to run the test). Controllers can be used with both driverless and passengerless designs, so long as NHTSA does not put restrictions on their design (i.e., controller could be inside or outside vehicle, wirelessly or physically connected, as noted in the ANPRM). The controller can also include functionalities like an emergency stop, and control over specific vehicle parameters required by some tests, and an accompanying display could also be used to show any information needed to ascertain whether a test was completed correctly, such as vehicle conditions (e.g., speed) and field of view (camera output). Finally, because autonomy is not used with a manual controller, the ADS's ODD constraints are not applicable, as they would be for testing done in autonomous mode, avoiding complexities like the need to map testing facilities. However, the FMVSS and testing conditions would still need to be adjusted to account for speed or other limitations inherent in the vehicle's design or operational capabilities.

It is important to note that the manual controller need not be representative of a standard passenger car's controls. For example, it need not have a dashboard, an automotive steering wheel, and so on, as the controller is not necessarily anticipated to function as a tool for driving the vehicle in everyday operation. As a result, the controller may not follow all standards as written pre-translation (e.g.,

[12] *See e.g.,* Alex Davies, *Self-Driving Cars Have a Secret Weapon: Remote Control*, Wired (Feb. 1, 2018) https://www.wired.com/story/phantom-teleops/ (discussing remote operation capabilities of 11 companies).

cancelling the turn signal by mechanical operation of the steering wheel), but this would not present an issue as we assume that NHTSA will have completed the regulatory translations. Therefore, NHTSA should anticipate that manufacturers will use manual controllers that are capable of operating the vehicle as required for all necessary tests of the vehicle, but the manual controller itself need not be analyzed according to the standards applied to a traditional passenger vehicle.

The security concerns NHTSA notes with an external controller can be mitigated by following best practices in encryption, limiting access to the controllers, and reducing the incentives to hacking by not requiring a universal controller that can take control of any ADS-DV on the market. And because manufacturers will likely be developing manual controllers for their own use regardless of NHTSA's testing procedures, as explained above, the use of a manual controller in testing does not generate new security concerns. In addition, for manufacturers unable to sufficiently harden their external controllers to cyber risks, NHTSA could allow manufacturers to use non-production vehicles with an external controller in verification testing, and not require that the controller functionality be included on production vehicles.

Because many ADS-DVs will not be offered for public sale, NHTSA cannot assume that the controllers will be publicly available or that any licensed driver will be able to safely operate them. On the contrary, it is likely that several weeks of proprietary training will be required, specific to each vehicle; manually operating a low-speed shuttle, passengerless vehicle, or bi-directional passenger vehicle will all be very different experiences from each other and from traditional passenger cars. As we described in our Safety Report, Nuro remote operators undergo extensive training before they are permitted to operate our custom vehicles, even on private roads.[13] We recommend that NHTSA works with manufacturers to ensure that a test engineer and test operator from the manufacturer, trained in the specific vehicle being tested, can come on-site to operate the vehicle and advise on procedures during any verification testing. This simple solution also will obviate any need for NHTSA to launch an expensive, complex, and risky R&D project to develop a universal controller; even if such a universal controller were to exist, operating each vehicle would still require specific training and so there would be little utility from having a common controller.

Pre-programmed test execution mode: In some cases, a pre-programmed test execution mode might be better suited to a particular manufacturer's design. It is possible that at least one manufacturer may develop a model that does not have an external controller capability. Or, a manufacturer may develop a vehicle that is capable of manual control, but uses different mechanisms for meeting a specific requirement (e.g., electronic stability control) in manual versus autonomous control. Because of these potential cases, NHTSA should give manufacturers the additional option to perform some or all of the testing in autonomy, using a test mode with pre-programmed execution.

This method does raise additional complexities, as noted in the ANPRM. However, they are likely surmountable if NHTSA works with manufacturers and provides sufficient flexibility.

- Security: A secure passcode or other secure system would need to be developed to ensure the test mode is not inadvertently accessed by a customer or bad actor. For example, Nuro's vehicle includes an external touchscreen that customers use to enter a pin code and open the vehicle compartments and retrieve their goods, presenting an interface that could also be used for test mode control (potentially in addition to an external, manual controller); other manufacturers could consider also providing such an interface. Instead of using a secure passcode,

[13] *Delivering Safety*, *supra* at 13.

manufacturers could also consider using a specialized version of the ADS operating system that includes test mode, but this test mode is not included in operating system releases used on production vehicles that travel on public roads. As with the test controller, for safety and security reasons, access to test mode should be limited to authorized manufacturer personnel.

- ODD: It is likely that most or all Level 4 ADS-DVs will have ODDs limited to previously mapped areas for the near future. One or more proving grounds would have to be designated for vehicle testing. These proving grounds would need to be within the environmental (e.g., weather) restrictions of the ODD for each manufacturer, and individually or in sum, provide surfaces suitable for completing all applicable testing (note some facilities may not be suitable for all tests, in all seasons). These proving grounds would also have to be willing to let manufacturers map their grounds (many do not allow this today, but perhaps NHTSA could work with them to assuage their concerns), and then each manufacturer would have to develop a map of the ground that works with their software prior to manufacturer or NHTSA testing.

  One possibility that NHTSA raised in the ANPRM is removing the ODD restrictions on the ADS to avoid these restrictions. This would be both unsafe and unrepresentative of the vehicle's capabilities. By definition, the ADS is designed only to operate within its ODD, and so any testing outside of that ODD would not be informative of the vehicle's performance within the ODD. And because ODD is defined based on where the vehicle can operate safely, removing ODD constraints could endanger test engineers.

- Positioning vehicles: For vehicles that also have a manual controller but choose to perform some tests in autonomy, it will be simple to use the manual controller to position them on the test grounds at a suitable place for performing each test. (This manual controller can also provide an emergency stop functionality during the test, even if it is not being used to control the driving.) If there is no controller, the vehicle might need to be towed into position.

Technical documentation: Assuming that regulatory barriers without safety benefit (such as brake pedals) have been removed, most of the applicable FMVSS requirements will focus on features of the vehicle hardware that can be tested with a controller or pre-programmed test execution mode. However, NHTSA may determine that it is necessary to confirm that some information currently provided to the driver (e.g., controls and telltales, view behind the vehicle…) is provided to the ADS. For these requirements, manufacturers can provide technical documentation demonstrating that the information is provided.

Overall, we encourage NHTSA to provide manufacturers options and flexibility, without compromising the safety purpose of the regulations, to ensure that all ADS-DVs are able to comply and that NHTSA adheres to the principles of technology-neutrality and business-model neutrality.

Exemptions and pilot program could inform rulemakings

To inform this rulemaking and NHTSA's other rulemakings to remove regulatory barriers to ADS-DVs, we encourage NHTSA to expeditiously complete its review of pending ADS-DV exemption petitions. In addition, we encourage NHTSA to finalize the pilot program for collaborative research on motor vehicles with high or full driving automations, and to include in the final program pilot applications with sufficient scope and scale to capture a meaningful quantity of data. Moving forward on exemptions and the pilot program would generate real world data for NHTSA and manufacturers, allow the testing and

certification of the first ADS-DVs, and inform NHTSA's rulemakings.

Barriers extend beyond manual controls

The Agency notes in the ANPRM that:

> NHTSA has determined that most of the potential regulatory barriers to the certification of ADS-DVs without traditional manual controls in the 100-series FMVSSs fall into three categories: (1) The standard requires a manual control; (2) the standard specifies how the agency will use manual controls in the regulatory description of how it will test for compliance; or (3) the definition or use of particular terms (e.g., "driver") become so unclear that clarification is necessary before certification and compliance verification testing is possible.[14]

We note that beyond manual controls and the term "driver," there are several other regulatory barriers in the 100-series FMVSS, particularly in the test conditions. Some examples include, but are not limited to, assumptions related to:

- Fuel tank (e.g., FMVSS Nos. 111, 135) in electric vehicles
- Driver's seating position (e.g., FMVSS No. 111) in vehicles with no interior seating positions
- Driver's door or passenger's door (e.g., FMVSS No. 111) in vehicles with no drivers or passengers
- Test driver, passenger front seat, and passenger foot well area (e.g., FMVSS No. 126) in vehicles intended to have no human occupants
- Occupant weights (e.g., FMVSS No. 135) in vehicles intended to have no human occupants
- Operation at high speeds (e.g., FMVSS Nos. 126 (50 mph), 135, 138, 305) in vehicles that have a lower maximum speed, per the vehicle specifications and/or ODD limitations. Note, there is precedent in the FMVSS for how to accommodate diverse max vehicle speeds: FMVSS No. 135.S6.5.2 includes a formula for translating the testing speeds to vehicles with a lower max speed, and this general approach could be applied more broadly across the standards.
- Weather and temperature conditions (e.g., FMVSS No. 124) in vehicles that have a more limited hardware specification due to a narrow ODD.

We encourage the Agency to review its list of barriers in the 100-series FMVSS to ensure the controls and terms identified include both driverless and passengerless vehicles, vehicles with various power sources, and vehicles that operate at a variety of max speeds. We also encourage the Agency to provide stakeholders with the opportunity to comment on the list of identified barriers at the earliest possible time.

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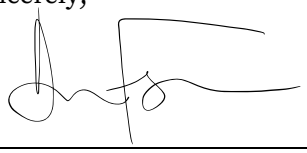
Thank you for the opportunity to comment on this advanced notice of proposed rulemaking. If you have any questions, please do not hesitate to contact us.

Sincerely,



[14] ANPRM, *supra* at 24437.

David Ferguson
President
Nuro, Inc.