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Mr. Stephen Wood and Mr. Daniel Koblenz
Office of Chief Counsel
National Highway Traffic Safety Administration
1200 New Jersey Avenue SE
Washington, DC 20590

Dear Mr. Wood and Mr. Koblenz,

We are pleased to submit these comments as NHTSA considers our petition for exemption from select elements of the FMVSS No. 500 standard for the R2X low-speed vehicle.

As a limited scale deployment of a low-speed, autonomous vehicle without any human occupants, Nuro's R2X petition is an important opportunity for NHTSA to exercise leadership on a transformative safety technology and advance its safety objectives. As articulated in Automated Vehicles 3.0: Preparing for the Future of Transportation, the Department has recognized that "[a]utomation has the potential to improve our quality of life and enhance the mobility and independence of millions of Americans, especially older Americans and people with disabilities."[1] Therefore, the Department stated that it seeks to "adopt flexible, technology neutral policies that promote competition and innovation as a means to achieve safety, mobility, and economic goals" and "modernize or eliminate outdated regulations that unnecessarily impede the development of automated vehicles."[2] By thoughtfully considering Nuro's petition and the public's comments, and granting this petition, NHTSA can help address regulatory barriers to innovation and accelerate the substantial safety, environmental, and economic benefits of robotics.

Nuro's petition establishes all elements of the exemption standard articulated at 49 USC § 30113(b)(3)(B)(iii) ("Category 3") and 49 CFR Part 555. While we believe the material contained in the petition is sufficient to support a grant of the petition, Nuro is pleased to be submitting additional comments in response to NHTSA's request for public comment on our R2X petition. We hope that these comments, which principally draw on information already publicly available from diverse sources, can help further educate the public about Nuro's vehicle, our planned operations, and autonomous vehicle technology, and inform future NHTSA rulemaking.

Below, we respond to several of the questions that NHTSA posed, in the order they appear in the notice. The quoted questions are listed in bold text followed by Nuro's response.

[1] US Department of Transportation, Automated Vehicles 3.0: Preparing for the Future of Transportation [hereafter, AV3.0], ii. (2018).
[2] Id. at iv.

Statutory Basis for Exemption

1. To what extent and in what ways does the choice of the basis affect the scope, depth and appropriateness of the safety analysis and finding?

According to the text of the statute and regulation, the basis of the safety analysis for Category 3 petitions is "unreasonabl[e]" safety risk.[3] This means that a vehicle may take on some additional risk compared to a non-exempt vehicle, so long as it is reasonable. For example, NHTSA has in the past granted exemptions to manufacturers who have omitted features with acknowledged safety benefits in their particular context,[4] because the safety degradation, while greater than zero, was not unreasonable. A willingness to accept at least some additional risk reflects a Congressional policy in favor of encouraging the development of low-emission vehicles, and Congress's decision to leave this section unamended even as they recently amended the Safety Act[5] indicates a continued policy of encouraging the development of electric vehicles.

To determine whether the impact is "unreasonable," the scope of NHTSA's inquiry has historically considered factors such as other safety features in the vehicle, the vehicle's limited speed, the number of vehicles being produced, and the locations where the vehicle is most likely to be used based on its design and typical driver behavior.[6] These factors continue to be appropriate and relevant in determining whether exemption from a specific standard would create an "unreasonable" risk to safety.

In Nuro's case, by contrast to other low-emission vehicle petitions where NHTSA accepted some safety degradation, granting an exemption would provide an equal or greater level of safety.[7]

The factors historically considered to determine the reasonableness of the risk also support a finding in favor of granting an exemption for Nuro's vehicle. For example, as articulated in the petition, Nuro's vehicle has numerous additional safety features that provide a superior safety performance than the exempted features, are limited to 25 mph, are limited in number, and operate exclusively at low speeds.

2. Is the basis for exemption (field evaluation of a low-emission vehicle (30113(b)(3)(B)(iii)) chosen by Nuro in its petition appropriate for the agency to use in determining whether to grant or deny an exemption for Nuro's vehicle? If not, what basis would be appropriate, and why?

As shown in the petition, an exemption would "make the development or field evaluation of a low-emission motor vehicle easier and would not unreasonably lower the safety level of that vehicle,"

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[3] 49 U.S.C. § 30113(b)(3)(B)(iii); 49 CFR § 555.6(c).
[4] See, e.g., Wheego Electric Cars, Inc., 77 Fed. Reg. 47915 (August 10, 2012) (electronic stability control system for brakes); Greenkraft, Inc., 80 Fed. Reg. 12057, 12060 (March 5, 2015) (headlamps with illumination less than the required level).
[5] Fixing America's Surface Transportation Act, (Public Law 114–94, 129 Stat. 1312) (2015).
[6] See e.g., Wheego, supra; Greenkraft, supra; Toyota Motor North America, Inc., 80 Fed. Reg. 101, 103 (January 2, 2015); Tesla Motors Inc., 76 Fed. Reg. 60124, 60126 (September 28, 2011).
[7] See Nuro, Inc., Petition for Exemption from Certain Provisions of Federal Motor Vehicle Safety Standard, No. 500 [hereafter, Petition], 7-18 (Oct. 19, 2018).

[8] and therefore this is an appropriate basis for granting the petition. Nuro's vehicle is "a low-emission motor vehicle," its "development or field evaluation" would be "easier" with the exemption than without the exemption, and this exemption would "not unreasonably lower the safety level." Therefore, the Secretary may grant Nuro's request for exemption on this basis. This is also consistent with past practice, as the Department has granted more than 20 petitions for exemption on the Category 3 basis.

3. In lieu of the low-emission basis, would it be more appropriate to consider Nuro's petition under 49 U.S.C. § 30113(b)(3)(B)(ii) (field evaluation of a new motor vehicle safety feature) or § 30113(b)(3)(B)(iv) (authority to grant exemptions from FMVSS for vehicles with an overall safety level at least equal to the overall safety level of nonexempt vehicles)? If so, why?

We believe the information in the petition, as supplemented in these comments, supports a determination under 49 U.S.C. § 30113(b)(3)(B)(iv) that R2X has an overall safety level at least equal to the overall safety level of nonexempt vehicles, and would not object if the Department chose to grant the petition on that basis. In particular, with respect to the three aspects of FMVSS 500 from which Nuro seeks exemption:

- Requirement for rearview mirror: The R2X will have no human driver who would need a rearview mirror, and the rearview mirror serves no auxiliary safety function for persons outside of the vehicle. The safety purpose of a rearview mirror is to permit the driver to avoid obstacles when operating in the reverse gear or observe other road users approaching from behind their vehicle. The R2X will achieve this purpose through the use of sensors that will detect objects to the rear of the vehicle. Omitting mirrors would also avoid excess mass and reduce pedestrian strike risk. Thus, a R2X without a rearview mirror has an overall safety level that is at least equal to the overall safety level of a vehicle that is equipped with a rearview mirror.

- Requirement for a windshield that complies with FMVSS 205: A windshield that complies with FMVSS 205 serves several safety purposes. One is to ensure adequate visibility for the driver. As the R2X will not have a human driver, it will achieve "visibility" through the use of sensors. Another safety purpose of the windshield is to contain the occupants in the event of a collision. The R2X will not have any human occupants. A third safety purpose of FMVSS 205 compliant glazing is to absorb some of the energy of a pedestrian or bicyclist who may collide with the vehicle and be thrown toward the windshield. This issue is discussed in more detail in response to question 14, below, but Nuro is confident that the evidence supports a conclusion that the pedestrian-protecting R2X design without an FMVSS 205 windshield is at least equal to the overall safety level of a vehicle that is equipped with a compliant windshield.

- Requirement for a rear visibility camera that complies with FMVSS 111: The safety purpose of a rear visibility camera is to provide information to the driver about obstacles behind the vehicle so that he or she can avoid them when operating in reverse gear. The R2X will achieve this purpose through the use of sensors that will detect objects to the rear of the vehicle. These sensors are redundant and have a 360-degree view with no blind spots,

[8] 49 U.S.C. § 30113(b)(3)(B)(iii).

exceeding the field of view requirements of the standard. Thus, an R2X without a rear visibility camera has an overall safety level that is at least equal to the overall safety level of a vehicle that is equipped with a compliant rear visibility camera.

4. Independent of the agency's disposition of this petition, NHTSA seeks comment on whether, and if so how, the agency should also consider creating a new vehicle classification category for light and/or low-speed passengerless [Automated Driving System (ADS)] vehicles like the R2X to which a subset of FMVSS requirements would apply.

Nuro strongly supports the creation of a new vehicle classification category for light passengerless ADS vehicles, to which a subset of FMVSS requirements would apply.

Today, vehicles with ADS but weighing more than 4000 pounds (double R2X's weight) and filled with people are permitted to operate under the FMVSS, but there are several requirements for cars and light trucks that complicate the design of delivery-specific vehicles, including requirements for a driver's seat, air bags, and brake pedals. Creating a new classification that specifically contemplates light passengerless ADS vehicles would facilitate the development of vehicles that have the potential to be among the safest on the road, encourage innovation, and create a level playing field for all ADS business models.

In addition, developing this new class would ensure that all light passengerless ADS vehicles conform to a high standard of safety. Nuro believes that all FMVSS with a safety purpose applicable to vehicles without occupants — namely, many of the crash avoidance standards in the 100 series of the FMVSS — should be applied to these vehicles, by making minor textual modifications to enable them to apply and be tested in passengerless vehicles, without reducing at all the safety performance compared to the present standard. Standards designed for occupant protection that do not provide a safety benefit in vehicles without occupants would not need to apply. This also means that NHTSA could more easily and quickly adapt the FMVSS for this new class of light passengerless vehicles because it would not be necessary to rewrite or adapt the 200 series of the FMVSS. A new vehicle classification would thus accelerate the deployment of life-saving technologies.

Granting the R2X petition would support the Department's development of this new class by generating additional data on the use and public acceptance of autonomous vehicles.

<u>The Development of a Low-Emission Vehicle</u>

5. Nuro contends that an exemption is necessary [to] facilitate the development of a[ ] LEV because it has "exhausted the safety gains that can accrue" from its current testing. Does the petition provide sufficient information to enable the agency to determine whether exempting the vehicle would make the development or field evaluation of a low-emission motor vehicle easier? If not, what additional information should the agency seek prior to rendering its final determination and why?

The petition provides sufficient information to determine that exempting the vehicle would make the development or field evaluation of a low-emission motor vehicle easier.

The petition establishes that the vehicle meets the standards of a low-emission vehicle because it is a battery-electric vehicle with no tailpipe emissions.[9]

To determine if providing the exemption would make the development or field evaluation of this vehicle easier, the Department must determine whether developing and evaluating (i.e., designing, obtaining supplies, manufacturing, testing, certifying, and operating in the field) this vehicle would be easier with the exemption or without. The very fact that Nuro has submitted such an exemption application, at significant effort and expense, strongly indicates that it would be easier to develop the vehicle with the exemption.

The petition also provides information showing that development would be easier without requirements for equipment that adds mass, increases pedestrian strike risk, and interferes with pedestrian safety features.[10] A vehicle without extraneous equipment is easier to design, supply, and manufacture, and it is easier to perform field evaluation with a safer vehicle.

In addition, providing clarity on how to apply the test procedure, linger time, and deactivation requirements of the rear visibility rule in the context of R2X's passengerless design would make the vehicle's development easier.[11]

As the Department has noted, "[o]n-road testing and early deployments are important to improving automated vehicle performance and allowing them to reach their full performance potential."[12] By making easier the certification of the vehicle, an exemption would support the on-road testing and deployments that the Department has recognized are "important" to the development of ADS technology.

6. Does Nuro ADS's reliance on "advanced machine learning" to improve driving performance justify public on-road testing to obtain additional ADS safety gains? Are there diminishing returns to continued testing with passenger cars retrofitted with ADS functionality?

As noted in the petition and described below, an exemption would make development and field evaluation easier for reasons beyond just the improvements to the ADS.[13] Therefore, while this rationale is important and sufficient to justify that the exemption would make the development and field evaluation of the vehicle easier, it is not necessary that the Department rely solely on this rationale.

As noted in the petition and in the Department's own public statements, public on-road testing provides valuable information about system performance, areas for improvement, and other road

[9] See Petition at 7.
[10] See Petition at 19.
[11] See Petition at 12-18 (e.g., "However, some of the testing procedures used to verify compliance with the standard, and some of the timing requirements, do not translate in a straightforward fashion to an autonomous vehicle.")
[12] AV 3.0 at 1.
[13] See Nuro, Inc., Petition for Exemption from Certain Provisions of Federal Motor Vehicle Safety Standard, No. 500 [Petition], 18-19 (Oct. 19, 2018).

users' behavior. Public road testing "allows developers to identify and rapidly fix system shortcomings, not just on individual vehicles but across fleets."[14]

Passenger car testing is an important component of a validation program, but there are also meaningful advantages to additional testing with R2X. R2X has a distinct design: narrower than most passenger cars, lower weight, distinct appearance. Testing with this specific vehicle provides information on maneuverability and how other road users may react to a vehicle with a different size and appearance.[15]

6 (continued). If AI machine learning is being used to continuously change its ADS software, how should the safety of the ADS be monitored and evaluated?

The software used on Nuro's vehicles is not updated "continuously" (e.g., without interruption or during public roads operation). Rather, we use a robust, multi-step software release process to improve the ADS.

As Nuro logs more miles of driving experience, that information is used to improve the machine learning algorithms so that the ADS becomes safer and more capable. Before any new machine learning model is deployed in our ADS through a software release, Nuro's robust design, testing, and validation process ensures the release is safe. New machine learning models must pass tests demonstrating their ability to correctly handle difficult scenarios, and any change to the autonomy software goes through both simulation and private course testing before being deployed on public roads.

Safety—General Questions

7. In determining whether to grant the petition, how should NHTSA consider whether an exemption would "unreasonably lower the safety level"? Should this consideration be solely limited to safety level provided by the exempted standards or the safety of the vehicle more generally?

As established by the text of the statute and regulation, and NHTSA's past practice in applying this basis, NHTSA should consider the safety level provided by the exempted standard in determining whether an exemption would "unreasonably lower the safety level."

The plain text of the statute and the regulation clearly states that the evaluation is limited to the effect of the exempted standards (or parts of standards): "The Secretary may act under this subsection on finding that . . . the exemption . . . would not unreasonably lower the safety level of that vehicle."[16] Category 3 therefore asks the Department to evaluate the effect of the exemption itself on the safety level, not the safety of the vehicle more generally. This analysis should be fact- and feature-specific, with its reference point fixed squarely at a compliant vehicle that is identical to the subject vehicle but for the exempted items. For example, for a vehicle with no human occupants, is the vehicle "unreasonably" less safe because it lacks mirrors, even though there is no human driver or

[14] AV 3.0 at 1.
[15] Petition at 19.
[16] 49 U.S.C. § 30113(b)(3) (emphasis added).

passenger to use them? If the mirrors do not provide a substantial safety benefit for the fully unmanned vehicle, then the safety inquiry is satisfied. This is likewise true for a windshield, rear camera deactivation requirements, and rear visibility test conditions where Nuro seeks exemption.

This reading is consistent with NHTSA's previous application of this safety inquiry. In each past petition, the Department has considered the safety purpose of the standard and compared the subject vehicle's performance in achieving that objective to a compliant vehicle. In Greenkraft, NHTSA looked to the safety purpose of FMVSS No. 108 (lamps) and assessed the performance of the subject vehicle's headlamps at illuminating pedestrians and animals "compared to a compliant lamp," in the context that vehicle would likely be used.[17] In Toyota, NHTSA looked to the safety purpose of FMVSS No. 305's electrical safety requirements and compared the performance of Toyota's vehicle after a crash with a complaint vehicle, including consideration of the alternative safety features Toyota supplied.[18] In Tesla, NHTSA looked to the safety purpose of the electronic stability control system and compared the performance of a Tesla Roadster (including considering its low center of gravity) in avoiding "loss-of-control crashes" to the performance of a compliant vehicle. [19] In Think, NHTSA looked to the safety purpose of the FMVSS No. 208 advanced air bag systems and compared the performance of Think's overall occupant protection system (including seat belts) to a compliant air bag system.[20] While these are just a few examples of this past practice, this approach has been consistently applied across NHTSA's past treatment of Category 3 petitions. We encourage the Department to continue to apply the statute and its regulations consistent with these precedents.

More generally, as far as we are aware, NHTSA has also never denied an exemption petition based on a part of the vehicle that was not regulated by any Federal Motor Vehicle Safety Standard. For example, NHTSA has never inquired into whether the acceleration capabilities of a vehicle or the cybersecurity of its CAN system are adequate before determining whether the exemption would unreasonably lower the safety level of the vehicle.

8. Is it appropriate for the agency to give any consideration to the quality of the performance of Nuro's ADS as part of its assessment whether granting Nuro's petition is in the public interest and consistent with the Safety Act?

As the Department notes, the statute requires a public interest inquiry: "The Secretary may act under this subsection on finding that .. . an exemption is consistent with the public interest and this chapter [the Safety Act] . . . ."[21] This section asks whether the public interest and the priorities of the Safety Act are better served by the R2X being granted an exemption or not. That is, would it be in the public interest to make easier the development of the R2X and allow it to operate without extraneous equipment that adds mass and width? Or, would it be more in the public interest if an exemption were not granted, and therefore mirrors and a windshield were added to R2X, and the vehicle were operated consistent with the requirement to deactivate the image from the rearview camera when operating in forward motion, with the same ADS?

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[17] Greenkraft, supra at 12060
[18] See Toyota, supra at 103.
[19] See Tesla, supra at 60126; see also Wheego supra (granting exemption relying on similar reasoning).
[20] See Think Technology AS, 74 Fed. Reg. 40634, 40636 (August 12, 2009).
[21] 49 U.S.C. § 30113(b)(3).

As the petition and these comments make clear, the answer to this inquiry is that granting Nuro's petition is in the public interest because it would make easier the development and field evaluation of a vehicle that can help advance important safety innovations in pedestrian protection and self-driving software, reduce emissions, increase public awareness of electric vehicle and autonomy technologies, and support employment and economic growth. Denying the exemption would make achieving those benefits more difficult by adding mass and width to the vehicle, which is not in the public interest or consistent with the Safety Act.

To take the most straightforward example of a safety benefit, the passengerless design of R2X vehicle means that for every trip to the store that Nuro replaces, the risk of injury to the driver and their passengers on the avoided shopping trip has been eliminated, setting aside any of the crash avoidance aspects of Nuro's technology. On top of this, the Department has recognized that the ADS technology itself also "could lead to breakthrough gains in transportation safety."[22] By enabling easier development and field evaluation of this technology, the Department would be furthering the Safety Act's purpose to "reduce traffic accidents and deaths and injuries resulting from traffic accidents."[23]

This is not to say that NHTSA might never have reason to consider the ADS performance in the public interest inquiry. In the face of these substantial safety and other public interest benefits, NHTSA might nonetheless find that making the field evaluation of a particular autonomous vehicle is not in the public interest, if the Department had evidence that the public roads testing of the vehicle's ADS was likely to result in an increase in traffic accidents substantial enough that it would outweigh the reduction in risk from passengerless vehicles, the development of a technology offering "breakthrough gains in transportation safety," and the environmental and economic benefits of the petitioned vehicle. For example, if a company had a record of reckless safety practices in developing or validating of their ADS, or had been found negligent in causing traffic accidents at a high rate, the Department might have cause to consider the performance of the ADS and determine that its testing is too great a danger to the public to make easier through an exemption.

In Nuro's case, there is no basis for such a determination. On the contrary, Nuro's autonomous vehicles have been in no collisions and Nuro's safety approach — as documented in our Voluntary Safety Self-Assessment (Safety Report), petition, and these comments — follows or exceeds many of the best practices in the industry and those outlined in the Department's own guidance documents, AV 2.0 and AV 3.0.[24]

As explained further below in response to question 9, the Department also has an established and sufficient means for evaluating the safety of all motor vehicles and motor vehicle equipment in its defect authority. The Department has stated that if it finds at any time that a vehicle equipped with an ADS poses an unreasonable risk to safety, it has the authority to order a recall — regardless of whether it has been granted an exemption.[25] This authority allows the Department to assess safety in response to real world operation, rather than relying only on the currently anticipated performance.

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[22] AV 3.0 at 1.
[23] 49 U.S.C. § 30101.
[24] See generally US Department of Transportation, Automated Driving Systems 2.0: A Vision for Safety (2017); AV 3.0.
[25] See NHTSA Enforcement Guidance Bulletin 2016–02: Safety-Related Defects and Automated Safety Technologies, 81 Fed. Reg. 65705 (Sept. 23, 2016).

9. How should safety considerations, including the performance of the ADS, be included in the "terms" of a granted exemption?

NHTSA's existing defect authority is the best approach to address safety considerations following the grant of an exemption. NHTSA has issued guidance specifically in response to regarding automated safety technologies like ADS, stating that this authority is "sufficiently general and flexible" to protect public safety and keep pace with technological innovation.[26] The defect authority allows NHTSA to seek remedies, including recalls, for any vehicle or motor vehicle equipment that contains a defect creating an unreasonable risk to safety,[27] and requires manufacturers of motor vehicles and motor vehicle equipment to notify NHTSA of any and all safety-related defects.[28] This authority also has established procedures — perfected over decades — that balance due process, efficient factfinding, and public safety.[29] Using this authority would avoid the need to create new procedures for fairly monitoring and enforcing the terms of this particular exemption.

Safety—Exempted Standards

11. Is Nuro correct in its conclusion that the safety purposes of the three requirements from which it is requesting an exemption are not relevant to the R2X because it would not have any occupants? Do these requirements serve any safety purposes beyond those discussed in the petition?

While FMVSS No. 500 does not specify the safety purpose of the specific equipment required in its text or its accompanying notices, the referenced standards do include a definition of the safety purpose. As this text was enacted into the regulation, this is the strongest evidence of the standard's purpose. The purpose of these requirements is further spelled out in NHTSA's regulatory notices and the statutes that motivated them. As described below, R2X meets all of the safety purposes in the regulations and their accompanying statements of reasons.

Mirrors: FMVSS No. 111, governing both mirrors (for, e.g., passenger cars) and backup cameras (for, e.g., LSVs), states that its purpose is "to reduce the number of deaths and injuries that occur when the driver of a motor vehicle does not have a clear and reasonably unobstructed view to the rear."[30] As the petition notes, Nuro is able to meet this safety purpose with its sensor system, which provides redundant, 360-degree views with no blind spots.[31]

Backup cameras: In addition to the purpose language of FMVSS No. 111, discussed above, the safety purpose of the backup camera portion of FMVSS No. 111 is illuminated by the Cameron Gulbransen Kids Transportation Safety Act of 2007,[32] which mandated the rulemaking, and NHTSA's final notice announcing the rulemaking. The Act directed NHTSA to conduct rulemaking "to expand

[26] Id. at 65707.
[27] See 49 U.S.C. § 30120.
[28] See 49 C.F.R. § 573.6(a).
[29] See, e.g., 49 U.S.C § 30118(e), § 30120(e); 49 C.F.R. Part 552.
[30] 49 C.F.R. § 571.111.S2.
[31] Petition at 8-10, 13-14.
[32] Cameron Gulbransen Kids Transportation Safety Act of 2007, (Public Law 110–189, 122 Stat. 639–642) (2007).

the required field of view to enable the driver of a motor vehicle to detect areas behind the motor vehicle to reduce death and injury resulting from backing incidents, particularly incidents involving small children and disabled persons."[33] The notice accompanying NHTSA's final rule reiterated this purpose, and noted that the rule's benefits would arise in particular from avoiding backover crashes involving pedestrians, including the emotional cost of such crashes, and from avoided property damage incurred in backover crashes.[34] The Department estimated that "[r]ear visibility systems meeting the requirements of [the backup camera] final rule are predicted to have an effectiveness of between 28 and 33 percent. . . ."[35] The reason the final rule was not predicted to be 100% effective is that the required camera's field of view is broad enough to see 90% of the road users injured in backover crashes, and more than half of the human drivers in NHTSA's studies did not consult or use the information provided by the cameras and therefore backed into the test objects even though they were visible.[36]

As described above and in Nuro's petition,[37] Nuro's vehicle meets the backup camera's safety purpose to "expand the required field of view . . . behind the motor vehicle." R2X includes a camera that meets the field of view requirements of FMVSS No. 111. In addition, R2X also has several other cameras that each meet or supplement the required field of view, along with LIDAR, radar, and ultrasonic sensors. Together, this sensor suite provides 360-degree vision with no blind spots, and multiple sources of redundancy to guard against a single sensor failure, substantially exceeding the field of view requirements in the regulation. And because R2X uses an ADS that does not get distracted and that does not forget to consult the screen, the effectiveness of R2X's backup system is likely several times the 28-33 percent effectiveness predicted by the rulemaking.

With regard to the specific linger time and deactivation requirements of FMVSS No. 111 that Nuro seeks exemption from, the Department noted that the purpose of these requirements was to "ensure that the required rearview image is available to the driver at the appropriate time without becoming a distraction at an inappropriate time."[38] Because Nuro's ADS is able to simultaneously consider sensor inputs from multiple sensors and in a 360-degree field of view, there is not a risk of "driver" distraction in the R2X.

With regards to the testing procedures from which Nuro seeks exemption for R2X:

- Fuel tank: NHTSA's notice indicated the purpose of specifying the fuel tank's loading was because it could "impact the vehicle's pitch in a way that alters the outcome of the visibility test."[39] The state of charge of Nuro's electric battery does not affect the vehicle's pitch.

- Driver's seat positioning: The notice indicates that the seat positioning test procedure is intended to verify that the driver is able to see the rearview image without obstacles in the vehicle cabin between the driver and the image.[40] R2X does not have a designated seating

[33] Id. at § 2(b).
[34] See Federal Motor Vehicle Safety Standards; Rear Visibility, 79 Fed. Reg. 19178, 19178-19181 (2014).
[35] Id. at 19180.
[36] See NHTSA, Final Regulatory Impact Analysis, Backover Crash Avoidance Technologies FMVSS No. 111 (March 2014).
[37] Petition at 8-10, 13-14.
[38] Rear Visibility, supra at 19182; see also, id. at 19217-19219.
[39] Id. at 19217.
[40] See id. at 19215.

position in the interior vehicle cabin that could be adjusted, or obstacles between a human driver and an image; in addition, the ADS does not require a physical screen to understand the input from the backup cameras.

- Steering wheel: NHTSA's notice indicates that the purpose of specifying the angle of the steering wheel is to avoid the risk that overlays (i.e., graphics superimposed on the displayed image to aid the driver) would obscure pedestrians behind the vehicle, and to ensure test repeatability.[41] R2X uses a drive-by-wire system (i.e., an electronically controlled system) and can angle the vehicle's tires in the same way as required by the test procedure, without the need for a steering wheel.

Glazing materials: FMVSS No. 205, governing glazing materials, states that its purpose is "to reduce injuries resulting from impact to glazing surfaces, to ensure a necessary degree of transparency in motor vehicle windows for driver visibility, and to minimize the possibility of occupants being thrown through the vehicle windows in collisions."[42] This has three components: impact to glazing surfaces, driver visibility, and occupants being thrown.[43]

- Impact to glazing surfaces: As described in response to question 14, below, because Nuro's vehicle does not require a transparent windshield, it can use materials designed to protect other road users and in particular pedestrians better than a conventional windshield design. Generally, windshields, A-pillars, and cowls adjacent to windshields have the most severe impact on pedestrians in the case of a collision. By using materials that are designed to minimize the severity of an impact to the front of the vehicle, Nuro's vehicle advances the regulation's goal to "reduce injuries resulting from impact to glazing surfaces." In addition, because there are no occupants in the vehicle, Nuro's vehicle also advances the regulation's goal of reducing injuries from impact to glazing surfaces by those inside the vehicle (in Nuro's case, eliminating entirely the risk of these injuries as there are no occupants, compared to other vehicles that partially mitigate this risk).

- Driver visibility: Because Nuro's vehicle does not have a human driver inside the vehicle and the sensor stack is not behind a windshield, the relative transparency of the motor vehicle windows does not impact "driver visibility."

- Occupants being thrown: Because there are no occupants in the vehicle, a windshield would not have any impact on preventing occupants from being thrown from the vehicle in collisions.

12. Regarding the rear visibility requirement, how would the agency assess whether the R2X actually would meet the "field of view" and "image size" requirements?

In Nuro's petition, diagrams were provided showing the field of view of Nuro's cameras and how this satisfies the requirements of FMVSS No. 111.[44]

[41] See id. at 19210-19211.
[42] 49 C.F.R. § 571.111.S2.
[43] See Petition at 10-11.
[44] Petition at 14.

For the purposes of verifying the field of view, R2X is capable of simultaneously broadcasting the precise image called for in FMVSS No. 111 — with the timing and nature of display requirements articulated in the standard — to the remote operator. Because that image would be broadcast directly from the vehicle, it provides a reliable means of external verification that all field of view and image size requirements are met.[45]

Vehicle Weight

In its notice, the Department states: "We note that Nuro does not provide the precise GVWR of the R2X, which is needed to determine whether the R2X would properly be classified as an LSV."[46] As noted in the petition, R2X's GVWR will be less than 1,361 kg.[47] Nuro estimates that R2X's GVWR will be 1,300 kg, below the low-speed vehicle threshold of 1,361 kg.[48] The precise GVWR will be determined upon completion of manufacturing and testing, during the certification process.

Nuro is not seeking an exemption from the weight requirement. If NHTSA grants Nuro's exemption petition, R2X must have a GVWR less than 1,361 kg for Nuro to certify the vehicle as compliant with all applicable FMVSS. This certification process, and NHTSA's associated authorities, will provide the same assurance that R2X is properly classified as it does for all motor vehicles.

Safety—Performance of the ADS

We note that several of the questions included in the notice concern the performance of the ADS, under the heading "Safety—Performance of the ADS." As discussed above in response to question 7, for exemptions submitted under the Category 3 basis, the statute requires a safety evaluation that assesses the safety impact of exempting a vehicle from a particular requirement (here, mirrors, windshield, and elements of the rear visibility standard). This safety evaluation is not dependent on the performance of the ADS, but rather on the utility of the equipment that R2X would omit, in the R2X's specific context. Nonetheless, we believe it will benefit the public to take this opportunity to provide additional information on how automated driving systems function and our perspective on issues related to autonomous vehicle safety; this information can help further public and policymaker understanding of these issues and support future rulemaking.

13. To what degree could the R2X's capabilities or ODD be changed through post-deployment software updates over the lifetime of the R2Xs for which Nuro is seeking an exemption? While Nuro states that it does not intend to "upgrade" the R2X's ADS to L5, are there ODD or other changes Nuro should be able to make to the R2X over the lifetime of the vehicles? How should NHTSA address the possibility of such changes in conducting its safety analysis?

In its notice, the Department sought clarification of Nuro's statement that the R2X vehicle is intended for "short neighborhood trips." The R2X is intended to replace vehicle trips to go shopping or complete other errands, which are typically short trips to stores near residential areas. According to

[45] Petition at 17.
[46] Nuro, Inc.; Receipt of Petition for Temporary Exemption for an Electric Vehicle With an Automated Driving System, 84 Fed. Reg. 10172, 10175 (March 19, 2019).
[47] Petition at 3.
[48] 49 U.S.C. § 571.3.

the National Household Travel Survey (NHTS), 60% of American vehicle trips are 5 miles or less, and 43% of all vehicle trips are to go shopping or perform other errands.[49] In addition, because Nuro's retail partners such as grocery stores are generally located close to their customers' homes, the trip is typically conducted on the low-speed roads that are characteristic of residential communities.[50]

The NHTS data are consistent with our experience and plans. To date, we have established operations in the San Francisco Bay Area near our headquarters in Mountain View, California; Scottsdale and Phoenix, Arizona; and Houston, Texas. In these areas, we have performed on-road testing and, as part of a pilot, delivered groceries. These trips were typically consistent with the "short neighborhood trips" described above. We anticipate operating R2X in these or similar environments.

With regards to the R2X's ODD, the operational limits Nuro would place on the R2X vehicles are, in part, a function of the inherent qualities of the vehicle (e.g., classification, physical capabilities, passengerless design), and therefore may not be readily modified. During the service life of the exempted vehicles, they will never be upgraded to L5 autonomy, go on high speed roads like interstates, or carry human passengers.

Just as for human drivers, certain road conditions are easier for our vehicle to navigate than others — snow and black ice or high-speed roadways present additional risk for a self-driving vehicle just as they do for humans. However, unlike a human driver that might choose to take on greater risk beyond his or her capabilities, we designed all Nuro vehicles to operate autonomously only in areas where we have high confidence that we are able to operate safely. The software is specifically programmed to choose routes that are only within the safe domain, and if weather conditions suddenly change, to pull over every time rather than operate in a dangerous environment. The current operational design domain of Nuro's vehicles is described in our Safety Report; in summary, the current ODD includes roads mapped by Nuro, with speed limits of 35mph or less (no highways, and nearly all of these miles are on roads with speed limits of 25mph), during the day or night, in generally fair weather (i.e., dry or wet pavement or asphalt, including light rain).[51]

The operational design domain (including, for example, what weather conditions the vehicle can operate in) is a function of the ADS's capabilities. Over time, we will improve the ADS, and in particular its ability to deal with certain environmental or road conditions. Just as a human driver gradually expands the conditions under which they are capable of driving as they get more experience, Nuro's ADS will improve as the software is refined and more situations are experienced. As the ADS improves, we anticipate — subject to the extensive testing and validation processes described in our Safety Report (pp. 22-23) and in response to question 6 — gradually expanding the operational design domain for R2X, while remaining within the scope of a L4 autonomous vehicle.

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[49] NHTS 2017, https://nhts.ornl.gov/vehicle-trips.
[50] See Kroger Co. 2012 Fact Book, available at http://ir.kroger.com/Cache/1500057702.PDF?O=PDF&T=&Y=&D=&FID=1500057702&iid=4004136 ("The combination store (combo) is Kroger's primary format. This format typically draws Customers from a 2.0 – 2.5 mile radius and offers them the advantage of 'one-stop shopping' in convenient locations for a wide selection of consumables.")
[51] Delivering Safety: Nuro's Approach at 18 [Safety Report]. Nuro's Safety Report, or Voluntary Safety Self Assessment, is available at www.nuro.ai/safety and is also provided as an attachment to these comments.

One of the public interest benefits of granting this petition is that it will facilitate R2X operations on public roads, which will help them develop and improve, and pushing ODD updates to the vehicles further improves safety and capability by reducing the need to, for example, execute pullover maneuvers in response to weather changes. Any ODD changes will be necessarily limited in scope based on the vehicle's inherent qualities (as discussed above) and subject to rigorous testing and validation before they are implemented.

We recommend that NHTSA conduct its safety analysis by assuming that the ODD may expand, but will be inherently limited by the vehicle's design. This is consistent with the Department's past consideration of vehicles that are primarily but not exclusively driven in a specific operating environment. For example, the Department has granted several exemption petitions for vehicles with headlamps conforming to European but not American standards, and noted that they are "driven primarily in urban areas."[52] The Department did not require that these vehicles forever be confined to these areas, but accounted for the unique environment in which they are "primarily" driven in making the safety determination. In the case of Nuro's vehicle, the Department can have even more confidence in the operating environment because the restrictions in ODD cited are related to inherent features of the vehicle design (as opposed to the average behavior of human drivers), and because Nuro intends to directly control and operate the R2X vehicles rather than selling them to the general public.

14. Did Nuro provide sufficient information about how the R2X would interact with human-controlled vehicles on the road?

R2X interacts with human-controlled vehicles on the road using its perception, prediction, and planning systems.[53]

- To perceive the world around it, Nuro's ADS uses the vehicle's sensors, including 12 high-definition cameras, radar, LIDAR, ultrasonic sensors, and audio sensors to provide a 360-degree, live image of the surrounding area. This enables the ADS to see what other road users are doing, observe traffic signals, and understand anything that's changed from our map.

- Then, the system needs to predict how other road users will move. The ADS combines observations of what's happening live around the vehicle with its experience observing the behavior of different kinds of road users — understanding the behavior differences between a pedestrian and a cyclist, a truck and a coupe. These predictions are based on models that have been trained using machine learning and extensive data from situations encountered on public roads, both routine and rare.

- Finally, the system needs to plot its course. Nuro's vehicles use the inputs from maps, localization, perception, and prediction to design multiple potential routes through any given situation. The ADS chooses the path with the greatest probability of safety, and continuously updates its plan based on new information. A vehicle may take preemptive action to, for

[52] Greenkraft, Inc., supra at 12060; see also Ford Motor Co., 58 Fed. Reg. 16907, 16910 (Mar. 31, 1993) (granting exemptions).
[53] See Safety Report at 12.

example, ensure it has enough time to react if another car turns without signaling or a pedestrian enters the street from behind a parked bus.

How R2X would interact with human-controlled vehicles on the road has also been shown by extensive interaction testing on public roads using vehicles with a substantially similar form-factor to the R2X: the "R1" (see Figure 1, below). In fall 2018, Nuro began public roads testing with R1, our first-generation custom vehicle with a substantially similar appearance to R2X, and in December 2018, began delivering groceries with this vehicle. R1 has not been in any collisions. This testing followed extensive public roads testing of the same ADS system in Toyota Prius and Nissan Leaf vehicles in California and Arizona, and testing of the Prius, Leaf, and R1 vehicles in a wide variety of scenarios (including both structured "edge case" scenarios and customer interactions) at our private testing facilities.

Figure 1: "R1"

14 (continued). Should the agency be concerned about the front-end stiffness of the R2X and its impact on collision partners?

Because of the environments in which Nuro operates, and the lack of human occupants, Nuro has designed R2X to primarily focus on protecting other road users, including both other vehicles and pedestrians.

To address crash compatibility with other vehicles, Nuro's vehicle is designed for crash compatibility and battery protection. R2X's front bumper has a crush structure voluntarily designed to the performance requirements of FMVSS No. 305 (battery protection) and Part 581 (bumper standard).[54]

Nuro has also placed special emphasis on pedestrian protection.[55] By removing the windshield, Nuro is able to design R2X to address risk to the parts of the front-end that are most likely to cause AIS3+ injuries to pedestrians (injuries to the pelvis, torso, and head) in passenger cars.

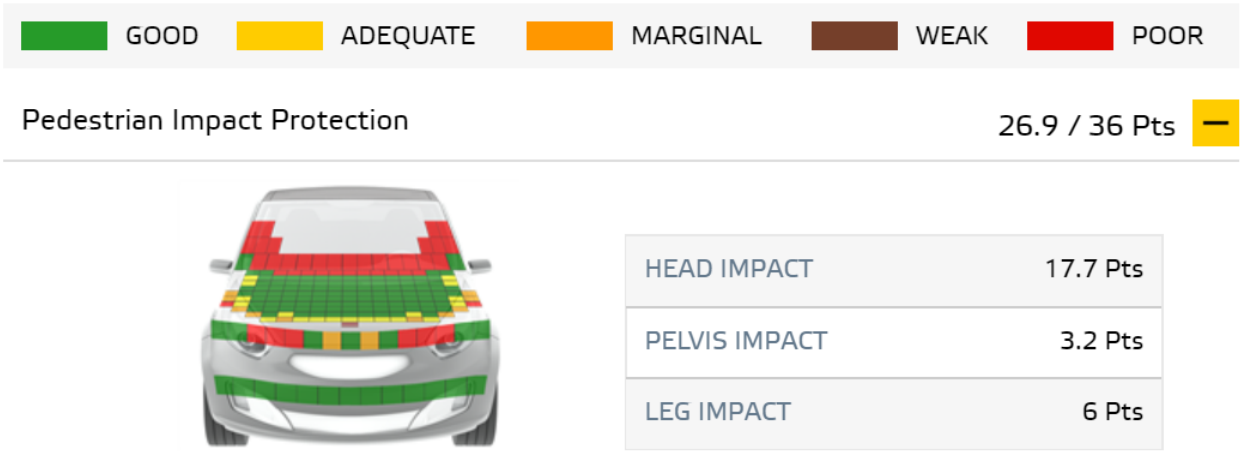
[54] See Insurance Institute for Highway Safety, "Crash Compatibility and Consumer Testing for Safety," 15, available at https://www.iihs.org/frontend/iihs/documents/masterfiledocs.ashx?id=1727; 48 CFR 581.
[55] See also Nuro's response to question 21, below.

There is substantial published evidence that windshield glazing is a leading cause of serious pedestrian injuries. NHTSA's pedestrian crash study found that "windshield glazing contacts are the primary source for both cerebrum and closed head injuries" and the second most common cause of AIS3-AIS6 pedestrian injuries overall, after the front bumper.[56] Pedestrian head trauma is responsible for the most serious of injuries and mortality in vehicle-to-pedestrian collisions, representing 80% of severe injuries and 62% of fatalities.[57] Similarly, an analysis of US and European data found that windshield glazing and wipers are the second most common cause of pedestrian injuries (27% of US cases and 15% of European cases), and that head and face injuries from A-pillar/header contact (features associated with the windshield) are also frequent, occurring in an additional 10% of US cases and 11% of European serious injury cases.[58] This study also found that windshield injuries are particularly likely to be to the head: "More than half of pedestrians with injuries due to windshield and A-pillar/header contact sustained head injuries."[59]

Nuro's R2X design can mitigate risk to pedestrians because the vehicle does not have any human occupants or a human driver, and therefore does not need a windshield or a stiff A-pillar. In passenger cars, a thin A-pillar is required for driver visibility, and therefore the A-pillar must be relatively strong and stiff to protect occupants in a rollover and to hold the windshield in place. While the center of the windshield has some energy absorbing capabilities, it comes at a cost: the A-pillar, and the areas of the windshield near the A-pillar, are amongst the most dangerous areas of the vehicle for a pedestrian, and as described above, are often hit by a pedestrian's head, leading to fatal injuries. Because Nuro's vehicle has no human occupants, the front cap does not need to support any significant mass of the vehicle, and therefore a thin and stiff A-pillar is not required. This is why Nuro is able to create a "crumple zone" design (i.e., outer surface of plastic body panels with clearance between the panels and interior rigid components) that absorbs energy across the entirety of the front cap, rather than just the center (i.e., Nuro's front-cap design is conceptually more similar to the hood in Figure 2 than the windshield).

[56] NHTSA Pedestrian Crash Study, 8. Available at https://www-nrd.nhtsa.dot.gov/pdf/esv/esv17/proceed/00105.pdf.
[57] Costin Untaroiu, Jaeho Shin & Jeff R Crandall, "A design optimization approach of vehicle hood for pedestrian protection," International Journal of Crashworthiness (2007).
[58] Mallory, Fredriksson, Rosén, Donnelly, "Pedestrian Injuries By Source: Serious and Disabling Injuries in US and European Cases," Ann. Adv. Automot. Med. (2012), available at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3503427/.
[59] Id.

Figure 2: Example of Pedestrian Impact Protection on Passenger Car Windshield vs. Hood, Euro NCAP[60]



Clearance between the outer surfaces of body panels[61] and the rigid components beneath ("crumple zones") allows for controlled deceleration of the body in pedestrian collisions. A NHTSA study investigating head impacts and underhood clearance showed that "less underhood clearance resulted in higher HIC" across the vehicles studied.[62] Optimization studies in the literature agree that designs with greater dynamic deformation[63] are more likely to result in HIC_{15} values less than 1000. Nuro is using human body modeling to tune the front cap design to absorb energy properly.

Nuro's focus on pedestrians is warranted by the risk to pedestrians presented by current road vehicles. In 2017, there were 5,977 pedestrian fatalities in the United States.[64] Preliminary data for 2018 points towards a 4% increase in pedestrian fatalities, reaching 6,227, the highest level since 1990.[65] At the same time, SUVs and light trucks, which are 2-3 times more likely to kill pedestrians in a collision than a passenger car,[66] are an increasing share of American vehicles, accounting for 69% of new US vehicle sales in 2018.[67] Nuro's R2X will replace trips by these SUVs, light trucks, and passenger cars with trips by a vehicle optimized for pedestrian protection.

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[60] Red (or "Poor") squares on the windshield indicate $HIC_{15} \geq 1700$. Image available at https://www.euroncap.com/en/results/volvo/s60/34631.
[61] R2X uses plastic materials for its front body panels; the design resembles a windshield in appearance to communicate to other road users which end of the vehicle is the front, but the panel does not contain glass.
[62] Jason Stammen et al., "Pedestrian Head Impact Testing and PCDS Reconstructions" (2001), available at https://www-nrd.nhtsa.dot.gov/pdf/esv/esv17/Proceed/00184.pdf
[63] >60 mm in Untaroiu et al., supra; >76 mm in Mizuno et al., "Pedestrian Headform Impact Tests for Various Vehicle Locations" (2001), available at https://www-nrd.nhtsa.dot.gov/pdf/esv/esv17/proceed/00185.pdf.
[64] NHTSA, "Pedestrian Safety," https://www.nhtsa.gov/road-safety/pedestrian-safety.
[65] Governors Highway Safety Association, "Pedestrian Traffic Fatalities by State: 2018 Preliminary Data" (2019), available at https://www.ghsa.org/sites/default/files/2019-02/FINAL_Pedestrians19.pdf..
[66] NHTSA, "New Car Assessment Program: Request for Comments," 80 Fed. Reg. 78522, 78547 (2015) citing Desapriya, E. et al. "Do light truck vehicles (LTV) impose greater risk of pedestrian injury than passenger cars? A meta-analysis and systematic review." Traffic Injury Prevention, 48-56 (2010).
[67] David Muller, "Light trucks take a record 69% of U.S. market," Automotive News, Jan. 7, 2019, https://www.autonews.com/sales/light-trucks-take-record-69-us-market.

15. Did Nuro provide enough information about its design features to enable the ADS to operate reliably and to minimize safety risks that may occur if the ADS malfunctions or otherwise encounters a driving situation it cannot handle? If not, what should the agency ask to see?

In a human driven vehicle, if the driver becomes unable to operate the vehicle (for example, if they fall asleep), they are at significant risk of crashing. In the R2X, if any of the critical systems fail, the vehicle has several forms of redundancy that enhance the safety performance of the vehicle.

Every critical hardware system in the R2X is redundant. The backup systems (e.g., braking) are deployed in parallel, with direct communication to the perception and autonomy systems, so that if the main system were to fail, the backup system is able to control the vehicle.

The functionality of all critical systems is checked hundreds of times per second. If the vehicle encounters a situation it cannot handle or a hardware or software problem, we use layered fallback strategies, including entering a minimal risk condition.[68] If any system fails, the vehicle will move to a safe state. This might include pulling into the shoulder, pulling to the side of a lane (facilitated by R2X's narrow design), or even, if appropriate, stopping immediately. The response depends on the context (e.g., stopping immediately is less appropriate in an intersection). The redundant onboard computer continually calculates multiple fallback trajectories so that it is able to execute these maneuvers as soon as an issue arises.

In addition, Nuro monitors vehicle systems remotely and can take over operations. Our trained operators can operate the vehicle if its critical systems (including backup systems) are still operating, or pull over safely.[69] For example, if the vehicle encounters a situation that it cannot handle such as closed lanes due to a car accident (an "edge case"), the vehicle can come to a safe stop and notify a remote operator of the issue. The remote operator can control the vehicle and navigate through the situation, and then return the vehicle to autonomous mode. Remote operators' control is enabled through redundant wireless connections and all transmissions are encrypted.

Beyond these specific design features, our system safety approach is designed to anticipate hazards before they occur, including practices such as hazard analysis and Safety of the Intended Functionality (SOTIF).[70]

16. Did Nuro provide enough information on development and testing to support the safety performance of the vehicle? Should more specificity on the types of sensors and their limitations be provided?

Nuro undertakes extensive development and testing to validate the safety performance of the vehicle. We validate the performance of both the self-driving software and the vehicle hardware, following industry best practices and quality assurance principles. Our approach to validating the ADS is rooted in our philosophy that we should avoid exposing the public to harm during the development and testing process. Therefore, we use a several step process, including simulation,

[68] Safety Report at 20-21.
[69] Id. at 21.
[70] See id. at 17.

private-road testing, real-world driving, and accelerated testing. Before deploying unmanned vehicles on public roads, the software must reliably meet our performance requirements in simulation and private-road testing; we also use our self-driving Prius and Leaf vehicles with a safety driver team to verify public roads autonomy capabilities before deploying the unmanned vehicle. Over the last three years, we have conducted extensive simulation, private road, and public road testing with safety drivers in California, Arizona, and Texas. This approach is described in more detail in our Safety Report.[71]

In addition, since the submission of our exemption petition and the publication of our Safety Report, Nuro began small-scale public roads testing with R1, our prototype autonomous, unmanned, low-speed, FMVSS-compliant vehicle in Scottsdale, Arizona. Prior to deployment in delivery service, extensive private and public road testing was performed. R1 was used to complete autonomous deliveries from December 2018 until the recent conclusion of the Arizona pilot. R1 has not been in any collisions.

Recently, we filed a public report with the California Department of Vehicles that covers Nuro's public roads autonomous vehicle testing in California from March 2017 through November 2018.[72] Note, this report only covers a fraction of our total testing, as we have also conducted testing in Arizona and Texas, as well as at our private testing facility. During the initial, early trial phases from March 2017 to November 2017, Nuro completed 8084 autonomous miles in California and from December 2017 to November 2018 24,680 autonomous miles in California. This testing was completed on suburban streets only, with drivers present. Nuro's testing vehicles were not involved in any collisions in California during the reporting period. Further, no Nuro vehicle has been in a collision in any state while operating autonomously.

As noted in the petition, R2X has a variety of sensors. These include 12 cameras, radars, and top-mounted LIDAR. These sensors have distinct capabilities that complement each other, overlapping fields of view, and distinct ranges (e.g., short- and long-range cameras). In addition, R2X is equipped with ultrasonic and audio sensors for near-range detection and redundancy.

The rear visibility standard (FMVSS No. 111) places special emphasis on cameras to provide information on the area behind the vehicle. In addition to the specifications provided in the petition, Nuro has developed an automated camera cleaning solution. Although FMVSS No. 500 contains no requirements to maintain a standard of operational visibility (other than initial durability testing), we have developed a solution that can clean the lenses of all 12 cameras on the vehicle. This solution ensures that the image quality of the cameras is maintained against conditions such as dirt.

17. Did Nuro provide enough information about pedestrian detection and mitigation strategies? Would the R2X be able to sense and respond appropriately around school buses, emergency vehicles, neighborhood construction, etc.? Would the R2X be able to understand traffic laws?

[71] Safety Report at 22-23.
[72] Nuro California Department of Motor Vehicles Autonomous Vehicle Disengagement Report (2018), available at https://www.dmv.ca.gov/portal/wcm/connect/7c622789-e41b-4f05-aac3-1a2e906c7c6a/Nuro.pdf?MOD=AJPERES&CVID=.

Vehicles like R2X use multiple sensors to perceive other road users such as pedestrians or school buses. The models that enable the ADS's perception system are trained on extensive data sets from the public roads experience of autonomous and data collection vehicles. This enables the perception system to improve over time its ability to detect and identify road users.

Nuro's petition, Safety Report, and this comment (see response to questions 14 and 15), describe several ways that Nuro's vehicle mitigates the risk to other road users. These include, for example, reduced speed, reduced mass, narrow design, and pedestrian-protection innovations.

In addition, Nuro mitigates the risk to pedestrians or other road users in a number of ways beyond the vehicle innovations described in the petition. One approach we use is considering safety when choosing the route, for example by choosing routes that minimize travel on roads with dangerous street designs that exposes certain road users like pedestrians vulnerable to excess risk. An advantage of our passengerless design is that no one inside can get impatient or distracted, and therefore we have more of an ability to choose safer routes. However, the most fundamental strategy to mitigate risk is that the ADS's planning function chooses its path down the road and through each intersection to minimize risk to other road users, even if it means arriving at our destination a minute or two later. Nuro's ability to predict which path is safer is enhanced by combining experiences from across our fleet.

Sometimes, Nuro's vehicles will encounter unusual situations like emergency vehicles or construction zones. R2X has audio sensors to enable detection of sounds, such as sirens from emergency vehicles. The ADS has also been tested in hundreds of unusual situations before deployment, and, by operating in multiple distinct environments in California, Arizona, and Texas, the ADS is continually being exposed to new, anomalous situations. If necessary, Nuro has the capability to alert a remote operator of an unusual situation so that they can take control and operate the vehicle. This is discussed in further depth in response to question 22, below.

It is also critical that we follow all state and local laws. This not only protects public safety but ensures our driving behavior is familiar to other road users, appearing as a safe, law-abiding, and conservative driver. One of the advantages of a self-driving vehicle like ours is that it is programmed to never speed or run a red light. To ensure we follow all applicable laws in a jurisdiction, the requirements setting stage of our System Safety approach[73] lays out all the laws for that locality and state, including the rules of the road that all motor vehicles must follow and any regulations specific to self-driving, which we then build into the custom-built, high-definition 3D maps that the ADS uses. This process involves consulting with the Federal Highway Administration's Manual on Uniform Traffic Control Devices (MUTCD) and rules presented in each state's DMV handbook, as well as any applicable municipal regulations. Before beginning to operate self-driving vehicles in an area, we also use human-driven vehicles to map all local road signs and markings so we can always be in compliance with the local speed limit, stop lines, and other rules.[74] The map is constantly validated as vehicles drive, and any changes or issues detected are triaged and repaired promptly. We also are automatically notified of updates to the MUTCD and frequently check for state DMV updates to stay informed on the latest rules of the road, including before entering a new geography.

[73] See Safety Report at 16-17.
[74] See Safety Report at 31.

18. What communication protocols should the R2X follow when faced with unexpected human interactions, such as being pulled over by a police officer or being directed through a construction zone by a road worker?

If R2X were directed to follow instructions by an official such as a police officer or road worker, it would communicate using the same tools as human driven vehicles, such as slowing down, using turn signals, or activating flashers. These controls can be activated by the autonomy system or remote operators.

Nuro has also developed, in collaboration with local and state law enforcement officers in three states, detailed Law Enforcement Interaction Plans.[75] These plans address potential scenarios where Nuro vehicles would need to interact with law enforcement, such as being pulled over by a police officer.

21. Would the pedestrian safety features described in the petition (rounded edges, pedestrian "crumple zones") be effective in the environment in which the R2X would be used? Can the effectiveness of these measures be validated? If so, should NHTSA require Nuro to provide testing data to demonstrate the effectiveness of these measures?

Pedestrian safety features are particularly important in the environments in which R2X will be used, i.e., primarily urban and suburban neighborhoods. R2X will operate primarily in residential neighborhoods and on low-speed roads. In 2017, 80% of pedestrian motor vehicle fatalities occurred in urban areas, accounting for 25% of all fatalities in urban areas (compared to 7% for suburban areas).[76] This is why Nuro has put such focus on pedestrian safety features.[77]

Exempting R2X from the windshield requirements would improve pedestrian safety even in low-speed environments. At 40km/hr (~25mph), pedestrian kinematics simulations show that 78% of head impacts for the 50th percentile male are against the windscreen (windshield).[78] Although head impacts are more likely to be against the windscreen at higher speeds than at lower speeds, the majority of head impacts simulated at speeds of 25mph or below were against the windscreen.[79]

22. Did Nuro's petition provide enough information regarding what types of "trigger" events would require the remote operator to take over? What sorts of events should "trigger" the remote operator to take over? Should these be specifically articulated as a term if the petition is granted? If so, did the petition provide sufficient information for the agency to establish such terms?

Remote operators can monitor and control the R2X vehicle. There are two potential modes of operation for a remote operator: monitoring or responding to a vehicle request.

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[75] See, e.g., Arizona Law Enforcement Interaction Plan, https://images.phoenixnewtimes.com/media/pdf/nuro-law-enforcement-protocol_redacted.pdf
[76] NHTSA Pedestrian Safety Facts 2019, available at https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812681; NHTSA Fatal Motor Vehicle Crashes Overview 2018, available at https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812603.
[77] See response to question 14 and cited research.
[78] Carmen Rodarius et al., "Pedestrian kinematics – A detailed study from the ASPECSS Project," 5 (2013), available at https://www-esv.nhtsa.dot.gov/Proceedings/23/files/23ESV-000410.PDF.
[79] Id.

In the monitoring role, the remote operator observes a vehicle's operations and expected behavior. They have the same responsibilities as a safety driver sitting behind the wheel in a manned autonomous vehicle: they are responsible for maintaining situational awareness of the vehicle's operation and may takeover under the same circumstances, i.e., whenever necessary to maintain safe operation of the vehicle. Nuro interprets this expansively, including scenarios where there is potential for minor situations such as low-speed curb overlaps.

In addition, remote operators may respond to an ADS request for them to take control. There are two principal cases where this arises. First, if the vehicle falls back to a minimal risk condition, a remote operator may take control of the vehicle to move it to a safer position. For example, if the primary steering system were to experience a malfunction, the vehicle will fallback to a minimal risk condition (e.g. pull over to the closest safe location using the parallel (backup) steering system). The remote operator may then operate the vehicle to move to another location to facilitate the response (e.g., an easier location from which to be towed). Second, if the vehicle encounters an edge case (i.e., an infrequently encountered situation that the ADS is not sure how to handle or that requires deviating from typical traffic laws to navigate safely), the vehicle may stop, and then a remote operator will navigate through the situation before returning operational control to the ADS.

Because the situations in which a safety driver may feel it necessary to take control of the vehicle are diverse and require decision making in the moment, we believe establishing a term in response to the petition that lists specific events requiring takeover would not be conducive to safe vehicle operation.

24. Would the various fail-safe protocols described in the petition provide a sufficient level of safety? What criteria/methodology should be used to assess their sufficiency? If the protocols are believed to be sufficient, explain why. If the protocols are not believed to be sufficient, explain why and discuss how the fail-safe protocols could be improved to deal with both expected and unexpected situations and events, so that they would provide a sufficient level of safety?

A detailed explanation of Nuro's approach to fail-safe protocols is available in our Safety Report.[80]

25. Did Nuro provide sufficient information concerning the training of the remote operators? What should be the level of training of remote operators? How should they be trained? How should be they evaluated?

The Remote Control Operator Training program familiarizes Autonomous Vehicle Operators with the remote control system and prepares them for the responsibility of remotely monitoring and piloting a driverless vehicle. The course typically lasts three weeks and may be extended to ensure that Remote Operators have met or exceeded a satisfactory level of understanding and ability.

Before beginning training, Nuro's safety drivers go through an intensive onboarding and training process designed to create a culture and practice of safe vehicle operations. Before they can begin training, we thoroughly screen candidates, including performing a background check on every

[80] "Fallback (Minimal Risk Condition)," Safety Report at 20-21

individual's driving history and completing a safety-focused driving interview with a veteran safety driver who observes the candidate operating a passenger car.

In our training program, we use a variety of methods to ensure each trainee becomes intimately familiar and comfortable with our vehicles, processes, policies, and standards. Throughout the training program, trainees participate in active observation, classroom learning, reading and understanding manuals, and watching videos, but they spend the majority of time operating vehicles under the supervision of veteran safety drivers. They learn about how the technology works, how to ensure the vehicle is ready for testing, and how to safely operate and monitor the systems. Instruction is led by a selected group of veteran safety drivers who are trained with hundreds of hours of self-driving vehicle operations experience. Instructors provide in-person instruction with real-life examples on both common and uncommon scenarios.

Training with vehicles is always conducted under the supervision of a remote operations instructor and with additional backup humans able to take over the vehicle from the trainee if needed (e.g., when testing with a modified passenger vehicle, with a safety driver within the vehicle). The training program is designed to provide realistic experience to the trainee and protect public safety. Training begins first on closed courses on private roads with modified passenger vehicles, and gradually proceeds to limited public roads testing with Nuro's unmanned vehicles (currently, R1). Trainees must pass proficiency exams at each stage before advancing.

Once training is complete, operators must follow all Nuro procedures, and they receive ongoing coaching to continue improving their driving.

27. Nuro states, if it receives the exemptions, it "would take a highly incremental and controlled approach to deployment" which would include extensive evaluation and mapping of any area where the vehicles would be deployed, and that "any early on-road tests would occur with human-manned professional safety drivers with override abilities supervising the vehicle for any anomalies in behavior." Over what portion of the R2X's life would this level of supervision be provided? What would be the circumstances under which Nuro would reduce or eliminate its supervision? Once this initial testing period is over, what is the expected ratio of remote operators to R2Xs, and would this ratio change over time? What would be the human oversight protocol for the R2X once it is past the initial testing stage?

By definition, a Level 4 autonomous vehicle has "sustained and ODD-specific performance by an ADS of the entire DDT [Dynamic Driving Task] and DDT fallback without any expectation that a user will respond to a request to intervene."[81] R2X is designed to be a Level 4 autonomous vehicle,[82] meaning that it is designed to not require immediate human intervention.

When we begin to operate a new vehicle platform or in a new area, we use professional, human safety drivers that are capable of controlling the vehicle, either directly from the driver's seat of the vehicle or, in the case of "unmanned" operation of a vehicle like the R2X where there is no driver's seat inside the vehicle, remotely. We anticipate that over time, the vehicle's autonomous technology will progress so that human monitoring is required for a smaller proportion of time. During the early

[81] SAE International, "SAE J3016: Taxonomy and Definitions for Terms Related to On-Road Motor Vehicle Automated Driving Systems," 19 (Dec. 2018).
[82] Petition at 3, footnote 2.

stages of testing, monitoring is used for a higher proportion of unmanned vehicle operation, and then as the technology's ability to perform without monitoring is validated, the share of time that requires active human monitoring declines.

Rather than establishing a "ratio," where a single remote operator monitors multiple vehicles simultaneously, we anticipate that monitoring will be conditional, where certain road types or conditions will require continuous remote monitoring, whereas other conditions will require remote operation only in response to specific vehicle requests (see response to question 22). As the ADS improves, the number of condition types requiring monitoring will decline.

Before designating certain conditions as not requiring continuous supervision, we undertake a validation process. This process requires validation of certain system capabilities (e.g., ability to request help when needed) as well as validation of the system performance under the specific conditions. Like our overall validation process, this includes simulation based on miles collected in the same area and similar ODD, followed by extensive successful public roads operation under those specific conditions without need for human intervention — first using our manned autonomous vehicle fleet, and then with our unmanned vehicle with remote operator backup. Validation proceeds from simpler conditions (e.g., daytime, good weather, few other road users) to more complex conditions.

28. How frequently should Nuro update its maps for accuracy, especially with regard to the reliability of cellular data? What other information is mapped?

Nuro uses custom-built, high-definition 3D maps to mark road features such as curbs, lane centers and markers, traffic signs and lights, crosswalks, and speed bumps. These maps are much more sophisticated and detailed than the maps on the typical smartphone. The map is constantly validated as vehicles drive, and any changes or issues detected are triaged and repaired promptly.

One of the many safety advantages of a vehicle that is not transporting passengers eager to get to their destination as fast as possible is that we have the option to avoid routes with known areas of poor cellular connectivity. However, maps of cellular data reliability are only one tool among several that we use to avoid an interruption in cellular service. For example, as noted in the petition, we also use redundancy in cellular connections, and tools that provide real time information on cellular connectivity and automatically adjust our protocols.

29. How should Nuro address the issue of the potential effects of cyber threats on safety? In particular, is Nuro's assurance of "end-to-end encryption" sufficient for the agency to grant an exemption? If not, what additional assurances should Nuro provide?

More information on Nuro's approach to cybersecurity is available in our Safety Report.[83] We also note that end-to-end encryption is only one of the cybersecurity features Nuro uses to protect its vehicles.

[83] Safety Report at 26.

Other Public Interest Considerations

31. We seek comment on whether the potential environmental and economic benefits described by Nuro in its petition are sufficient (or sufficiently likely to occur) to enable NHTSA to make a finding that an exemption is in the public interest and is consistent with the Safety Act, per 49 U.S.C. 30113(b)(3)(A).

We believe the environmental and economic benefits cited in our petition are substantial and demonstrate that granting the petition is in the public interest.

R2X, as a zero-emission battery-electric vehicle, will provide environmental benefits by enabling customers to avoid vehicle trips with their personal automobiles, of which more than 98% are powered by an internal combustion engine as of 2017.[84] In addition, R2X has two compartments, each of which is highly customizable and can be further subdivided, giving it the capability to batch multiple orders and reduce the total number of vehicle trips taken. Each replaced or eliminated trip reduces the amount of carbon dioxide, carbon monoxide, hydrocarbons, oxides of nitrogen, and particulate matter emissions in the air. While the initial scale of Nuro's R2X production and deployment will be limited, the information Nuro learns will provide valuable insight into the design, manufacturing, and operation of its future electric vehicles, creating impact at a greater scale over the long term.[85] The deployment of the R2X will also, as described below in response to question 32, provide greater public exposure to electric vehicles and build public acceptance.

Granting R2X's petition would also provide economic benefits. Nuro today employs hundreds of people in the United States, including over 200 employees and 100 contractors (and growing), and supports many other jobs through our automotive and services supply chain. Granting this petition would support these jobs designing, manufacturing, maintaining, and overseeing the R2X vehicles.[86] In addition, we expect that the retailers we partner with will often hire workers to pick-and-pack goods and load the vehicles, and may see increased overall sales. As stores that never had delivery before add this capability due to the availability of autonomous delivery vehicles, and the number of people who can afford goods delivery increases as Nuro makes the service more affordable, the number of retail jobs can be expected to increase.[87]

In addition to the environmental and economic benefits summarized here, R2X introduces several safety innovations that can benefit the public, both by replacing trips by full speed, heavier vehicles during the period of the exemption, and by providing new data and insights that will enable Nuro to continue improving in the future.[88] Further, there are substantial benefits to consumers in saved time from avoiding driving to the store or completing errands and reduced costs for goods delivery.

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[84] International Energy Agency, "Global EV Outlook 2018," https://www.iea.org/gevo2018. Preliminary reports indicate that electric vehicle sales grew substantially in 2018, but remain below 3% of US sales.
[85] See Toyota Motor North America, Inc. 80 Fed. Reg. 101, 103 (January 2, 2015) (granting exemption in part on the grounds that it will "contribute to not only Toyota's development of future FCV models but also the aggregate knowledge of real world use of FCVs.")
[86] Cf., Greenkraft, Inc., supra at 12060 (March 5, 2015) (granting exemption, finding the exemption is in the public interest in part because "Greenkraft is a manufacturer located in California that employs approximately 35 people.")
[87] See generally, Morgan Stanley, North America Insight: Food Delivery: What If All Food Could Be Delivered as Easily as Pizza?, 33-35 (June 14, 2016) (showing that in restaurants, introducing delivery increases total sales by an average of about 15%, on net).
[88] See Petition at 4-6; Safety Report at 9.

32. In particular, we seek comment on whether a petitioner under the low-emission vehicle exemption basis must cite benefits that are directly related to the original purpose of 30113(b)(3)(B)(iii), which was to encourage the development of vehicles with low-emission propulsion technologies.

The structure of § 30113's text indicates that the "public interest" inquiry goes beyond the specific basis on which the exemption is requested. The requirement that the Secretary "make a finding that—(A) an exemption is consistent with the public interest" is a separate subsection from the several possible bases listed under § 30113(b)(3)(B), and applies to petitions made under any exemption category. This reading is consistent with NHTSA precedent, as the Department has previously considered factors such as employment,[89] consumer choice,[90] and driving performance[91] in the public interest inquiry for Category 3 petitions. We encourage NHTSA to consider similar benefits with regards to Nuro's R2X petition as well.[92]

Nonetheless, as recognized by question 32 of NHTSA's notice, Congress's intent in Category 3 was "to encourage the development of vehicles with low-emission propulsion technology,"[93] and the public interest benefits of granting the R2X petition are consistent with that intent. As noted in the petition, Nuro's vehicle is a "vehicle with low-emission propulsion technolog[y]."[94] By producing its low-emission vehicle, Nuro can provide environmental benefits by replacing trips by conventionally-fueled vehicles with trips by a zero-emission R2X, and reducing the total number of trips taken by combining neighbors' orders into a single vehicle.[95] This will help address the "increasing air pollution" that Representative Murphy pointed to as motivating his original amendment.[96] Therefore, granting this petition would advance the purpose of the exemption basis.

In addition to the environmental benefits of the vehicle generally, Nuro's vehicle would also specifically advance the development of low-emission propulsion technology in several ways:

- R2X will draw power from the battery for propulsion, its ADS, and its sensing systems. Understanding the effects of this power draw will help Nuro improve its battery and software

[89] See, e.g., Greenkraft, supra at 12060 (granting exemption); Wheego Electric Cars, Inc., 77 Fed. Reg. 47915, 47917 (August 10, 2012) (granting exemption); Tesla Motors Inc., 76 Fed. Reg. 60124, 60126 (September 28, 2011) (granting exemption).
[90] Id.
[91] See, e.g., Toyota Motor North America, Inc., supra at 103 (granting exemption in part on the grounds of "driving range, refueling time, and cold weather performance advantages")
[92] See response to question 31 and petition at 4-6.
[93] Although question 32 describes the statute's purpose as encouraging low-emission "vehicles," footnote 21 of the notice describes the purpose as referring to encouraging the development of the propulsion system itself, rather than the overall vehicle. The text, history, and intent of the provision is more consistent with the wording of question 32. The plain text of the statute indicates that the purpose of the provision is to "make the development or field evaluation of a low-emission motor vehicle easier." § 30113(b)(3)(B)(iii) (emphasis added). The legislative history is consistent with this interpretation. As Representative Murphy noted in 1968, it is the "electric automobile" that he is seeking to encourage, not electric drivetrain, and "vehicles with low-emission propulsion technologies," not the low-emission propulsion technologies themselves. 114 Cong. Rec. 7285 (1968) (Statement of Rep. Murphy). Likewise, Senator Hartke's statement in 1972 points to encouraging the development of "low-emission vehicles." 118 Cong. Rec. 34209 (1972) (Statement of Sen. Hartke). Representative Murphy explained that the overall intent of the provision was to address "increasing air pollution," which is achieved by increasing the prevalence of electric vehicles. 114 Cong. Rec. 7285 (1968) (Statement of Rep. Murphy).
[94] Petition at 6.
[95] Id. at 3.
[96] 114 Cong. Rec. 7285 (1968) (Statement of Rep. Murphy).

designs, and build future electric vehicles that are optimized for the autonomous delivery use case, increasing their adoption.[97]

- R2X will be one of the first vehicles without human occupants to use an electric drivetrain and battery. This will provide Nuro with the opportunity to understand how this innovation impacts approaches to battery protection, which have historically had to both avoid battery leaks into the passenger compartment as well as outside the vehicle; a passengerless vehicle has the opportunity to prioritize road users outside the vehicle.[98]

- R2X's unique design and new safety technologies will draw public attention to the benefits of electric propulsion technology and build public acceptance, encouraging adoption of other, commercially available electric vehicles amongst consumers and fleet owners.[99] Customers' first interaction with an electric vehicle could be with a R2X, spurred by interest in autonomous vehicle technology or the convenience of the service, as well as the ability to interact with an electric vehicle without having to outlay the capital for a full car purchase. Although electric vehicle sales are increasing in the US, there still remains substantial room for advancement, particularly in consumer awareness, as electric vehicles had a market share of just 1.2% in 2017.[100]

Terms

33. If NHTSA were to grant Nuro's petition, what would be the potential utility of NHTSA's placing terms requiring the submission of . . . data?

Nuro would be pleased to voluntarily provide NHTSA with data to further the objectives of the Safety Act. The sharing of data that Nuro recommends below would represent an unprecedented amount of data sharing on the actual operation and performance of an exempt vehicle, compared to the terms on any prior exemptions that Nuro is aware of. We would welcome the opportunity to discuss further with the Department the specific form and content of this data sharing.

We believe that NHTSA might usefully and appropriately require the submission of data from the testing or operation of R2X if it furthers an objective relevant to the exemption petition. We see three such potential objectives:

1. Ensure that R2X does, in practice, fulfill the safety objectives of the standards from which Nuro seeks exemption.

2. Verify that the claims in Nuro's petition about the intention to generally operate R2X in a low-risk environment bear out in practice.

[97] See, e.g., Tesla Motors Inc., supra at 60126 (granting exemption in part on the grounds that it will "assist [the manufacturer] in optimizing its battery design and vehicle software for future all-electric offerings.")
[98] See, e.g., Toyota Motor North America, Inc., supra at 103 (granting exemption in part on the grounds that it will "contribute to not only Toyota's development of future FCV models but also the aggregate knowledge of real world use of FCVs.")
[99] See, e.g., Greenkraft, Inc., supra at 12060 (granting exemption in part on the grounds that it will "demonstrate to the public the environmental benefits and viability of CNG powered vehicles.")
[100] International Energy Agency, "Global EV Outlook 2018," https://www.iea.org/gevo2018/.

3. Gather information to help develop standards for a new class of light passengerless vehicles, as contemplated by the Department in question 4.

We recommend that Nuro provide data that can directly aid the Department in each of these objectives.

1. Ensuring R2X fulfills safety objectives of exempted standards

The goal of this information is to provide information that the Department can use to evaluate whether particular kinds of crashes relevant to the exempted standards are more or less likely to occur with the R2X compared to other vehicles.

- Statistics on, and summaries of, injury-causing collisions when R2X is moving in reverse: This would enable comparison to other FMVSS 111 compliant vehicles.

- Statistics on, and summaries of, injury-causing pedestrian collisions involving R2X: This would enable assessment of the benefits of Nuro's front-end features designed for pedestrian protection.

- Report on results of rear visibility test procedure as applied with proposed interpretations (one time report): This would verify that R2X meets the field of view requirements of FMVSS 111.

2. Verify low-risk operating environment

The goal of this information is to understand how frequently the environmental factors surrounding R2X's operation that reduce risk are, in practice, present.

- Report the number and percentage of miles that R2X is driven on roads with a posted speed greater than 35mph: This would verify that R2X does not frequently travel with much faster traffic.

- Report number of times that R2X operates in forward or reverse motion with human occupants: Although R2X is not designed for human occupants and Nuro has taken multiple precautions to avoid such misuse, and we therefore expect this to be "zero," it is possible that some users may attempt to contort their bodies and enter the vehicle compartment. By reporting data showing that the vehicle does not operate with human occupants, Nuro would show the effectiveness of the precautions and provide evidence for NHTSA's use in future regulation that demonstrates it is not necessary to apply occupant protection standards to light passengerless vehicles.

3. Inform future regulation

The goal of this information is to help inform the design of a future class of light passengerless vehicles and support the Department's justification for that regulation. In addition to the information recommended above, Nuro would report:

- Number of injury-causing collisions while R2X is operating autonomously and number of autonomous miles driven: This will enable some preliminary assessment of the frequency of collisions with light passengerless vehicles compared to passenger vehicles, as the technology stands today. Note, however, that there will be several limits to this data: it cannot serve as a proxy for autonomous vehicles from other manufacturers; the size of Nuro's deployment is anticipated to be small and may not enable statistically significant conclusions; and Nuro's ADS (including as it will be used with R2X) is continually being tested, validated, and improved.

- Summaries of injury-causing accidents: This information will be perhaps more useful to the Department than the pure statistics, because it can inform what FMVSS would need to be adapted and what risks in particular the Department would need to address in creating a light passengerless vehicle class.

CBI protection

Nuro would be willing to submit this information provided the Department protects it as Confidential Business Information (CBI). Protecting this information would be consistent with the statutory purposes of the CBI authority.[101] The disclosure of this information would be likely to reveal competitively valuable information about Nuro's operational capacities and its approach to testing innovative products, and this information is likely to retain its competitive value (and its potential to inflict substantial competitive harm upon Nuro) for several years. In addition, the disclosure of this information would assist competitors in bringing their own products to market more quickly and at less cost by informing of them of Nuro's operational capabilities and, depending on the detail of collision summaries, the design of its vehicle. If this information were to be denied CBI protection, it could also discourage the most full and open descriptions and dialogue between NHTSA and Nuro, impeding the Department's objectives of learning for the future.

Avoiding terms that could impede safe operation

As the Department considers terms for the exemption, it is critical that these terms avoid restricting Nuro's ability to safely operate or improve the vehicle's ADS. Terms governing the performance or development of the ADS go beyond the scope of this petition for exemption from mirrors, a windshield, and elements of the rear visibility standard, and they would present a risk to public safety. For example, a term that aims to require certain behavior by the vehicle in specified situations could prevent the vehicle from taking the safest path under the circumstances, which will likely be more diverse than the Department anticipates while crafting such a term. Likewise, restrictions on the development or software releases of improvements to the ADS could prevent or delay a safety-critical enhancement. The Department has interpreted the ADS to be the "driver" of the vehicle,[102] and for the same reasons that the Department has never before put terms on an exemption regarding what drivers are allowed to buy a vehicle or how they must drive it, it would not be in the public interest to apply such terms to the R2X.

[101] See 5 U.S.C. § 552(b).
[102] AV 3.0 at iv.

As discussed in response to question 9, the Department may fully address safety performance risks through its long-established defect authority, which the Department has stated is "sufficiently general and flexible" to protect public safety and keep pace with technological innovation such as automated driving systems.[103] This is the most effective means of achieving the Department's objectives related to maintaining public road safety.

35. If the agency were to require the reporting of data, for what period should the agency require it to be reported—the two-year exemption period, the R2X's entire normal service life, or a time period in between?

For the data items listed above, we recommend that data be reported for R2X vehicles for as long as they are owned and operated by Nuro on public roads in the United States. This will provide the most relevant information to the Department for as long as Nuro is able to meaningfully provide it. If after two years Nuro seeks and the Department grants a renewal of the exemption, the Department may wish to revisit this term.

36. Given estimates that vehicles with high and full driving automation would generate terabytes of data per vehicle per day, how should the need for data be appropriately balanced with the burden on manufacturers of providing and maintaining it and the ability of the agency to absorb and use it effectively?

Based on the data elements recommended above, we do not expect the volume of data to be unwieldy (e.g., terabytes per day). These recommendations consider what information would be useful to NHTSA, and to be useful the data must be amenable to meaningful analysis without the Department having to incur significant costs.

To enable analysis that is both timely and meaningful (i.e., based on sufficient data), and to avoid undue burdens on both Nuro and NHTSA, we recommend that data be provided on a quarterly basis.

If different data were to be required, a different time period or reporting mechanism might be appropriate.

Conclusion

We believe that this petition presents the Department with an opportunity to support the advancement of a life-saving technology with substantial environmental and economic benefits. The Nuro R2X would be a limited autonomous vehicle deployment — limited in number of vehicles, low-speed, and without human occupants — but would nonetheless generate valuable information to advance important safety innovation.

Thank you for your consideration of Nuro's petition and these comments. If you have any questions, please do not hesitate to contact us.

[103] NHTSA Enforcement Guidance Bulletin, supra at 65707.

Respectfully,

David Ferguson

President

Nuro, Inc.