

DEPARTMENT OF TRANSPORTATION

National Highway Traffic Safety Administration

[Docket No. NHTSA–2019–0017]

Nuro, Inc.; Grant of Temporary Exemption for a Low-Speed Vehicle With an Automated Driving System

AGENCY: National Highway Traffic Safety Administration (NHTSA), Department of Transportation (DOT).

ACTION: Notice of grant of a petition for a temporary exemption from three provisions of Federal Motor Vehicle Safety Standard (FMVSS) No. 500, “Low-speed vehicles.”

SUMMARY: This notice grants the petition of Nuro, Inc. (Nuro) for a temporary exemption from three requirements of FMVSS No. 500 under two bases: (1) That 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; and (2) that compliance with these requirements would prevent Nuro from selling a motor vehicle with an overall safety level at least equal to the overall safety level of a nonexempt vehicle. The vehicle that Nuro intends to manufacture under this exemption—the “R2X”—is a highly automated, electric, low-speed vehicle (LSV) that lacks seating positions and manual driving controls and is smaller, lower, and narrower than conventional vehicles. The exemption applies to the requirements that an LSV be equipped with exterior and/or interior mirrors; have a windshield that complies with FMVSS No. 205, “Glazing materials”; and a backup camera system that meets the requirement in FMVSS No. 111, “Rear visibility,” limiting the length of time that a rearview image can remain displayed by the system after a vehicle’s transmission has been shifted out of reverse gear.

DATES: Nuro’s petition is granted as of February 11, 2020.

FOR FURTHER INFORMATION CONTACT: Daniel Koblenz, Office of Chief Counsel, Telephone: 202–366–2992, Facsimile: 202–366–3820. The mailing address for this official is: National Highway Traffic Safety Administration, 1200 New Jersey Avenue SE, Washington, DC 20590.

SUPPLEMENTARY INFORMATION:

Table of Contents

- I. Executive Summary
- II. Background
 - a. Statutory Requirements for Temporary Exemption Petitions

- b. Low Speed Vehicles (LSVs) and FMVSS No. 500
 - III. Nuro’s Petition
 - IV. Notice of Receipt
 - V. Selection of Statutory Basis for Analyzing the Merits of the Petition
 - VI. Safety Analysis
 - a. An Exemption From the Requirement That an LSV Be Equipped With Exterior and/or Interior Mirrors Would Not Lower the Safety of the R2X
 - b. An Exemption From the Requirement That an LSV Be Equipped With FMVSS No. 205-Compliant Windshield Would Not Lower the Safety of the R2X
 - c. An Exemption From the Requirement That an LSV’s Backup Camera Meet the “Linger Time” Requirement of FMVSS No. 111 Would Not Lower the Safety of the R2X
 - d. An Exemption From Portions of the FMVSS No. 111 “Field of View and Image Size Test Procedure” and “Image Response Time Test Procedure” Would Not Lower the Safety of the R2X
 - VII. Nuro’s Requests for Exemptions From the LSV Mirror, Windshield, and Backup Camera “Linger Time” Requirements Are Granted Under Both the “Low-Emission Vehicle” (LEV) and “Equivalent Overall Safety” (EOS) Exemption Bases
 - a. Findings Specific to the LEV Basis
 - b. Findings Specific to the EOS Basis
 - c. Granting Nuro’s Petition Is Consistent With the Public Interest and the Vehicle Safety Act
 - VIII. Nuro’s Request for an Exemption From the Backup Camera “Deactivation” Requirement Is Moot
 - IX. Other Issues Raised by Commenters
 - a. Relevance of the Driving Capability of the R2X’s ADS
 - b. ADS-Related Data Reporting
 - c. Compliance With FMVSS Requirements Not Applicable to the R2X
 - d. Cybersecurity
 - e. Engagement With Local Authorities
 - X. Number of Vehicles
 - XI. Terms
 - XII. Conclusion
- Appendix: Terms

I. Executive Summary

This document grants a petition submitted by Nuro Inc. (Nuro) for a temporary exemption of a vehicle from three requirements of FMVSS No. 500, Low-speed vehicles. Nuro’s vehicle, the R2X, is a highly automated (SAE Level 4 or L4), low-speed (25 mph maximum), electric-powered delivery vehicle.¹ According to Nuro, the R2X is designed to carry exclusively cargo and operate without a human driver. Accordingly, the R2X does not have any occupant compartments, designated seating

positions, or manual controls for driving the vehicle.²

Nuro seeks exemptions from various FMVSS that are designed to provide safety benefits for occupants. Since the R2X does not accommodate any occupants, Nuro argues that these FMVSS do not serve their intended functions in the R2X. Accordingly, Nuro has sought exemptions from these requirements. NHTSA has analyzed the request for exemption and is granting them in accordance with its exemption authority under the Vehicle Safety Act and its implementing regulations in part 555.³

Pursuant to the Vehicle Safety Act, NHTSA may grant an exemption from an FMVSS if NHTSA determines that such exemption is consistent with the public interest and the Act, and meets at least one of four additional bases for exemption, described further below.⁴ Nuro applied for its exemption on the basis that it “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.”⁵ NHTSA has determined to grant this petition under this basis. In addition, NHTSA believes that the Vehicle Safety Act provision allowing the agency to grant an exemption when “compliance with the standard would prevent the manufacturer from selling a motor vehicle with an overall safety level at least equal to the overall safety level of nonexempt vehicles”⁶ would also be an appropriate basis for granting the exemption, based on the evidence provided in the application and in public comments, and given NHTSA’s institutional expertise as the federal agency vested with the responsibility for promoting motor vehicle safety.

The three substantive requirements in FMVSS No. 500 from which the agency is granting an exemption are the exterior and/or interior mirror requirement (S5(b)(6)), the windshield requirement (S5(b)(8)), and the backup camera “Linger time” requirement (S5(b)(11)).⁷

² The R2X is equipped with a “remote operation” system through which a remote operator can take over the driving functions of the R2X. Although remote operators presumably input driving commands to the R2X using some sort of manually operated set of controls from an offsite location, NHTSA understands the remote operator system to be a “fallback” safety feature and thus not a primary means of controlling the vehicle.

³ See 49 U.S.C. 30113; 49 CFR part 555.

⁴ 49 U.S.C. 30113.

⁵ 49 U.S.C. 30113(b)(3)(B)(iii).

⁶ 49 U.S.C. 30113(b)(3)(B)(iv).

⁷ This provision requires that LSVs meet all of FMVSS No. 111, S6.2, “Rear visibility.” While exempted R2X vehicles are not required to comply with FMVSS No. 111, S6.2.4, “Linger time,” they are still required to comply with the rest of S6.2.

¹ See SAE International, J3016_201806: Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles (Warrendale: SAE International, 15 June 2018), https://www.sae.org/standards/content/j3016_201806/.

The agency is also granting Nuro an exemption from certain provisions of the backup camera test procedures in FMVSS No. 111 that cannot be performed due to the R2X's unique design.

NHTSA made its decision to grant Nuro's petition after making several statutorily mandated agency findings, including its finding that exempting the R2X from three of the requirements in FMVSS No. 500 would not lower the safety of the R2X as compared to a compliant version of the vehicle—which, as described below, means that this finding is sufficient for the safety determinations required under both the "Low Emission Vehicle" (LEV) and the "equivalent overall safety" (EOS) bases. To examine the effects of the requested exemptions and make this finding, NHTSA compared two nearly identical versions of the same vehicle: A compliant version of the R2X⁸ and an exempt, noncompliant R2X. This approach enabled the agency to make the statutorily required comparisons more concrete and understandable and to simplify and focus its analysis on the requirements from which an exemption is being sought and on the vehicle features that would be directly affected by an exemption.

The question of whether an exemption would lower the safety of an exempt version of the R2X as compared to a compliant version of the vehicle turns on the very limited differences between those two versions of the R2X, which are only that the exempted R2X would not comply with the certain requirements described in this notice. Importantly, under the Vehicle Safety Act, manufacturers are permitted include any design feature they want on a vehicle so long as the vehicle conforms to the FMVSS, and the vehicle does not contain a defect that poses an unreasonable risk to safety. As discussed in more detail below, because NHTSA does not currently have in place FMVSS requirements that regulate Automated Driving System (ADS) driving capability, and NHTSA does not have any basis to believe that it poses an unreasonable risk to safety, no barrier prevents including such a system on a vehicle. Moreover, because LSVs (unlike most vehicle classes) are not required to have human-operated driving and signaling controls, nothing in the

FMVSS prevents a manufacturer from producing an LSV without manual controls that is operated exclusively by an ADS. Given that both an exempted and compliant R2X would have no occupants and would operate without a human driver, compliance with the three requirements from which Nuro seeks an exemption would not provide a safety benefit.

First, the requirement for internal and external mirrors is meant to improve situational visibility for human drivers, who internalize information about the driving environment through direct or reflected line of sight. In a vehicle without manual controls that operates using an ADS, mirrors do not serve a safety purpose because the ADS perceives the driving environment using cameras and sensors that directly feed it information about the vehicle's surroundings. Moreover, because exterior mirrors protrude from the side of the vehicle, they may act as a potential hazard to other road users in certain situations. Second, the requirement for a windshield made of compliant glazing material is meant to protect human occupants from intrusion, ejections, or laceration while ensuring driver visibility. In an occupantless vehicle that operates using an ADS, there are no human occupants for the glazing to protect, and, as we have already noted, visibility through the windshield is not a concern because the ADS obtains information about the driving environment through the use of cameras and sensors. Lastly, the requirement that a rearview camera image cease to be illuminated (*i.e.*, "linger") after shifting from reverse is meant to avoid distraction of the human operator. Without a human driver, there is no risk of distraction. Further, by permitting the backup camera system to remain active in all driving situations, the ADS has more consistent access to information about the area immediately behind the vehicle, which may assist the ADS in performing the driving task.⁹

Based on its engineering expertise and the information available to it, NHTSA finds that exempting the R2X from these three requirements would result in a vehicle that is at least as safe as a compliant version of the R2X. NHTSA has also determined that an exemption would be consistent with the public

interest and the Safety Act because, by allowing for the manufacture and commercial deployment of their desired design vehicle, an exemption would further the development of innovative technologies used in the R2X (most notably, its ADS), which could lead to safety, environmental, and economic benefits to the communities in which the R2X operates, and could eventually lead to benefits for other communities where ADS vehicles are deployed in the future. Moreover, an exemption would further the development and implementation of innovative business models, like Nuro's delivery service, for putting those technologies to use. This determination is consistent not only with NHTSA's exercise of its longstanding safety authority and expertise on motor vehicle issues, but also, with the broad authority that Congress vested in the Secretary of Transportation to grant exemptions in the public interest.

The R2X will be the first ADS vehicle exempted under NHTSA's general exemption authority, and, according to Nuro, will be deployed as part of a commercial operation that will involve frequent interaction with the public. Accordingly, the agency has taken efforts to ensure the vehicles operate in as safe a manner as a non-exempted vehicle. Specifically, NHTSA has determined that it is in the public interest to establish a number of reporting and other terms of deployment of the vehicles that will apply throughout the useful life of these vehicles—violation of which can result in the termination of this exemption. The agency also notes that it retains the full suite of its investigative and enforcement authorities with respect to Nuro's vehicles and operations.

II. Relevant Legal Authority and Regulations

a. Statutory Requirements for Temporary Exemption Petitions

The National Traffic and Motor Vehicle Safety Act (Vehicle Safety Act), codified at Chapter 301 *et seq.*, of title 49, United States Code, provides the Secretary of Transportation with broad authority to exempt motor vehicles from an FMVSS or bumper standard on a temporary basis, under specified circumstances, and on terms the Secretary deems appropriate. This authority is set forth at 49 U.S.C. 30113. The Secretary has delegated the authority for implementing this section to NHTSA.¹⁰

⁸Nuro has already produced a vehicle that appears to be an FMVSS compliant version of the R2X: Its model R1. As noted below, this vehicle has already been deployed for certain delivery services in Arizona. A discussion comparing the R1 and R2X, which includes a side-by-side visual depiction of the two vehicles, is included later in this document.

⁹We note that Nuro also asked for an exemption from the backup camera "Deactivation" requirement (FMVSS No. 111, S6.2.5), and from certain portions of the FMVSS No. 111 test procedures for the "Field of View" and "Size" requirements (FMVSS No. 111, S6.2.1 and S6.2.2). NHTSA has deemed these requests moot for the reasons explained later in the document, so they will not be discussed extensively in the Executive Summary.

¹⁰49 CFR 1.95.

In exercising this authority, NHTSA must look comprehensively at the request for exemption and find that an exemption would be consistent with the public interest and with the objectives of the Vehicle Safety Act.¹¹ In addition, NHTSA must make at least one of the following more-focused findings, which NHTSA commonly refers to as the “basis” for the exemption:

(i) Compliance with the standard[s] [from which exemption is sought] would cause substantial economic hardship to a manufacturer that has tried to comply with the standard[s] in good faith;

(ii) the exemption would make easier the development or field evaluation of a new motor vehicle safety feature providing a safety level at least equal to the safety level of the standard;

(iii) the 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; or

(iv) compliance with the standard would prevent the manufacturer from selling a motor vehicle with an overall safety level at least equal to the overall safety level of nonexempt vehicles.¹²

NHTSA’s procedural regulations implementing these statutory requirements are codified at 49 CFR part 555, “Temporary Exemption from Motor Vehicle Safety and Bumper Standards.”

The statute and implementing regulations provide the Secretary and, as delegated, NHTSA with significant discretion in making these required determinations.¹³ As the expert agency in automotive safety and the interpretation of its existing standards, NHTSA has significant discretion in making the safety findings required under these provisions. Further, the broad authority to determine whether the public interest and general goals of the Vehicle Safety Act will be served by granting the exemption allows the

Secretary to consider many diverse effects of the exemption, including: The overall safety of the transportation system beyond the analysis required in the safety determination; how an exemption will further technological innovation; economic impacts, such as consumer benefits; and environmental effects.

b. Low Speed Vehicles (LSVs) and FMVSS No. 500

NHTSA defines a low-speed vehicle (LSV) as “a motor vehicle, (1) [t]hat is 4-wheeled; (2) [w]hose speed attainable in 1.6 km [kilometers] (1 mile) is more than 32 kilometers per hour (20 miles per hour) and not more than 40 kilometers per hour (25 miles per hour) on a paved level surface, and (3) [w]hose GVWR [gross vehicle weight rating] is less than 1,361 kilograms (3,000 pounds).”¹⁴

Unlike other vehicle categories that must meet a wide array of FMVSSs and other vehicle standards, LSVs are only required to meet a single standard: FMVSS No. 500, “Low-speed vehicles.” Currently, FMVSS No. 500 requires that LSVs be equipped with headlamps, stop lamps, turn signal lamps, taillamps, reflex reflectors, parking brakes, exterior and/or interior mirrors, a windshield constructed from FMVSS No. 205-compliant glazing, seat belts, a vehicle identification number, and a rear visibility system that complies with S6.2 of FMVSS No. 111 (*i.e.*, a backup camera). In addition, all electric LSVs manufactured on or after September 1, 2020 will be required to comply with FMVSS No. 141, “Minimum Sound Requirements for Hybrid and Electric Vehicles.”

NHTSA created the LSV classification and established FMVSS No. 500 in June 1998 in response to safety concerns over the growing use of golf cart-sized, 4-wheeled “Neighborhood Electric Vehicles” (NEVs) on public roads.¹⁵ In developing FMVSS No. 500, NHTSA determined that, given the speed and weight limitations of the LSV classification, and the closed or controlled environments in which LSVs typically operate (usually planned communities and golf courses), there was not a safety need to apply the full range of FMVSS to these vehicles. Moreover, at the time NHTSA was developing the LSV standard, some States had begun to enact laws limiting

where and when speed-limited vehicles like LSVs could operate, and currently most States have enacted legal restrictions on where LSVs can operate.¹⁶ Accordingly, the safety equipment that the agency determined should be required under FMVSS No. 500 is far more limited than what is required for other vehicle categories.

III. Nuro’s Petition

NHTSA received Nuro’s petition for a temporary exemption on October 23, 2018, seeking an exemption from three of the requirements that apply to LSVs: The exterior and/or interior mirror requirement (FMVSS No. 500, S5(b)(6)), the windshield requirement (FMVSS No. 500, S5(b)(8)), and the backup camera “Linger time” and “Deactivation” requirements (FMVSS No. 500, S5(b)(11); FMVSS No. 111, S6.2.4 & S6.2.5). In addition, Nuro requested an exemption from portions of the test procedures in FMVSS No. 111 that relate to the backup camera “Field of view” and “Size” requirements. Nuro submitted its petition under the basis that an exemption would make easier the development or field evaluation of a low-emission vehicle (LEV) and that an exemption would not unreasonably lower the safety of that vehicle. As described in Nuro’s petition, the vehicle for which Nuro requested an exemption, the “R2X,” would be an occupantless, electric LSV that is designed to be operated almost exclusively by an ADS. According to Nuro, the R2X would not be sold, but rather would be operated by Nuro in partnerships with grocery stores and other merchants to autonomously deliver goods to nearby customers.

Nuro argued in its petition that provisions of FMVSS No. 500 from which it is seeking an exemption require the inclusion of safety features that do not serve a safety purpose on the R2X, due to the fact that the R2X is operated by an ADS and does not have any occupants. Moreover, Nuro argued that including these required features would reduce the safety of the R2X. Nuro’s arguments for its three exemption requests are summarized in the table below:

¹⁶ See “Summary of State Speed Laws, Twelfth Edition,” December 2013, DOT HS 811 769, available at https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/summary_state_speed_laws_12th_edition_811769.pdf.

¹¹ 49 U.S.C. 30113(b)(3)(A).

¹² 49 U.S.C. 30113(b)(3)(B).

¹³ *Cf. Geier v. American Honda Motor Co.*, 529 U.S. 861, 883 (2000) (explaining that, in the context of interpreting the Vehicle Safety Act’s preemption provisions, “Congress has delegated to DOT authority to implement the statute; the subject matter is technical; and the relevant history and background are complex and extensive,” and, thus, “[t]he agency is likely to have a thorough understanding of its own regulation and its objectives and is ‘uniquely qualified’ to comprehend the likely impact of state requirements,” concluding that, “[i]n these circumstances, the agency’s own views should make a difference.”) (internal citations omitted).

¹⁴ 49 CFR 571.3.

¹⁵ 63 FR 33194 (June 17, 1998).

Requirement from which an exemption is requested	Safety purpose of the requirement	Nuro's argument for why the safety purpose is not relevant to the R2X	Nuro's argument for why compliance would be detrimental to the safety of the R2X
Exterior Mirrors, <i>FMVSS No. 500, S5(b)(6)</i> .	To provide the driver of the LSV with information about the driving environments to the rear.	The R2X's ADS does not use mirrors to perceive its surroundings for purposes of performing the driving task.	Exterior mirrors increase pedestrian strike risk, and interfere with the R2X's pedestrian safety features such as rounded corners.
Windshield made from FMVSS No. 205-compliant glazing material, <i>FMVSS No. 500 S5(b)(8)</i> .	To prevent the ejection of vehicle occupants, and to ensure forward visibility for the driver.	The R2X does not have occupants who need protection, and the ADS does not require a transparent windshield to perceive the driving environment in front of the vehicle.	FMVSS No. 205-compliant glazing is both heavy and rigid and must be held in place by a rigid frame, and so it would interfere with plans to provide a "front-end safety system, including rounded contouring, softer materials, and a 'crumple zone' on exempted vehicles.
Backup Camera "Linger time" and "Deactivation" requirements, <i>FMVSS No. 500 S5(b)(11); FMVSS No. 111 S6.2.4 & S6.2.5</i> ¹⁷ .	Linger time: To prevent the driver from being distracted by the rearview image when traveling in the forward direction. Deactivation: To allow deactivation of the image either when the driver modifies the view, or the vehicle direction selector is removed from the reverse position.	The R2X's ADS is not a human. It can process the information from all of its cameras simultaneously, regardless of the direction of their aim, without distraction.	Because R2X's ADS uses its rearview cameras during forward motion to gain a comprehensive understanding of its environment and avoid collisions with vehicles or objects approaching from the rear, deactivating the view to these cameras while in forward motion would decrease the vehicle's safety.

In addition, while Nuro stated that the R2X would conform to the backup camera "Field of view" (FOV), "Size," and "Response time" requirements (FMVSS No. 111, S6.2.1, S6.2.2, S6.2.3), Nuro requested an exemption from portions of the test procedures in FMVSS No. 111 related to those requirements, because the design of the R2X precluded those test procedure steps from being executed. Nuro provided an alternative test procedure that it argued would enable NHTSA to verify the R2X's compliance with the FOV and Size requirements through the use of the vehicle's remote operator system. Nuro supported its arguments with the analyses and documentation required under 49 CFR 555.6, which are discussed in our safety analysis below.

Nuro stated in its petition that granting its exemption would be in the public interest and consistent with the Vehicle Safety Act because the R2X incorporates various design features that

enable the ADS to operate reliably, and minimize safety risks that may occur if the ADS malfunctions or otherwise encounters a driving situation it cannot handle. Nuro also argued that enabling it to field test its ADS would lead to downstream environmental improvements and economic productivity.

It is important to note that the most unusual characteristics of the R2X—its lack of occupants and autonomous operation—do not require an exemption to be included on the R2X, as there is nothing in the FMVSSs that preclude Nuro from manufacturing a fully compliant version of the R2X that includes these two novel design features.¹⁸ In fact, within two months of

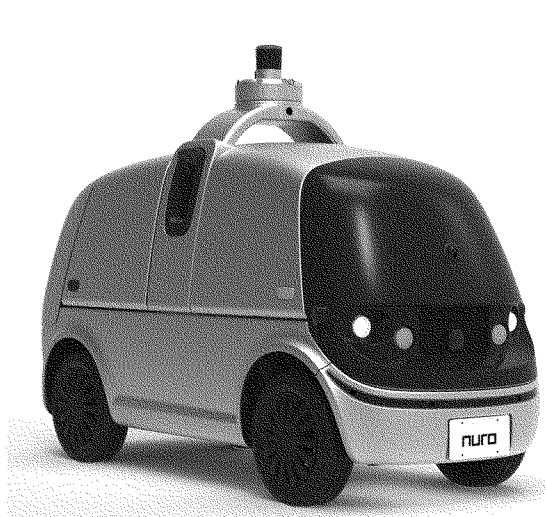
¹⁸ The Vehicle Safety Act provides that, for aspects of vehicle performance that are not covered by an FMVSS, the only Federal restriction on the vehicle's performance is that the vehicle cannot contain a defect that poses an unreasonable risk to safety. Because ADS driving capability is not regulated under the FMVSS, and LSVs are not required to have human-operated driving and signaling controls, no regulatory barrier prevents Nuro from deploying the R2X's ADS on a fully compliant version of the vehicle. Moreover, given Nuro's track record with on-road testing of its ADS systems, NHTSA does not have a basis to believe that the R2X's ADS poses an unreasonable risk to safety.

¹⁷ As is explained later in this document, NHTSA has determined that Nuro's exemption request from the "Deactivation" requirement (FMVSS No. 111, S6.2.5) is moot. Therefore, although this request is discussed in this summary of Nuro's petition, it is not discussed in the agency's safety analysis or findings.

submitting its petition, Nuro began testing on public roads an occupantless, low-speed ADS vehicle that the company states it has certified as FMVSS-compliant. Nuro deployed this vehicle, the "R1," in December 2018 as part of a grocery delivery testing program in partnership with a Kroger location in Scottsdale, Arizona. Based on Nuro's descriptions in its public comment, NHTSA understands the R1 to have been an occupantless, low-speed ADS vehicle that has a very similar design to the R2X, except that the R1 was equipped with exterior mirrors, a windshield constructed out of FMVSS No. 205-compliant glazing, and a backup camera that meets the "Linger time" requirement of FMVSS No. 111, S6.2.4. (See Figures 1 and 2 below for a visual comparison of the R1 and R2X vehicles.) For purposes of NHTSA's analysis of Nuro's petition, NHTSA assumes that a compliant version of the R2X would also differ from an exempted R2X in that the compliant R2X would be equipped with these features. This assumption is reasonable because such equipment is required by law unless subject to an exemption.

Figure 1: Photograph of Production R1

Source: Nuro's Public Comment,
Docket No. NHTSA-2019-0017-0023

Figure 2: Illustration of Prototype R2X

Source: Nuro's Petition for Exemption,
Docket No. NHTSA-2019-0017-0002

IV. Notice of Receipt

NHTSA published its Notice of Receipt of Nuro's exemption petition in the **Federal Register** on March 19, 2019.¹⁹ In addition to summarizing the petition, the Notice of Receipt posed 39 questions for the public on a variety of topics, including the appropriateness of the LEV exemption basis, the safety of the R2X, the performance of the R2X's ADS, whether an exemption would be in the public interest, and potential terms or conditions that NHTSA may impose should the agency grant the petition. Given the novel issues raised by the fact that the R2X is an occupantless ADS vehicle, NHTSA provided the public with a 60-day comment period, instead of the 30 days normally provided for an exemption petition.

In response to the Notice of Receipt, NHTSA received 24 comments from a variety of commenters, including trade associations, individual manufacturers, advocacy groups, and individuals. The trade associations that submitted comments were the Alliance of Automobile Manufacturers (the Alliance), the American Trucking Associations (ATA), the Consumer Technology Association (CTA), the Association for Global Automakers (Global), and the National Society of Professional Engineers (NSPE). NHTSA also received comments from the individual vehicle manufacturer Local Motors. The advocacy groups that submitted comments were the American

Automobile Association (AAA), the American Association of Motor Vehicle Administrators (AAMVA), Advocates for Highway Safety (Advocates), Center for Auto Safety (CAS), DEVCO, and Securing America's Future Energy (SAFE). In addition, NHTSA received comments from Kroger, Inc., the Mercatus Center of George Mason University, the Center for Autonomous Vehicles and Sensor Systems, Edge Case Research, the Mayor of Scottsdale, Arizona, and the Scottsdale, Arizona Chief of Police. In addition, NHTSA received a comment from the petitioner itself. The major points raised by the commenters are briefly summarized below, and are discussed in greater detail in later sections of this document.

The principal comments made by commenters who were generally critical of Nuro's petition were:

- The LEV basis is an inappropriate basis under which to consider Nuro's petition because the purpose of that exemption basis is to encourage the development of low-emission propulsion technologies.
- The petition did not include sufficient information about the ability of the ADS to perform the driving task (especially as compared to a human driver), the R2X's Operational Design Domain (ODD), or the operational details of Nuro's remote operator system.
- The petition did not include documentation demonstrating the efficacy of some of the safety features Nuro describes in the petition, such as pedestrian "crumple zones."

- The petition does not sufficiently address the issue of cybersecurity.

- If NHTSA were to grant the petition, the agency should impose extensive reporting requirements on Nuro that include providing NHTSA and/or the public with information about ADS performance. These reporting requirements should last for the life of the vehicle.

- Nuro should be required to coordinate extensively with local authorities in the communities in which the R2X will operate.

The principal comments made by commenters who were generally favorable to Nuro's petition were:

- The LEV basis is an appropriate exemption basis under which to consider Nuro's petition because the R2X meets the qualifications for being an LEV, and because one benefit of vehicles like the R2X is lower overall emissions.

- The ability of the ADS to perform the driving task should not be considered as part of NHTSA's safety analysis of Nuro's petition, because the compliant version of the R2X against which NHTSA must compare an exempted R2X would also be equipped with an ADS.

- The three requirements from which Nuro sought an exemption do not serve a safety purpose on a vehicle that is operated exclusively by an ADS.

- If NHTSA were to deny the petition, this would effectively require Nuro to equip the R2X with extraneous equipment (*i.e.*, mirrors and glazing material) that could decrease the safety of the vehicle.

¹⁹ 84 FR 10172.

- If NHTSA imposes terms that include mandatory data reporting, it should not be unreasonably broad, and should be limited to the two-year exemption period.

NHTSA also received several comments that were either general discussions of the role of exemptions in the regulation of ADS vehicles, or previously published newspaper articles or academic papers that discuss automated vehicle policy generally. While the policy considerations and issues discussed in these comments are certainly relevant to NHTSA's and the Department's Automated Vehicle policy generally, they are not directly pertinent to the findings that NHTSA must make regarding Nuro's specific petition, and thus are not extensively discussed in this document. However, we note that the agency shares some of the concerns some of the commenters raised about ADS safety, and has conditioned this exemption grant on terms that the agency believes will appropriately mitigate potential risk and ensure the agency can maintain adequate oversight of deployed R2X vehicles.

Following the publication of the Notice of Receipt, at Nuro's written request, NHTSA met with representatives of Nuro on April 11, 2019, at NHTSA headquarters.²⁰ Nuro stated that it requested the meeting to provide the agency with an opportunity to improve the agency's understanding of the R2X's specifications and how it would be used. Nuro offered to participate in a more technical follow-up call, which took place on July 18, 2019. Both of these meetings clarified various operational and technical details about the R2X (e.g., the capacity of the vehicle's propulsion battery), as well as some details about the operation of the vehicle's ADS. The agency did not learn any new information relevant to its evaluation of Nuro's petition. Finally, NHTSA held an additional call with Nuro on August 23, 2019, to request clarification on how Nuro intended to certify that the R2X complies with the portions of FMVSS No. 111 backup camera requirements from which Nuro did not seek an exemption. As Nuro did not seek an exemption for the performance requirements discussed in this call, the information NHTSA learned in this call was not germane to the agency's decision to grant or deny the petition. NHTSA's decision to grant Nuro's petition is based entirely on public

information and views provided in the petition and public comments.²¹

V. Selection of Statutory Basis for Analyzing the Merits of the Petition

NHTSA has determined that it is appropriate to consider Nuro's petition under both the "Low-Emission Vehicle" (LEV) and "Equivalent overall safety" (EOS) exemption bases, and has decided to evaluate Nuro's petition under both bases.

Nuro submitted its petition for an exemption from FMVSS No. 500 under the LEV exemption basis, which authorizes NHTSA to grant an exemption if doing so "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."²² NHTSA also sought comment on whether it would also be appropriate to consider Nuro's petition under the "new safety feature" ("NSF")²³ or "equivalent overall safety" ("EOS")²⁴ exemption bases.²⁵ The key substantive difference between the LEV basis and these other two bases is that LEV basis would allow for the deployment of a vehicle that lowers safety, so long as that lowering is not unreasonable.

NHTSA received comments on the appropriateness of the LEV exemption basis from AAMVA, Advocates, Global, and SAFE. AAMVA and Advocates both argued that the LEV exemption basis may not be appropriate despite the R2X's LEV status because the specific requirements from which Nuro requested an exemption are unrelated to the R2X's electric propulsion system. According to AAMVA, the NSF basis would be preferable because the design features that are the subject of the exemption relate to the removal of the driver (although AAMVA does not explain why this makes the NSF basis preferable over EOS).²⁶ Advocates did not express a view on what an appropriate basis would be, but did express concern that the LEV basis would allow for lowering the level of safety of the exempted vehicle, even if NHTSA did not find such a lowering to be unreasonable.²⁷

Conversely, Global²⁸ and SAFE²⁹ argued that the LEV basis is appropriate

for Nuro because vehicles like the R2X could potentially reduce emissions by reducing the number of trips made in conventional (i.e., internal combustion engine) vehicles, and by performing the driving task more efficiently. In addition, SAFE notes that NHTSA has previously granted petitions on the LEV basis for exemptions that are not directly related to the development of a new low-emission propulsion system, and that the petitioners in those cases argued that their primary purpose for seeking an exemption was either the development of low-emission propulsion technologies³⁰ or to allow a vehicle with a new low-emission propulsion technology to be brought to market more quickly or cheaply.³¹

First, NHTSA has determined that the LEV basis is appropriate for Nuro's petition. Based upon its interpretation of both the Vehicle Safety Act and part 555, and consistent with prior agency grants of exemption petitions, NHTSA has determined to grant the petition under the LEV basis. The Vehicle Safety Act requires that NHTSA find that the exemption is in the public interest and consistent with the Vehicle Safety Act and (1) that the vehicle is an LEV, (2) that an exemption would make easier the development or field evaluation of the vehicle, and (3) that an exemption would not unreasonably lower the safety of the vehicle. It does not state that NHTSA must find a nexus between the exemption and the LEV status of the exempted vehicle.³² Further, part 555 also does not explicitly require this nexus.³³ The agency notes that not

³⁰ E.g., Toyota Motor North America, Inc.; Grant of Petition for Temporary Exemption from an Electrical Safety Requirement of FMVSS No. 305, 80 FR 101.

³¹ E.g., Greenkraft Inc.; Grant of Application for a Temporary Exemption from FMVSS No. 108, 80 FR 12057.

³² We note, however, that it is within NHTSA's discretion to determine what constitutes an "unreasonable" lowering of vehicle safety. While NHTSA does not need to make this determination here because we have found no decrease in safety, the innovativeness and emission-reducing potential of the low emission technology in the vehicle may be a factor in considering whether any lowering of safety is reasonable or not, as a more innovative technology may have greater environmental benefits than a more established technology. On the other hand, established technologies that have been mass produced for years and have widespread availability, such as those underpinning battery electric vehicles, cannot reasonably justify much, if any, lessening of safety.

³³ The agency acknowledges that part 555.2 explains that the purpose of the exemption process is to "provide a means by which manufacturers of motor vehicles may obtain temporary exemptions . . . on the basis of . . . facilitation of the development of . . . low-emission engine features," and that one of the required submissions demonstrating safety under part 555.6(2)(i) is, "[a] detailed description of how the motor vehicle

²¹ These discussions are described in a memorandum that can be found in the docket indicated in the header of this notice.

²² 49 U.S.C. 30113(b)(3)(B)(iii)

²³ 49 U.S.C. 30113(b)(3)(B)(ii)

²⁴ 49 U.S.C. 30113(b)(3)(B)(iv)

²⁵ See Notice of Receipt, Question 3.

²⁶ See NHTSA–2019–0017–0025.

²⁷ See NHTSA–2019–0017–0026.

²⁸ See NHTSA–2019–0017–0022.

²⁹ See NHTSA–2019–0017–0016.

²⁰ NHTSA's regulations entitle any interested person to, upon written request to the agency, appear informally before an appropriate official to discuss an exemption petition or an action taken in response to a petition. See 49 CFR 555.7(c).

requiring a nexus actually incentivizes that more vehicles with advanced technologies be designed with low emission technologies, even off the shelf technologies, which furthers the overarching goal of allowing more LEVs on the roads. Finally, granting an exemption under this basis is consistent with the agency's past practice in its earlier grants to both Toyota and Greenkraft, as cited by SAFE.

We also agree with AAMVA and Advocates that, since innovation related to safety and mobility is the central focus of Nuro's petition, the agency may also consider the petition under the EOS or NSF ground. Nuro, in its comments, expressed openness to being considered under the EOS basis instead of the LEV, though Nuro did not amend its application as part of these comments.³⁴ For these reasons, we have considered whether the petition should also be granted under the NSF or EOS bases.

As between the NSF and EOS bases, NHTSA has determined that the EOS basis is more appropriate than the NSF basis here. Although it is possible that an exemption could make easier the development or field testing of a new (*i.e.*, innovative) safety feature, either the R2X's ADS or one of the other features described in the application (*e.g.*, the pedestrian crash protection systems), those technologies are not intended to provide a level of safety equivalence compliance with FMVSS No. 500, which does not contemplate ADS driving competence or pedestrian safety. Rather, those features are intended to improve the safety of aspects of performance that are not regulated under FMVSS No. 500. Because the NSF basis limits the scope of the agency's safety analysis to how an exemption would impact safety solely in terms of performance under an individual standard, whereas the EOS basis allows NHTSA to consider aspects of a vehicle's safety performance, the EOS basis would allow the agency to weigh broader considerations of safety that may not be captured at the individual standard level.

equipped with the low-emission engine would, if exempted, differ from one that complies with the standard." NHTSA, though, does not believe that either of the provisions require a nexus, but simply reflect a general purpose of the requirement and information that should be submitted if relevant. In all events, the language of the governing statute controls, as discussed above.

³⁴ See NHTSA-2019-0017-0023. On page 3, Nuro states: "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."

For these reasons, NHTSA has decided to evaluate Nuro's petition under both the LEV and EOS exemption bases.

VI. Safety Analysis

In order to make the statutorily required safety findings to grant an exemption under either the LEV or EOS basis, NHTSA must first determine whether the level of safety of an exempted vehicle would be lower than that of a compliant vehicle. If, based on this analysis, NHTSA finds that an exemption would not lower overall safety of the vehicle, NHTSA is permitted to grant the petition under both exemption bases. Thus, if NHTSA determines that an exemption would not lower the safety of the vehicle (which would obviate the need under the LEV basis to make the second finding of whether safety is unreasonably lowered), the entire safety analysis under the EOS and LEV bases would be identical. NHTSA's analysis would only diverge under the two bases if NHTSA finds that safety would be lowered, in which case the agency must deny the petition under the EOS basis, and may only grant the petition under the LEV basis upon finding that an exemption would not *unreasonably* lower the safety of the vehicle.³⁵

Because the mirror, windshield, and backup camera "Linger time" requirements are discrete aspects of vehicle performance, we discuss them individually in separate subsections below. Note that, because NHTSA has deemed moot Nuro's request for exemptions from the backup camera "Deactivation" requirement, it is not included in our safety analysis. Rather, the reasons we deemed this request moot are explained in a later section.

a. An Exemption From the Requirement That an LSV be Equipped With Exterior and/or Interior Mirrors Would Not Lower the Safety of the R2X

NHTSA has determined that an exemption from the requirement that LSVs be equipped with exterior and/or interior mirrors would not lower the safety of the R2X, and in fact may incrementally increase the safety of the R2X, because mirrors would not serve a safety-related purpose on an occupantless LSV operated by an ADS, and the presence of protruding exterior

³⁵ We note that NHTSA has determined that the other two findings NHTSA must make for both bases as part of its evaluation of Nuro's petition—whether granting the exemption would be in the public interest and consistent with the Vehicle Safety Act—are identical regardless of the exemption basis. As these are not safety findings, they are not discussed in this section.

mirrors on such a vehicle may increase strike risk for pedestrians and other vulnerable road users.

FMVSS No. 500, S5(b)(6) requires that LSVs be equipped with an "exterior mirror mounted on the driver's side of the vehicle and either an exterior mirror mounted on the passenger's side of the vehicle or an interior mirror." Nuro argued in its petition and its public comment that, because the safety purpose of these mirrors is to enable a human driver to observe objects to the rear of the vehicle, the mirror serves no safety function on the R2X. First, according to Nuro, the ADS uses an array of sensors to detect objects behind the vehicle. Moreover, Nuro states that mirrors serve no auxiliary safety purpose for people outside of the vehicle, and their omission reduces the risk of striking pedestrians and lowers the mass of the vehicle.

Commenters who discussed the mirror requirement agreed with Nuro that exterior mirrors did not serve a safety function on the R2X. The Alliance,³⁶ Local Motors,³⁷ and the Scottsdale, Arizona Chief of Police³⁸ all state that the three safety features for which Nuro has requested an exemption do not serve a functional purpose on an ADS vehicle like the R2X. CTA stated in its comment that if NHTSA were to deny Nuro's exemption, the agency would effectively require Nuro to add what CTA terms "extraneous equipment" that would likely raise the risk and severity of a pedestrian strike.³⁹

NHTSA agrees with Nuro and the commenters that that mirrors do not serve a safety function on a vehicle with no occupants that is operated by an L4 ADS, since the ADS perceives the driving environment using a suite of sensors that do not rely on the mirrors. Further, NHTSA has concluded that the fact that the mirrors protrude from the vehicle means that they could potentially increase the risk of injury to pedestrians or cyclists, however incrementally and thus concurs with Nuro's assertion in the petition about this potential benefit.⁴⁰ Moreover, we note that ancillary benefits that mirrors provide, such as providing a warning to

³⁶ See NHTSA-2019-0017-0020.

³⁷ See NHTSA-2019-0017-0017.

³⁸ See NHTSA-2019-0017-0019.

³⁹ See NHTSA-2019-0017-0015.

⁴⁰ Although the mirrors on LSVs are not required to meet the performance criteria in FMVSS No. 111, NHTSA implicitly acknowledges through that standard that outside mirrors do present some level of safety hazard to pedestrians, because the standard requires that outside mirrors be free of "sharp points or edges that could contribute to pedestrian injury." FMVSS No. 111, S5.2.1. We see no reason why outside mirrors on LSVs would not also present a pedestrian strike risk.

vehicle occupants about hazards (such as approaching cyclists) when opening the vehicle door, are not a concern in a vehicle with no occupants. Therefore, the removal of said mirrors would, at worst, have no impact on the overall level of safety of the vehicle.

b. An Exemption From the Requirement That an LSV be Equipped With FMVSS No. 205-Compliant Windshield Would Not Lower the Safety of the R2X

NHTSA has determined that an exemption from the requirement that LSVs be equipped with a windshield constructed from FMVSS No. 205-compliant glazing materials would not lower the safety of the R2X because a compliant windshield would not serve a safety-related purpose on an occupantless LSV operated by an ADS, due to the fact that a windshield is not necessary to assure (human) driver visibility, nor is it needed to protect occupants in a crash.

FMVSS No. 500, S5(b)(8) requires that LSVs be equipped with “a windshield that conforms to the Federal motor vehicle safety standard on glazing materials (49 CFR 571.205).” FMVSS No. 205, “Glazing materials,” is an equipment standard for glazing materials (*i.e.*, glass) used in vehicles to both ensure driver visibility and to minimize the risk of occupants being ejected from the vehicle in a crash. In its petition, Nuro argued that an FMVSS No. 205-compliant windshield would not serve a safety need on the R2X because (1) the R2X would not have occupants, so there is no risk that human occupants could be injured by an impact with glazing or ejected from the R2X, and (2) the R2X uses an ADS to perform the driving task, which does not require a transparent windshield to observe the driving environment. Nuro further argued that removing the windshield would, in fact, improve the safety of the R2X because a windshield constructed out of FMVSS No. 205-compliant glazing could injure pedestrians in a collision due to its rigidity (if the glazing does not break), or due to the harm that could result should the glazing shatter. Nuro also argues that equipping the R2X with a compliant windshield would interfere with the operation of the R2X’s pedestrian “crumple zones,” which are designed to reduce pedestrian injuries in a crash, because equipping the R2X with a compliant windshield would necessitate a more rigid design. Nuro notes that, while the R2X would not be equipped with a windshield, the front of the vehicle will be equipped with a “plate” that resembles the appearance of

a windshield but is not constructed out of compliant glazing, and which deforms to provide pedestrian/cyclist protection in case of a crash. Nuro stated that this “plate” will serve the windshield ancillary safety function of providing other road users with a visual cue for the front of the vehicle (and thus, its direction of movement).

Commenters generally did not dispute Nuro’s argument that an FMVSS No. 205-compliant windshield would not serve a safety purpose on a vehicle without occupants. The Alliance⁴¹ and Local Motors⁴² explicitly agreed with Nuro’s analysis that a windshield would not serve a safety purpose, and CTA stated that, if NHTSA were to deny Nuro’s exemption, it would effectively require Nuro to add what CTA terms “extraneous equipment” that would likely raise the risk and severity of a pedestrian strike.⁴³ While Advocates⁴⁴ and AAMVA⁴⁵ did not dispute Nuro’s argument that a windshield was not necessary, they expressed concern that Nuro did not provide sufficient information to assess the effectiveness of the R2X’s pedestrian “crumple zones” and rounded edges for mitigating pedestrian injuries (though it should be noted that FMVSS No. 500 does not contain performance requirements for pedestrian injury mitigation).⁴⁶ The Alliance noted that front-end stiffness of LSVs is not regulated under FMVSS No. 500.

In its comment, Nuro explained further why it believes that not equipping the R2X with an FMVSS No. 205-compliant windshield will increase the safety of the R2X.⁴⁷ According to Nuro, the R2X would require very sturdy A-pillars to support the weight of an FMVSS No. 205-compliant windshield, which make it necessary that the front outboard corners of the vehicle (which would support the windshield) be rigid. Thus, an R2X that complies with the windshield requirement could not incorporate the front-end pedestrian “crumple zone” crash mitigation feature described in its

petition. Nuro states that, if exempted, the R2X’s A-pillars would not need to support as much weight, so they could be designed to be deformable in a crash, which would allow the front end of the vehicle to absorb impact energy at the sides as well as in the center. In addition, Nuro states that the R2X voluntarily complies with both FMVSS No. 305, “Electric-powered vehicles: electrolyte spillage and electrical shock protection,” (49 CFR 571.305)⁴⁸ and the Bumper Standard (49 CFR part 581).

NHTSA has concluded that an exemption from the windshield requirement would not lower the level of safety of the R2X because the safety concerns that the windshield addresses—protecting occupants from ejection and intrusion, and ensuring occupants (particularly a human driver) can see the driving environment—are not present in the R2X, due to its lack of occupants and its operation by an ADS that relies on cameras and sensors instead of a human driver.⁴⁹ Accordingly, not equipping the R2X with a compliant windshield would, at a minimum, have no net safety impact on the R2X. We note that NHTSA’s determination that an exemption from the windshield requirement would not lower the safety of the R2X does not rely on the effectiveness of its pedestrian “crumple zones” or other safety features because, as Advocates and others have noted, Nuro has not provided documentation to support the effectiveness of these features. While NHTSA encourages manufacturers to include additional safety features that are not required under the FMVSS, the lack of data to support the effectiveness of these features precludes the agency from considering the safety impact of these features in its safety finding.

⁴⁸ FMVSS No. 305 requires that electric vehicles meet certain requirements relating to electrical safety after multiple types of barrier crashes that the standard requires to be conducted at speeds that exceed 25 mph, the maximum speed for an LSV. See, *e.g.*, FMVSS No. 305, S6.1. However, these barrier crashes are typically performed using a tow cable to propel the vehicle (as opposed to the vehicle’s own propulsion system), so it would be possible to run these tests on an LSV like the R2X. We note that Nuro does not state whether “compliance” with FMVSS No. 305 means that the R2X would meet the standard’s performance criteria after being crashed at the R2X’s maximum speed of 25 mph, or after being crashed at the higher speeds articulated in the standard’s test procedures.

⁴⁹ We assume that Nuro has designed the R2X so that the sensors used by the ADS are not obstructed by whatever material is used to cover the front of the vehicle in place of FMVSS No. 205-compliant glazing.

⁴¹ See NHTSA–2019–0017–0020.

⁴² See NHTSA–2019–0017–0017.

⁴³ See NHTSA–2019–0017–0015.

⁴⁴ See NHTSA–2019–0017–0026.

⁴⁵ See NHTSA–2019–0017–0025.

⁴⁶ AAMVA also raised the concern that NHTSA should ensure that the material used for the front end of the R2X would keep cargo from being ejected in a crash at least as well as an FMVSS No. 205-compliant windshield. However, NHTSA notes that the R2X does not appear to be designed in such a way that a windshield would be the only, or even the primary, barrier separating the cargo compartments from the outside. See NHTSA–2019–0017–0023.

⁴⁷ See NHTSA–2019–0017–0023.

c. An Exemption From the Requirement That an LSV's Backup Camera Meet the "Linger Time" Requirement of FMVSS No. 111 Would Not Lower the Safety of the R2X

NHTSA has determined that an exemption from backup camera "Linger time" requirement (FMVSS No. 111, S6.2.4) would not lower the safety of the R2X because the safety concern underlying the linger time requirement—driver distraction—does not exist for an occupantless LSV operated by an ADS.

FMVSS No. 500, S5(b)(11) states that LSVs "shall comply with the rear visibility requirements specified in paragraphs S6.2 of FMVSS No. 111." One of the requirements that falls under FMVSS No. 111, S6.2.4, limits the duration of the system's "Linger time," which is the period in which a rearview image continues to be displayed by the backup camera system after the vehicle's transmission has been shifted out of reverse gear. Per S6.2.4, the rearview image produced by the backup camera system "shall not be displayed after the backing event has ended." NHTSA explained in the final rule establishing the backup camera requirement that the safety justification for the linger time restriction was the possibility that a driver would be distracted by a rearview image.⁵⁰ FMVSS No. 111, S6.2.4 currently requires that the "Linger time" period end at the end of the "backing event."⁵¹

In its petition, Nuro argued that the "Linger time" requirement does not serve a safety purpose on the R2X because the safety risk it is intended to mitigate against—the possibility that a human driver would be distracted by the rear visibility image when traveling in the forward direction—is not a concern for the R2X, since the R2X uses an ADS that is not susceptible to distraction. Nuro further argues that an exemption from the "Linger time" requirement would, in fact, improve the safety of the R2X, as it would eliminate a condition in which the R2X's rear-facing camera and sensors shut off, which Nuro says has the effect of partially blinding the ADS.

NHTSA agrees with Nuro that distraction is unlikely to be a concern for the R2X's ADS, which is not a human and thus would not be

susceptible to cognitive distraction.⁵² And we see no reason why permitting the ADS to use an additional source of information about the driving environment would reduce the safety of the R2X.

d. An Exemption From Portions of the FMVSS No. 111 "Field of View and Image Size Test Procedure" and "Image Response Time Test Procedure" Would Not Lower the Safety of the R2X

NHTSA has determined that an exemption from the provisions in the FMVSS No. 111 "Field of view and image size test procedure" relating to fuel tank loading (S14.1.2.2), driver's seating position (S14.1.2.5), and steering wheel adjustment (S14.1.7); and an exemption from the provisions of the FMVSS No. 111 "Image response time test procedure" relating to the driver's door and activation of the starting system (S14.2(a)–(c)); would not lower the safety of the R2X because the R2X's backup camera would still be required to produce a rearview image that meets the substantive performance requirements for "Field of view" (S6.2.1), "Size" (S6.2.2), and "Response time" (S6.2.3).

While Nuro states in its petition that the R2X meets these substantive requirements—and thus meets the minimum level of performance established by the standard—Nuro requested an exemption based on language in a 2016 Chief Counsel's interpretation letter issued to Google in 2016.⁵³ Nuro cited and quoted language from NHTSA's letter to Google in making this request for an exemption. Nuro stated: "Previously, the Department has interpreted 'driver' and 'operator' in FMVSS No. 111 as referring to the self-driving system in cases of autonomous vehicles. However, in its letter to Google, the Department noted the need for a testing procedure to satisfy itself that the images provided to the self-driving system meet the requirements for field of view, image size, timing, and durability."⁵⁴

In its discussion of FMVSS test procedures, NHTSA's letter to Google explained: "As self-driving technology moves beyond what was envisioned at the time when standards were issued,

NHTSA may not be able to use the same kinds of test procedures for determining compliance."⁵⁵ The letter explained that "since the [Vehicle] Safety Act creates a self-certification system for compliance, NHTSA's verification of a manufacturer's compliance . . . is based on our established test procedures."⁵⁶ Although the letter recognized that test procedures are for NHTSA's use in compliance testing, the letter also stated that "in order for NHTSA to interpret a standard as allowing certification of compliance by a vehicle manufacturer, NHTSA must first have a test procedure or other means of verifying such compliance."⁵⁷ To enable Google to certify its vehicles in the absence of appropriate test procedures, the agency suggested that Google may seek exemptions, as Nuro noted in its petition.⁵⁸

NHTSA notes that the 2016 interpretation letter to Google diverged, without explanation, from NHTSA's longstanding position that manufacturers are not required to certify compliance based on NHTSA's FMVSS test procedures.⁵⁹ While beyond the

⁵⁵ Letter from P. Hemmersbaugh, NHTSA, to C. Urmson, Google (Feb. 4, 2016), <https://www.nhtsa.gov/interpretations/google-compiled-response-12-nov-15-interp-request-4-feb-16-final>.

⁵⁶ *Id.*

⁵⁷ *Id.*

⁵⁸ See NHTSA–2019–0017–0002, at 13.

⁵⁹ NHTSA has expressed this concept in both rulemaking and letters of interpretation going back several decades. See, e.g., 76 FR 15902, 15905 & 08 (Mar. 22, 2011) (explaining that "manufacturers are not required to test their products in the manner specified in the relevant safety standard, or even to test the product at all, as their basis for certifying that the product complies with all relevant standards. A manufacturer may evaluate its products in various ways to determine whether the vehicle or equipment will comply with the safety standards and to provide a basis for its certification of compliance. Depending on the circumstances, the manufacturer may be able to base its certification on actual testing (according to the procedure specified in the standard or some other procedure), computer simulation, engineering analysis, technical judgment or other means . . . manufacturers can use their judgment, including engineering or technical judgment, to certify vehicles. Testing, as provided in the FMVSS, is not required as a matter of law to certify a vehicle. Instead, sound judgment may be used.") (footnote omitted); 36 FR 5856 (Mar. 30, 1971) ("Manufacturers have the responsibility of ensuring, by any methods that constitute due care, that their products meet the requirements at the stated level. Normally this is done by setting their own test conditions slightly on the 'adverse side' of the stated level."); Letter from A. Cooke, NHTSA, to K. Manke, Dakota Manufacturing (Apr. 15, 2008), <https://isearch.nhtsa.gov/files/07-005971as%20underride%20guards.htm> ("Keep in mind that the test procedures in FMVSS No. 223 describe how NHTSA will test guards for compliance with the standard's requirements, and are not binding upon guard manufacturers. A manufacturer is not required to use the standard's procedures when certifying compliance with the standard."); Letter from E. Jones, NHTSA, to D. Cole, Nat'l Van Conversion Ass'n, Inc. (Nov. 1,

⁵⁰ 79 FR 19177, 19219.

⁵¹ FMVSS No. 111 defines the "backing event" as an amount of time which starts when the vehicle's direction selector is placed in reverse, and ends at the manufacturer's choosing, when the vehicle forward motion reaches: (a) A speed of 10 mph, (b) a distance of 10 meters traveled, or (c) a continuous duration of 10 seconds, whichever the manufacturer chooses. FMVSS No. 111, S4.

⁵² The specific distraction that we discussed in the backup camera final rule—the prolonged illumination of the required image at night—would not be an issue for the R2X, since the ADS does not rely on an illuminated display to perceive the rearview image.

⁵³ See Letter from P. Hemmersbaugh, NHTSA, to C. Urmson, Google (Feb. 4, 2016), <https://www.nhtsa.gov/interpretations/google-compiled-response-12-nov-15-interp-request-4-feb-16-final>.

⁵⁴ See NHTSA–2019–0017–0002, at 17 (footnote omitted).

scope of this notice, NHTSA intends to clarify the application of test procedures in a subsequent notice.⁶⁰ However, prior to revisiting this issue, NHTSA is considering Nuro's request for an exemption from provisions of the test procedures on its merits.⁶¹

Nuro notes that the R2X is an electric vehicle and does not have a gas tank that can be fully loaded with fuel—an express requirement of the FMVSS No. 111 test procedures—and, pursuant to the Google interpretation described above, is therefore incapable of being certified as compliant with the standard.

Similarly, because of the R2X's occupantless design and exclusive ADS operation, the vehicle is not equipped with a driver's seat or a display screen,

which means that NHTSA is not able to independently verify this compliance using the test procedures in FMVSS No. 111.⁶² An exemption from the test procedure provisions that require manual operation by a human driver to execute would not permit Nuro to equip the R2X with a backup camera system that, if installed on a conventional vehicle, would produce a rearview image that fails to comply with FMVSS No. 111; rather, it permits Nuro to certify the R2X's rearview image, which is transmitted directly to the R2X's ADS during normal operation, would be able to meet the substantive requirements for field of view, size, and response time if it were displayed on a screen in a

conventional vehicle. Put another way: An exemption from the test procedures would not, in any way, permit Nuro to equip the R2X with a subpar backup camera system; rather it enables Nuro to demonstrate that the R2X's backup camera system transmits to the ADS the visual information that would be needed to meet the minimum performance criteria in FMVSS No. 111, even if the test procedures in FMVSS No. 111 cannot be performed using the R2X.

As part of its exemption request, Nuro provided suggestions for how NHTSA could modify the FMVSS No. 111 test procedures to accommodate the R2X's unique design:

Required test condition	Reason it cannot be performed	Nuro's suggested modification
S14.1.2.2, "Fuel tank loading"	The R2X is an electric vehicle that runs on a charge in a battery, not on fuel in a fuel tank.	Conduct the test with the battery at full charge capacity.
S14.1.2.5, "Driver's seat positioning"	The R2X has no driver's seat, or designated seating position of any kind.	Treat a remote operator's seat as the driver's seating position.
S14.7, "Steering wheel adjustment"	The R2X has no steering wheel	Conduct the test with the wheels pointed in the forward direction, as would be consistent with the test state in the standard.
S14.2, "Image response time test procedure" ..	The R2X has no driver's door to open or close	Perform the test procedure using the cargo compartment doors, which are the primary method for accessing the interior of the R2X.

Given the design differences between the R2X and a typical LSV, NHTSA has determined that Nuro's proposed modifications to the FMVSS No. 111 test procedures are reasonable, since they would condition the R2X in the same way as would the test procedures in the standards if applied to a conventional vehicle. Most commenters did not discuss whether NHTSA should grant Nuro's request for an exemption from the FMVSS No. 111 test procedures, or their views on the adequacy of Nuro's suggested modifications. The only comment on this subject was from AAMVA, which stated that it was "skeptical" of what is meant by treating the remote operator seat as a driver's seating position. We think that Nuro's suggestion to use the remote operator as a stand-in for the driver, for purposes of compliance certification, is reasonable. The purpose of the FMVSS No. 111 "Field-of-view,"

"Size," and "Response time" requirements are to ensure that the image displayed communicates information about the area behind the vehicle to the driver in a format that the driver is able to understand from the start of the backing event. If the rearview image meets the "Field of view," "Size," and "Response time" criteria when viewed by a remote operator who is located a similar distance from the rearview image screen as would be a human driver in a conventional vehicle, NHTSA believes this would be sufficient to demonstrate that Nuro exercised reasonable care in certifying the R2X because it indicates that the ADS is receiving the same information that a human driver would receive from the backup camera system in a conventional vehicle, and that this information is being transmitted at the start of the backing event. Similarly, we believe that Nuro's suggestion that it

perform test procedures with a fully charged battery in lieu of a fully-loaded gas tank, for purposes of compliance certification, is reasonable.

Advocates claimed that the act of applying a vehicle's brakes to prevent a back over crash is an integral part of the safety purpose of the backup camera, and that NHTSA should therefore incorporate into its analysis whether the R2X would appropriately brake in response to an object in the backup camera zone. We do not agree with Advocates that FMVSS No. 111 extends to how the vehicle must react in response to the presence of an object behind the vehicle. Although Congress enacted the K.T. Safety Act (the statute that mandated NHTSA to create the backup camera requirement) to reduce back over crashes, FMVSS No. 111 requires that the driver be provided with information that would *enable* the driver to take action to avoid a back over

1988), <https://isearch.nhtsa.gov/files/3140o.html> ("I would like to point out that manufacturers are not required by Standard No. 302 to test the flammability of their vehicles in only the manner specified in the standard. The standard only sets the procedure that the agency will use in its compliance testing.").

⁶⁰ NHTSA believes that this issue is more appropriately addressed in a separate **Federal Register** notice, rather than in this notice

addressing a specific petition from a specific manufacturer.

⁶¹ NHTSA notes that under its prior, longstanding position that manufacturers are not required to certify compliance based on NHTSA's FMVSS test procedures, Nuro's request for an exemption from provisions of the test procedures would likely have been considered moot.

⁶² Note that FMVSS No. 111 does not require that LSVs be equipped with a display screen; it only

requires that the LSV produce a "rearview image" that meets the criteria of S6.2. While most conventional vehicles with human drivers comply with this requirement through the use of a screen on which the rearview image is displayed, the R2X does not have such a screen because, since it cannot be operated by a human driver, such a screen is unnecessary.

crash.⁶³ Specifying appropriate performance requirements for ADS brake activation would require significant research that is not feasible for purposes of this exemption, applicable to a limited number of vehicles. NHTSA notes, however, that Nuro, like all motor vehicle manufacturers, must safeguard against safety-related defects.⁶⁴ NHTSA would not hesitate to exercise its defect authority should information indicate that an ADS does not appropriately brake in response to the presence of objects in its vicinity. NHTSA also mitigates any potential risk through the limited number of vehicles that can be produced pursuant to this exemption, and through the terms and conditions described below.

VII. Nuro's Requests for Exemptions From the LSV Mirror, Windshield, and Backup Camera "Linger Time" Requirements Are Granted Under Both the "Low-Emission Vehicle" (LEV) and "Equivalent Overall Safety" (EOS) Exemption Bases

Based on the contents of Nuro's public petition and the comments received in response to the Notice of Receipt, NHTSA has made the findings required to grant Nuro's petition for an exemption from the mirror, windshield, and backup camera "Linger time" requirements under both the Low-Emission Vehicle basis and the Equivalent Overall Safety basis.

a. Findings Specific to the LEV basis

i. The R2X Is a Low-Emission Vehicle

A vehicle is considered a low-emission vehicle for the purposes of § 30113 of the Vehicle Safety Act if it emits air pollutants significantly below the standards for new vehicles applicable to the vehicle set under § 202 of the Clean Air Act. Since the R2X is an electric vehicle and would not emit any such pollutants, it is a low-emission vehicle under § 30113. This issue was not contested in the public comments. Further, as discussed above, there is no need for the agency to find a nexus

between the fact that the vehicle is an LEV and the reason the vehicle is non-compliant.

ii. An Exemption From the Mirror, Windshield, Backup Camera "Linger Time" Requirements, and Portions of the Backup Camera Test Procedures Relating to Rearview Image FOV, Size, and Response Time, Would Not Unreasonably Lower the Safety Level of the R2X

Given that an exemption from the mirror, windshield, and backup camera "Linger time" requirements would not lower the level of safety of the R2X, NHTSA finds that an exemption would not unreasonably lower the safety of the R2X as compared to that of a compliant R2X. In addition, NHTSA finds that, because an exemption from the FMVSS No. 111 test procedure provisions relating to fuel tank loading (S14.1.2.2), driver's seating position (S14.1.2.5), steering wheel adjustment (S14.1.7), and the opening of the driver's door and activation of the starting system (S14.2(a)–(c)) would not affect whether the R2X's backup camera system meets the substantive requirements for "Field of view" (S6.2.1), "Size" (S6.2.2), and "Response time" (S6.2.3), an R2X exempted from these test procedure provisions would not lower the safety of the vehicle. Because NHTSA finds that safety would not be lowered, NHTSA does not reach the question of whether safety would be unreasonably lowered.

iii. An Exemption From the Mirror, Windshield, and Backup Camera "Linger Time" Requirements Would Make Easier the Development or Field Evaluation of the R2X

An exemption from the mirror, windshield, and backup camera "Linger time" requirements would make easier the development or field evaluation of the R2X because it will permit Nuro to deploy the R2X without equipping the vehicle with extraneous safety features that, as noted earlier, NHTSA has found to not serve a safety function on an occupantless low-speed ADS vehicle.

Nuro argues in its petition that compliance with these requirements potentially imposes costs on Nuro and make it more difficult to field test the R2X because compliance "increases pedestrian strike risk, adds mass, and worsens the impact of collisions." NHTSA agrees that, because compliance would require the R2X to be equipped with additional equipment, compliance with the standard would increase the cost of performing field evaluations of the R2X due to higher manufacturing costs and design restrictions. NHTSA also agrees that increased weight would

make field evaluation of the vehicle harder by limiting the utility of the R2X as a delivery vehicle, because extra equipment may increase the curb weight of the vehicle, which could decrease the amount of cargo it can carry. (LSVs are required to have a GVWR of 3,000 pounds or below, regardless of the curb weight of the vehicle.)⁶⁵

While the exemption from the backup camera linger time requirement would not impact the manufacturing cost or weight of the vehicle, NHTSA finds that granting an exemption from that requirement would also make easier the field evaluation of the R2X because it would allow the R2X's ADS to operate continuously with full sensor input at all times, which would aid with Nuro's evaluation of the ADS's performance.

b. Findings Specific to the EOS Basis

i. An R2X Exempt From the Mirror, Windshield, Backup Camera "Linger Time" Requirements, and Portions of the Backup Camera Test Procedures Relating to Rearview Image FOV, Size, and Response Time, Would Have an Overall Level of Safety Equivalent to That of a Nonexempt Vehicle

Because an exemption from the mirror, windshield, and backup camera "Linger time" requirements would not lower the level of safety of the R2X, NHTSA finds that an R2X exempted from these requirements would have a level of safety at least equal to that of a compliant version of their R2X. In addition, NHTSA finds that because an exemption from the FMVSS No. 111 test procedures relating to fuel tank loading (S14.1.2.2), driver's seating position (S14.1.2.5), steering wheel adjustment (S14.1.7), and the opening of the driver's door and activation of the starting system (S14.2(a)–(c)) would affect whether the R2X's rearview image meets the substantive "Field of view" (S6.2.1), "Size" (S6.2.2), and "Response time" (S6.2.3) requirements, an R2X exempted from these test procedure provisions would provide a level of safety equivalent to a vehicle tested in accordance with the FMVSS No. 111 test procedures.

ii. Compliance With FMVSS No. 500 Would Prevent Nuro From Selling the R2X

Compliance with FMVSS No. 500 would prevent Nuro from commercially deploying the R2X because it requires the R2X to be equipped with the three additional features that are the subject of this exemption (exterior and/or interior mirrors, a windshield

⁶³ NHTSA considered this technology as part of the rulemaking that established the backup camera requirement. In the Final Rule on the subject, NHTSA acknowledged that "it may be possible that automatic braking or other future systems offer comparable or greater protection to the public without the use of a rearview image," but noted that the agency was "not currently aware of any established, objective, and practicable way of testing such systems to ensure that they offer a minimum level of protection to the public." 79 FR 19178, 19203 (Apr. 7, 2014). NHTSA has not yet taken action to add an automatic braking element to the backup camera requirements in FMVSS No. 111.

⁶⁴ See 49 U.S.C. 30112(a)(3), 30118–20.

⁶⁵ See 49 CFR 571.3

constructed from FMVSS No. 205-compliant glazing materials, and a backup camera that meets the “Linger time” requirement of FMVSS No. 111).

We note that, while the statutory language for the EOS states that NHTSA must find that compliance with the FMVSS would prevent Nuro from “selling” the R2X, this language does not limit the application of the statutory basis to only vehicles that will be offered for sale (which Nuro states the R2X will not). Rather, to grant an exemption under the EOS basis, NHTSA must find that compliance with the standard would prevent Nuro from selling the R2X *regardless* of whether Nuro actually intends to sell the R2X. Section 30113 of the Vehicle Safety Act does not require that a vehicle exempted under the EOS basis enter into interstate commerce only through a sale, and NHTSA can think of no reasonable safety-related policy justification for reading such a requirement into the statute. Accordingly, we have determined that Nuro may introduce the R2X into interstate commerce by means other than selling, even if the vehicle is exempted under the EOS basis.

c. Granting Nuro’s Petition Is Consistent With the Public Interest and the Vehicle Safety Act

As discussed above, the Vehicle Safety Act and its implementing regulations provide the Secretary and, by delegation, NHTSA with broad authority and discretion in determining whether granting the petition is consistent with the public interest and Vehicle Safety Act. Here, NHTSA finds that granting Nuro’s petition is consistent with the public interest and 49 U.S.C. Chapter 301 because an exemption would enable a limited-risk deployment⁶⁶ of an occupant-less ADS-equipped vehicle that has been designed without any residual consideration of human occupants that are not actually able to be inside the vehicle. Further, granting the petition will provide the agency with valuable information that can facilitate its knowledge of ADS functionality to advance future policy and regulatory decisions. Given the agency’s above determination in the safety findings that the exemption will not lower the safety of the R2X as compared to a compliant version of the vehicle, and could instead provide incremental benefits to vehicle safety due to certain design changes, the agency believes that these reasons are

more than sufficient to justify this finding.

More specifically, allowing for the introduction of the R2X as it has been designed by Nuro to optimize its performance as an occupant-less vehicle could further the development of new and innovative vehicle automation technologies, which may in turn lead to future benefits for vehicle safety, the environment, and the economy. While the extent of the anticipated benefits of ADS vehicles like the R2X are uncertain, commenters Local Motors and SAFE suggested that these vehicles could provide a variety of benefits, including increased safety (because ADS vehicles may reduce the number of crashes caused by human error), decreased emissions (because ADS vehicles could perform the driving task more efficiently and, in the case of the R2X, efficiently combine trips), and socioeconomic benefits (because ADS vehicles could provide expanded goods delivery services to poor and/or underserved communities).

While NHTSA cannot fully predict the extent to which these benefits will materialize in the future and, more specifically, the effect that granting this petition would have on those benefits, the agency understands that development of the ADS technology necessary to make these potential benefits possible requires the technology be used on vehicles that are designed from the ground-up to be automated and in real-world (non-simulated) environments, both to validate the safety of the current ADS technologies and to expose those technologies to new situations in which “machine learning” capabilities can be used to improve performance.⁶⁷ In all events, the exemption request must be considered based upon the information available to the agency at this time, and NHTSA may revisit the issues here in the future as circumstances warrant. By virtue of filing this petition, Nuro believes that this exemption would better facilitate their development of this technology. Given that the R2X has a much lower top speed and lower weight than a typical passenger motor vehicle, and that the R2X will not have occupants, NHTSA believes that LSV-

based ADS vehicles like the R2X provide a low-risk platform for validating and improving ADS technologies.⁶⁸

Finally, granting this exemption is in the public interest and consistent with the Vehicle Safety Act because it would encourage the development of new safety and automated technologies, like ADS, with an eye toward future regulatory changes. To this end, NHTSA believes that both the public interest and the goals of the Vehicle Safety Act would be best served if NHTSA were able to maintain a dialogue with Nuro about its experience operating the R2X, which may help inform the agency’s future policy decisions towards ADS technologies. Accordingly, NHTSA has decided to condition the grant of an exemption on Nuro providing the agency with specified periodic and incident-based reporting of information about the R2X’s ADS, notwithstanding that the driving capability of the ADS is not relevant to the requisite safety findings.

VIII. Nuro’s Request for an Exemption From the Backup Camera “Deactivation” Requirement Is Moot

NHTSA has deemed moot Nuro’s request for an exemption from the backup camera “Deactivation” requirement (FMVSS No. 111, S6.2.5) because the requirement does not mandate that the backup camera deactivate when the vehicle shifts out of reverse, as Nuro assumed in its petition. Accordingly, an exemption from the “Deactivation requirement” is not necessary for Nuro to design the R2X to operate with the backup camera activated at all times, which was Nuro’s stated purpose of requesting an exemption.

The deactivation requirement specifies the circumstances in which the backup camera image may be deactivated, *i.e.*, when “the driver modifies the view, or the vehicle direction selector is removed from the reverse position.” Contrary to Nuro’s understanding, S6.2.5 does not require the backup camera to deactivate; rather, the requirement prohibits the backup camera from being deactivated prior to either of the two specified conditions being met. That is, S6.2.5 requires that

⁶⁷ We note that the FAST Act (Pub. L. 114–94, 129 Stat. 1312 (Dec. 4, 2015)) amended the Vehicle Safety Act to permit vehicle manufacturers that existed before December 2015 to operate uncertified vehicles on public roads for purposes of testing and evaluation. See 49 U.S.C. 30112(b)(10). As Nuro has only been a manufacturer since 2018 (see <https://vpic.nhtsa.dot.gov/mid/manufacturers/details/18808>), Nuro does not qualify for this exclusion and so must certify its vehicles as FMVSS-compliant, or obtain a temporary exemption, before deploying them in any capacity on public roads.

⁶⁸ We note that our determination that the R2X is a lower-risk platform for testing ADS technologies is, in part, premised on Nuro taking its responsibility for the safety of its vehicles seriously, which includes compliance with the terms set out at the end of this notice. If NHTSA determines that Nuro has violated the terms laid out at the end of this notice, NHTSA may determine at that time that the exemption is no longer in the public interest, and may withdraw the exemption. See 49 CFR 555.8(d)(1).

⁶⁶ In terms of vehicle size, weight, and speed, as well as limited operational design domain and fleet size.

the rearview image be displayed prior to either the driver manually modifying the view or the gear selector being taken out of reverse. The requirement does not mandate that the image shall cease to be visible when one of these conditions is met. Thus, assuming the driver has not manually modified the rearview image, S6.2.5 would permit the rearview image to be displayed even after the gear selector had been taken out of reverse;⁶⁹ but, per S6.2.4, it may not be displayed after the end of the backing event, as that term is defined in S4.

Since the deactivation requirement in S6.2.5 permits, but does not require, deactivation of the rearview image when the vehicles is taken out of reverse, Nuro's request for exemption from the requirement is moot.

IX. Other Issues Raised by Commenters

a. Relevance of the Driving Capability of the R2X's ADS

Several commenters raised the issue of whether, and the extent to which, the driving ability of the R2X's ADS was relevant to the safety findings NHTSA must make to grant an exemption under § 30113, under any basis. Advocacy groups, including AAMVA,⁷⁰ Advocates,⁷¹ and NSPE,⁷² assumed, without providing a legal basis for their assumption, that the ability of the R2X's ADS to perform the driving task must be a major factor for NHTSA to consider in its evaluation of Nuro's petition. These groups argued that Nuro's petition did not include sufficient information about the ADS for NHTSA to grant an exemption because Nuro did not include documentation of the various testing it had done in developing its ADS, though these groups generally did not specify in detail what data they believed Nuro should have provided. However, one safety advocate, CAS, did include a discussion of why it believed the driving ability of the R2X's ADS should be an element of NHTSA's in its safety findings.⁷³

According to CAS, the driving ability of the R2X's ADS is relevant because the FMVSS often have "an implicit human operator bias." Accordingly, CAS argues that manufacturers of ADS vehicles must be required to demonstrate that the manufactures "have successfully replicated in their automatic systems the human sensory capability,

responses, and judgement implicit in the specific FMVSS for which an exemption is sought." Using the mirror requirement as an example, CAS argues that, for Nuro to be exempted from the LSV mirror requirement, its petition must demonstrate that the R2X's ADS will respond as a human using mirrors would in a potential crash scenario. However, CAS does not cite a legal basis for reading into the FMVSS a requirement that the ADS must react in a certain way in these driving scenarios. While other comments from advocacy groups were not as thorough as CAS in their discussion of the relevance of the ADS, they all roundly criticized Nuro's petition for a perceived lack of information about the ADS and other related subjects (such as the ODD and remote operator system) they claim are relevant to the safety findings NHTSA must make.

On the other side, SAFE, Local Motors, and the Alliance, argued in their comments that the driving capability of the R2X's ADS is not relevant to the safety findings NHTSA must make to grant an exemption. According to SAFE, the R2X's ADS is not relevant to NHTSA's safety findings because the exemption statute requires NHTSA to determine how the safety level of the non-compliant R2X would differ from that of a compliant vehicle, which in this case, would be a compliant occupantless, low-speed ADS vehicle.⁷⁴ Thus, based on SAFE's logic, NHTSA's findings must focus on the safety implication of non-compliance as it relates to the specific standards from which an exemption is sought, not on how safe an exempted vehicle would be generally.⁷⁵ Using similar logic, Local Motors argued that "ADS performance measurement is less meaningful to the specific features being omitted," although Local Motors did encourage NHTSA to require some information reporting to maintain oversight of the vehicles.⁷⁶ The Alliance argued for the same outcome—that the R2X's ADS should not be considered in NHTSA's safety findings—but justified its argument on the grounds that ADS competency should not be considered because it is already "addressed" through the Voluntary Safety Self-Assessment (VSSA) criteria and the Department's ADS 2.0 and AV 3.0 guidance.⁷⁷

NHTSA agrees with SAFE and Local Motors that the ADS does not factor into the comparative safety findings NHTSA must make to grant an exemption under either the EOS or LEV bases in this instance. As we briefly explained at the start of the "Safety Analysis" section, neither the statute nor regulations call upon NHTSA to assess the absolute level of safety of the exempted vehicle in question and find whether the vehicle's safety exceeds some minimum threshold that exists in the abstract. Instead, the agency is tasked with making a judgment about relative safety, *i.e.*, whether an exempted, noncompliant version of a highly automated R2X would have a level of safety equivalent to that of a nonexempt, compliant version of a highly automated R2X. As we noted, Nuro has stated that an R2X that is exempted from the requirements of FMVSS No. 500 would use the same ADS as an R2X that is fully compliant, which would rely on the same sensors and would perform the same classifying, decision making and executing functions. Thus, because a compliant version of the R2X would also operate using an ADS, there is no meaningful difference in the safety impact of the ADS between a compliant and non-compliant R2X.⁷⁸

While we agree with the Alliance that the driving performance of the ADS is not germane to the safety findings NHTSA must make to grant Nuro's petition, we do not agree with the Alliance that the VSSA process is the appropriate framework NHTSA should use to exercise oversight of ADS vehicles that are produced subject to an exemption. First, as stated in NHTSA's ADS 2.0 guidance, and reemphasized in the Department's AV 3.0 and other statements, VSSAs are completely voluntary and the agency has no mechanism with which to compel their submission. VSSAs are intended to be documents by which ADS developers convey to the public information about how safety is factored into the development of the ADS in several specific critical areas and, thus, are not intended to be tools of regulatory oversight. Further, the agency is not, in this notice, foreclosing the possibility that, in considering whether to grant an ADS-related exemption petition for a vehicle that is requesting exemption

⁶⁹ The only restriction on when the rearview image must be deactivated is the linger time requirement (S6.2.4), from which we have decided to grant Nuro an exemption, as is explained in the previous section.

⁷⁰ See NHTSA-2019-0017-0025.

⁷¹ See NHTSA-2019-0017-0026.

⁷² See NHTSA-2019-0017-0011.

⁷³ See NHTSA-2019-0017-0024.

⁷⁴ See NHTSA-2019-0017-0016.

⁷⁵ We note that SAFE discusses only the LEV and NSF bases, but its point could be applicable to the EOS basis as well.

⁷⁶ See NHTSA-2019-0017-0017.

⁷⁷ See NHTSA-2019-0017-0020.

⁷⁸ As noted earlier, the Vehicle Safety Act permits manufacturers to include any design feature they want on a vehicle so long as the vehicle conforms to the FMVSS, and the vehicle does not contain a defect that poses an unreasonable risk to safety. Thus, the ADS would be subject to NHTSA's defects authority, and some aspects of its competence may be appropriately considered in a defect investigation of the R2X by NHTSA.

from many more FMVSS requirements than Nuro, NHTSA would determine that the competency of the ADS is relevant to making the requisite safety finding. Rather, the agency has simply determined that such an analysis is not necessary here.

It is important to note that, while the driving capability of the R2X's ADS was not a factor in NHTSA's findings concerning whether the agency should grant Nuro's petition, as described above, nothing in this decision precludes NHTSA from seeking information about the ADS as part of a defect investigation, just as the agency would be able to seek information about the ADS in an investigation of a FMVSS compliant ADS-equipped vehicle. Neither this decision nor the Vehicle Safety Act prohibits NHTSA from mitigating ADS-related risks in determining the number of vehicles to exempt or the terms that apply to the exemption. Accordingly, NHTSA has conditioned this exemption grant on terms that the agency believes will mitigate risk and ensure the agency can maintain adequate oversight of deployed R2X vehicles. The agency has included several terms that require Nuro to report both general and incident-related information to NHTSA, including certain data about the operation of the R2X and its ADS. As described above, NHTSA believes granting this petition is in the public interest in part because this data will assist the agency both with its oversight of the R2X, and with developing regulatory changes to facilitate the safe introduction of fully compliant ADS vehicles.

b. ADS-Related Data Reporting

Several commenters also raised the issue of whether, and to what extent, NHTSA should require Nuro to report data about the operation of the R2X to the agency. While most commenters agreed that some required post-grant data reporting requirement would be appropriate, the commenters disagreed on whether this reporting should include information about the operation of the R2X using the ADS.

The commenters in favor of broad reporting requirements that cover information about the operation of the R2X and/or its ADS included advocacy groups like Advocates, CAS, and AAMVA, as well as the manufacturer Local Motors. Advocates argued that NHTSA should use the exemption process to increase the agency's understanding of ADS technologies through "required data sharing," though it did not provide detail as to what data it believed would be useful for NHTSA

to collect, nor what exactly is meant by "sharing."⁷⁹ Both CAS⁸⁰ and AAMVA⁸¹ suggest that NHTSA should "monitor" and require periodic reporting from Nuro, though they do not specify details of the scope or frequency of this monitoring and reporting. Local Motors suggested that NHTSA could require reporting of information related to route hazards, near misses, collision incidents, injuries, and disengagements of the ADS.⁸² Regardless of what is reported, both AAMVA and Advocates argue that, because the R2X could potentially operate beyond the two-year exemption period, and could develop over time through software changes, any reporting requirements should last for the entirety of the R2Xs' useful life.

Commenters who argued against significant reporting requirements included the Alliance and Nuro itself. The Alliance argued that data reporting on the operation of the R2X and/or its ADS should not be required, both because of what it refers to as the "limited" nature of Nuro's exemption request, and because NHTSA has the VSSA process to obtain this information.⁸³ The Alliance argues that if NHTSA does impose any reporting requirements, such requirements should be limited to the specific exemptions from the FMVSS requirements at issue in the petition, and that information about the ADS should be pursued in other ways, such as through a pilot program. In addition, the Alliance argues that, if there are any reporting requirements, they should not extend beyond the two-year exemption period. While Nuro did not object to reporting generally, it did suggest that NHTSA should only require reporting of information relating to a small subset of potential crash events, or narrowly tailored to the discrete aspects of vehicle performance affected by individual exemptions (which would omit reporting of any information about the operation of the R2X or its ADS).⁸⁴

NHTSA has determined that limiting reporting requirements in the way suggested by the Alliance and Nuro would not be appropriate, because it could harm the public interest both by hindering NHTSA's oversight of the R2X and limiting NHTSA's ability to learn from information from Nuro to potentially inform future activities. Accordingly, NHTSA has decided to include terms that would require both

crash-related information that is sent to the agency very soon after any crash, and periodic reporting of general information about the operation of the R2X, and that this reporting should extend throughout the useful life of the vehicles produced pursuant to the exemption.

c. Compliance With FMVSS Requirements Not Applicable to the R2X

AAMVA argues in its comment that Nuro should be required to apply for an exemption from the requirement that LSVs come equipped with an FMVSS No. 209-compliant seat belt, despite the vehicle's lack of designated seating positions, because AAMVA is concerned that allowing this would set a precedent that manufacturers could simply decide that certain FMVSS requirements do not apply to their vehicles.⁸⁵ NHTSA does not agree with AAMVA's assertion that Nuro is free to choose which FMVSS apply. FMVSS No. 500 is quite clear as to the seat belt requirement. It is written as an "if-equipped" requirement; that is, it requires that an LSV have an FMVSS No. 209-compliant seat belt at each designated seating position (DSP). Since the R2X does not have any DSPs, it is not required to have any seat belts. All LSVs with DSPs are subject to the requirements of FMVSS No. 209.

Similarly, CAS argues that NHTSA should require that the R2X be equipped with an FMVSS No. 401-compliant trunk release in its cargo compartments as a term of granting the petition.⁸⁶ Although NHTSA encourages Nuro to make its vehicles as safe as possible, and to consider installing trunk releases, FMVSS No. 401 does not apply to LSVs. Under section 30113 and Part 555, the question that Nuro's petition puts before NHTSA is whether Nuro should be exempted from three of the requirements to which its vehicle is subject under FMVSS No. 500.

The question of whether LSVs should be subject to additional performance requirements is outside the scope of this proceeding, and the agency does not have a legal basis to impose additional FMVSS requirements on the R2X, either as a pre-condition of granting an exemption, or as a term for maintaining an exemption grant. However, the agency may consider whether to include a trunk release requirement should we decide in the future to amend the FMVSS to specifically regulate occupantless delivery vehicles, as described in the Notice of Receipt for this petition.

⁷⁹ See NHTSA-2019-0017-0026.

⁸⁰ See NHTSA-2019-0017-0024.

⁸¹ See NHTSA-2019-0017-0025.

⁸² See NHTSA-2019-0017-0017.

⁸³ See NHTSA-2019-0017-0020.

⁸⁴ See NHTSA-2019-0017-0023.

⁸⁵ See NHTSA-2019-0017-0025.

⁸⁶ See NHTSA-2019-0017-0024.

d. Cybersecurity

Three commenters—CAS, NSPE, and Patrick Coyle—all raised cybersecurity concerns as well. CAS states that “end-to-end encryption,” which Nuro states the R2X’s communications will have, is insufficient to assure cybersecurity alone.⁸⁷ CAS also commented that safety-critical cybersecurity issues should be covered by Nuro’s safety plan and that there should be ongoing assessments of Nuro’s compliance with this plan. Similarly, NSPE states that the cybersecurity measures Nuro describes in its petition are insufficient, given the dangers an ADS vehicle could pose if hacked, and says that NHTSA should withhold approval until Nuro submits a detailed cybersecurity plan.⁸⁸ Mr. Coyle, a private individual, also states that Nuro’s petition does not contain an adequate discussion of cybersecurity.⁸⁹

Although the agency has no reason to believe that the cybersecurity risk between the R2X and a hypothetical compliant version of the R2X are any different, given the critical importance of cybersecurity, we have decided it would be in the public interest to include terms requiring Nuro to report any cybersecurity incidents and safety-critical cybersecurity vulnerabilities, and cease operation of all R2X vehicles if a cybersecurity incident that has an effect on safety occurs until the incident has been remedied.

e. Engagement With Local Authorities

Both AAMVA and AAA argue in their comments that community engagement would be important to ensuring the safe operation of the exempted vehicles and to gaining consumer acceptance. AAMVA stated that NHTSA should carefully consider how state and local authorities would be affected by the presence of exempted vehicles, and suggested that the acceptability of features like remote operation as a risk mitigation strategy should be up to State and local authorities.⁹⁰ AAA also stated that petitioners should describe outreach efforts in their petition.⁹¹

Although the question of whether Nuro adequately engaged with the local communities in which it is deploying the R2X is not a factor in the safety findings NHTSA must make to grant Nuro’s petition, NHTSA agrees that community outreach and compliance with local regulation is important for both the safe operation of the R2X within the community (e.g., safely

interacting with first responders in an emergency) and social acceptance of the vehicles. For this reason, NHTSA has determined it is in the public interest to include terms that require Nuro to certify that it has engaged with and gained any legally necessary approval of all State and local authorities in the communities in which the R2X will be deployed.

X. Number of Vehicles

The Vehicle Safety Act provides that NHTSA may grant an exemption under the LEV and EOS bases for the production of a maximum of 2,500 vehicles during any 12-month period.⁹² Nuro is permitted to produce up to 2,500 exempted R2X vehicles during any 12-month period of the exemption, or a maximum of 5,000 exempted vehicles over the full two-year exemption period.

XI. Terms

The Vehicle Safety Act grants the Secretary, as delegated to NHTSA significant discretion to condition the grant of an exemption “on terms [NHTSA] considers appropriate.” 49 U.S.C. 30113(b)(1) (delegation of authority at 49 CFR 1.95). Pursuant to this authority, NHTSA’s grant of an exemption is subject to the terms set out in the Appendix following the preamble. Although, as we have noted, the performance of the R2X’s ADS need not be addressed for this exemption, the Vehicle Safety Act does not limit the agency’s authority solely to terms and conditions directly relevant to its specific determination. This is particularly true in instances, such as here, where the agency has considered the potential benefits of automation in its public interest finding, and where the party seeking the exemption is using a novel form of technology.

The exemption Nuro is receiving today is the first exemption NHTSA has granted under section 30113 to permit the deployment of an ADS vehicle that will be used for commercial purposes. As such, NHTSA appreciates that there will likely be heightened public interest about the vehicles allowed under this exemption petition, as evidenced by the public comments, and, the agency has decided to include provisions concerning the performance of the ADS in the terms for this exemption. NHTSA notes that violation of these terms may lead NHTSA to determine that the exemption is no longer in the public interest, which is a ground for the agency to terminate the exemption under 49 CFR 555.8(d). NHTSA may

also take other appropriate enforcement action.

The terms NHTSA has chosen are designed to enhance the public interest and include post-crash reporting, periodic reporting, particular terms concerning cybersecurity, and certain general requirements. The post-crash reporting requirements would provide NHTSA with information necessary to understand the cause of the crash (including any role the ADS may have played), so the agency can take appropriate remedial action—up to and including requiring a recall, or even terminating the exemption and include the type of information the agency may request as a matter of course in any safety defect investigation involving an ADS-equipped vehicle. The periodic reporting requirements are intended to provide NHTSA with information about the operation of the R2X on public roads to facilitate improved safety oversight. NHTSA has also included restrictions on Nuro to ensure that the company is in a position to learn of and quickly resolve cybersecurity incidents related to safety. The general requirements are intended to ensure that Nuro removes from operation any vehicle determined not to be safe, Nuro comply with all relevant State and local laws, retain ownership of the vehicles, and provide a hotline for safety concerns.

We note that the terms we have included in this notice are similar to terms NHTSA has previously imposed on the importation of noncompliant ADS vehicles under 49 CFR part 591, though, consistent with the differing requirements of part 591, Nuro’s exemption will allow for commercial deployment, rather than simply testing and demonstration. Finally, though not included in the terms below, Nuro must also comply, as a matter of law, with the requirements for a label that must be affixed to its exempted vehicles under part 555.9.

XII. Conclusion

In accordance with 49 U.S.C. 30113(b)(3)(B)(iii) and (iv), the agency is granting Nuro NHTSA Temporary Exemption No. EX 20–01 from paragraphs S5(b)(6) and S5(b)(8) of FMVSS No. 500; and paragraphs S6.2.4, S14.1.2.2, S14.1.2.5, S14.1.7, and S14.2(a)–(c) of FMVSS No. 111; provided that Nuro complies with the terms and conditions described in the Appendix to this document. The exemption shall be effective from February 11, 2020 to February 10, 2022.

⁸⁷ See NHTSA–2019–0017–0024.

⁸⁸ See NHTSA–2019–0017–0011.

⁸⁹ See NHTSA–2019–0017–0004.

⁹⁰ See NHTSA–2019–0017–0025.

⁹¹ See NHTSA–2019–0017–0021.

⁹² 49 U.S.C. 30113(d).

Appendix: Terms**1. Reporting Following a Crash**

As soon as practicable, but no later than 24 hours after the R2X is involved in any crash

in which either (1) the R2X is in motion, or (2) the R2X is struck by another motor vehicle, Nuro must inform NHTSA's Office of Vehicle Safety Compliance (OVSC) that the crash took place.

As soon as practicable, but no later than 7 calendar days after Nuro informs OVSC of a crash, Nuro must report to NHTSA the data elements specified in Table I.⁹³

TABLE I—REPORTED DATA ELEMENTS

Data element	Recording interval/time (relative to time zero)	Data sample rate (samples per second)
Delta-V, longitudinal	0 to 250 ms or 0 to End of Event Time plus 30 ms, whichever is shorter	100.
Maximum delta-V, longitudinal	0–300 ms or 0 to End of Event Time plus 30 ms, whichever is shorter	N/A.
Time, maximum delta-V	0–300 ms or 0 to End of Event Time plus 30 ms, whichever is shorter	N/A.
Delta-V, lateral	0–250 ms or 0 to End of Event Time plus 30 ms, whichever is shorter	100.
Maximum delta-V, lateral	0–300 ms or 0 to End of Event Time plus 30 ms, whichever is shorter	N/A.
Time, maximum delta-V, lateral	0–300 ms or 0 to End of Event Time plus 30 ms, whichever is shorter	N/A.
Time, maximum delta-V, resultant	0–300 ms or 0 to End of Event Time plus 30 ms, whichever is shorter	N/A.
Lateral acceleration	N/A	N/A.
Longitudinal acceleration	N/A	N/A.
Normal acceleration	N/A	N/A.
Speed, vehicle indicated	–5.0 to 0 sec	2.
Engine throttle, % full	–5.0 to 0 sec	2.
Service brake, on/off	–5.0 to 0 sec	2.
Ignition cycle, crash	–1.0 sec	N/A.
Ignition cycle, download	At time of download	N/A.

The data elements specified in Table I must be reported in accordance with the

range, accuracy, and resolution specified in Table II.

TABLE II—REPORTED DATA ELEMENT FORMAT

Data element	Minimum range	Accuracy	Resolution
Lateral, Longitudinal and normal acceleration	At option of manufacturer	At option of manufacturer.	At option of manufacturer.
Longitudinal, Longitudinal Maximum, Lateral, Lateral Maximum delta-V.	–100 km/h to +100 km/h	±10%	1 km/h.
Time, maximum delta-V, longitudinal and lateral.	0–300 ms, or 0—End of Event Time plus 30 ms, whichever is shorter.	±3 ms	2.5 ms.
Time, maximum delta-V, resultant	0–300 ms, or 0—End of Event Time plus 30 ms, whichever is shorter.	±3 ms	2.5 ms.
Speed, vehicle indicated	0 km/h to 200 km/h	±1 km/h	1 km/h.
Engine throttle, percent full	0 to 100%	±5%	1%.
Ignition cycle, crash and download	0 to 60,000	±1 cycle	1 cycle.

In addition, Nuro must provide NHTSA's OVSC with the following information about the status of the ADS and/or remote operator before and during the crash event:

- If the ADS was in control of the vehicle during the event, a detailed timeline of the 30 seconds leading up to the crash, including a detailed read-out and interpretation of all sensors in operation during that time period, the ADS's object detection and classification output, and the vehicle actions taken (*i.e.*, commands for braking, throttle, steering, etc.).

- If a remote operator took over control of the vehicle prior to the event, a detailed timeline of the 30 seconds leading up to the remote operator taking over control, including a detailed read-out and interpretation of all ADS sensors in operation during that time period, the ADS's object detection and classification output, and the

vehicle actions taken (*i.e.*, commands for braking, throttle, steering, etc.).

- If a remote operator was in control of the R2X at any point during or up to 30 seconds before the event, Nuro must provide a detailed timeline of any actions the remote operator took that affected the crash event, as well as any technical problems that could have contributed to the crash (signal latency, poor field of view, etc.).

Finally, Nuro must provide NHTSA with any additional information about the event that NHTSA deems pertinent for determining either crash or injury causation, including additional information related to the ADS or remote operator system.

2. Periodic Reporting

Beginning 90 days after the date of the exemption grant, and at an interval of every 90 days thereafter, Nuro must submit to NHTSA's OVSC a report detailing the

operation of each R2X vehicle in operation during that time period. This report may provide this information either in aggregate or on a per-vehicle basis, but it must include the following:

- A calculation of the total miles the vehicle has traveled using the ADS during the report period, and heat maps of the geofenced area in which the vehicle operates to illustrate travel density. Nuro must provide the same information for miles traveled using a remote operator.

- Detailed descriptions of any material changes made to the R2X's Operational Design Domain (ODD) or ADS software during the reporting period.

- Detailed descriptions of any incidents in which the R2X has violated any local or state traffic law, whether operating using the ADS or under remote operation.

- Detailed descriptions of any incidents in which the R2X has experienced a sustained

⁹³ These data elements are based on the requirements in 49 CFR part 563, Event Data Recorders, with data elements related to occupant

protection systems omitted. For purposes of reporting the data elements in this table, "End of Event Time" means the moment at which the

vehicle's cumulative delta-V within a 20 ms time period becomes 0.8 km/h (0.5 mph) or less.

acceleration of at least 0.7g on any axis for at least 150 ms, or of any incidents in which the vehicle has an unexpected interaction with humans or other objects (other than crashes that require immediate reporting).

- Detailed descriptions of all instances in which a public safety official, including law enforcement, has attempted to interact with an R2X, such as to pull it over, or has contacted Nuro regarding an attempted interaction with the R2X.

- Detailed descriptions of any “minimal risk condition fallback”⁹⁴ or “remote operator takeover”⁹⁵ events that have occurred, even if no crash has occurred. If the event has occurred because the vehicle self-diagnosed a malfunction of a vehicle system, the report must include a detailed description of the cause and nature of the malfunction, and what remedial steps were taken. If the event was caused by the vehicle encountering a complex or unexpected driving situation, the report must include a detailed timeline of the ADS’s decision-making process that led to the event, including any difficulties the ADS had in detecting and classifying objects. For any remote operator takeover event, Nuro must provide information about any technical issues encountered, such as signal latency.

In addition, Nuro must make necessary staff available to meet with NHTSA staff quarterly to discuss the status of its deployment program.

3. Cybersecurity

- Nuro must have a documented cybersecurity incident response plan that includes its risk mitigation strategies and the incident notification requirements listed below.

- Nuro must cease operations of all R2X vehicles immediately upon becoming aware of any cybersecurity incident⁹⁶ involving the R2X and any systems connected to the R2X that has the potential to impact the safety of the R2X.

- No later than 24 hours after being made aware of a cybersecurity incident, Nuro must

inform NHTSA’s Office of Defects Investigations (ODI) of the incident. Nuro must also respond to any additional requests for information from NHTSA on the cybersecurity incident.

- Prior to resuming its operation of R2X vehicles following the discovery of a cybersecurity incident, Nuro must inform NHTSA of the steps it has taken to patch the vulnerability and mitigate the risks associated with the incident, and receive NHTSA approval to resume operation.

4. Other Conditions

- Nuro must be capable of issuing a “stop order” that causes all deployed R2X vehicles to, as quickly as possible, cease operations in a safe manner, in the event that NHTSA or Nuro determines that the exempted vehicles present an unreasonable or unforeseen risk to safety.

- Nuro must coordinate any planned deployment of the R2X or change to the ADS/ODD with state and local authorities with jurisdiction over the operation of the vehicle as required by the laws or regulations of that jurisdiction.

- The R2X must comply with all state and local laws and requirements at all times while in operation. Each vehicle must be duly permitted, if applicable, and authorized to operate within all properties and upon all roadways traversed.

- Nuro must maintain ownership and operational control over the R2Xs that are built pursuant to this exemption for the life of the vehicles.

- Nuro must create and maintain a hotline or other method of communication for the public and Nuro employees to directly communicate feedback or potential safety concerns about the R2X to the company.

Authority: 49 U.S.C. 30113 and 49 U.S.C. 30166; delegations of authority at 49 CFR 1.95 and 49 CFR 501.4.

Issued in Washington, DC, under authority delegated in 49 CFR 1.95 and 501.4.

James C. Owens,

Acting Administrator.

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DEPARTMENT OF TRANSPORTATION

Pipeline and Hazardous Materials Safety Administration

Hazardous Materials: Notice of Applications for Modifications to Special Permits

AGENCY: Pipeline and Hazardous Materials Safety Administration (PHMSA), DOT.

ACTION: List of applications for modification of special permits.

SUMMARY: In accordance with the procedures governing the application for, and the processing of, special permits from the Department of Transportation’s Hazardous Material Regulations, notice is hereby given that the Office of Hazardous Materials Safety has received the application described herein. Each mode of transportation for which a particular special permit is requested is indicated by a number in the “Nature of Application” portion of the table below as follows: 1—Motor vehicle, 2—Rail freight, 3—Cargo vessel, 4—Cargo aircraft only, 5—Passenger-carrying aircraft.

DATES: Comments must be received on or before February 26, 2020.

ADDRESSES: Record Center, Pipeline and Hazardous Materials Safety Administration, U.S. Department of Transportation, Washington, DC 20590.

Comments should refer to the application number and be submitted in triplicate. If confirmation of receipt of comments is desired, include a self-addressed stamped postcard showing the special permit number.

FOR FURTHER INFORMATION CONTACT: Donald Burger, Office of Hazardous Materials Approvals and Permits Division, Pipeline and Hazardous Materials Safety Administration, U.S. Department of Transportation, East Building, PHH–30, 1200 New Jersey Avenue Southeast, Washington, DC 20590–0001, (202) 366–4535.

SUPPLEMENTARY INFORMATION: Copies of the applications are available for inspection in the Records Center, East Building, PHH–30, 1200 New Jersey Avenue Southeast, Washington, DC.

This notice of receipt of applications for special permit is published in accordance with part 107 of the Federal hazardous materials transportation law (49 U.S.C. 5117(b); 49 CFR 1.53(b)).

Issued in Washington, DC, on February 3, 2020.

Donald P. Burger,

Chief, General Approvals and Permits Branch.

⁹⁴ The term “minimal risk condition fallback” refers to a situation in which the ADS pulls over using a “failsafe trajectory,” as described on page 21 of Nuro’s VSSA, which Nuro submitted as an attachment to its comment. See Docket No. NHTSA–2019–0017–0023.

⁹⁵ The term “remote operator takeover” refers to a situation in which a remote operator takes control of a vehicle either because the ADS recommends remote operation, or because the remote operator deems it appropriate without being prompted by the ADS.

⁹⁶ As used in these terms, “incident” is defined as an occurrence that jeopardizes the functionality, confidentiality, integrity, or availability of a vehicle computing platform through the potential use of an exploit. “Exploit” refers to an action that takes advantage of a vulnerability to cause unintended or unanticipated behavior to occur on computer software and/or hardware.