Report to Congress

July 2025

NHTSA Research and Rulemaking Activities on Vehicles Equipped with Automated Driving Systems

Automated Driving System (ADS) – Equipped Vehicles

Introduction

House Report No. 118-154—incorporated by reference into the Joint Explanatory Statement accompanying the Transportation, Housing and Urban Development and Related Agencies Appropriations Act, 2024 (Division F of the Consolidated Appropriations, Transportation, Housing and Urban Development and Related Agencies Appropriations Act, 2024, H.R. 4366, Pub. L. 118-42), enacted on March 9, 2024—requests that the National Highway Traffic Safety Administration (NHTSA) submit biannual reports on its autonomous vehicle (AV) rulemaking and research activities, following the guidelines included in the Joint Explanatory Statement accompanying the Consolidated Appropriations Act, 2023 (Pub. L. 117-328). Specifically, the report states:

> *Regulatory framework for autonomous vehicles (AVs).*—The Committee previously directed the NHTSA to submit a report on the status of research and rulemakings related to autonomous vehicles with novel designs that improve mobility and access for all. As China and other countries are establishing regulatory frameworks for this important technology, the Committee continues to believe it is critical that the NHTSA modernize its rules in a timely manner to ensure that the U.S. can safely deploy this new technology and not cede leadership to global competitors in this growing and important industry. In order to track the progress on these rulemakings, the Committee directs the NHTSA to submit biannual reports on its AV rulemaking and research activities, following the guidelines included in the Joint Explanatory Statement accompanying the Consolidated Appropriations Act, 2023 (P.L. 117–328).

In response to this directive, NHTSA submitted its first biannual Report to Congress in January 2025.[1]

This second biannual report summarizes NHTSA's research and rulemaking activities associated with Automated Driving Systems (ADS), with a focus on updates since the previous report.

While driving automation capabilities also include systems designed to support, but not replace, human drivers, the opportunities and complexities associated with lower levels of driving automation differ significantly from those of ADS. These reports focus on ADS consistent with SAE International (SAE) driving automation Levels 3-5.[2] ADS-equipped vehicles are designed to operate without a human driver or to allow the driver to relinquish control entirely while the ADS is engaged.

[1] *Available at* https://www.nhtsa.gov/sites/nhtsa.gov/files/2025-01/Research-and-Rulemaking-Activities-on-Vehicles-Equipped-with-Automated-Driving-Systems-Report-to-Congress.pdf/

[2] SAE International, Recommended Practice J3016, "Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles," J3016_202104

AV Regulatory Framework

U.S. Department of Transportation (USDOT or Department) Secretary Sean Duffy has identified[3] the accelerated establishment of a regulatory framework for AVs as one of the Department's top priorities. He has directed NHTSA to move swiftly in updating key federal requirements to provide clarity for developers, to mitigate the risks posed by a patchwork of state laws, and to streamline existing processes for greater efficiency.

On April 24, 2025, the Department unveiled[4] the three principles of NHTSA's AV Framework:

- Prioritize the safety of ongoing AV operations on public roads.
- Unleash innovation by removing unnecessary regulatory barriers.
- Enable commercial deployment of AVs to enhance safety and mobility for the American public.

USDOT's announcement included two immediate actions:

(1) NHTSA issued an amendment[5] to the agency's Standing General Order for vehicles equipped with Level 2 advanced driver assistance systems and with ADS, aiming to streamline reporting by preserving key manufacturer notification elements, eliminating redundant reporting requirements, and adjusting reporting cadence based on insights gained to date.

(2) NHTSA expanded the automated vehicle exemption program (AVEP) to now include domestically produced vehicles, removing an unnecessary barrier to innovation and leveling the playing field for all manufacturers. NHTSA announced the change in an open letter[6] to AV developers. NHTSA also has an open rulemaking (RIN 2127-AM14) to update its regulations, which currently only address imported vehicles, to confirm that domestically produced vehicles are eligible for an exemption.

These are initial actions that will be followed by additional measures aligned with the core principles of the new AV Framework. NHTSA is also streamlining its research and rulemaking activities to support more effectively the framework's underlying objectives and will provide further details on these updates in future reports.

Updates on NHTSA's Automated Driving System (ADS) Research

NHTSA's ADS research program advances the body of knowledge on ADS-equipped vehicle safety. The following program areas target safety assessment methodologies that enable

[3] *Available at* https://www.transportation.gov/innovation-agenda
[4] *Available at* https://www.transportation.gov/briefing-room/trumps-transportation-secretary-sean-p-duffy-unveils-new-automated-vehicle-framework
[5] *Available at* https://www.nhtsa.gov/sites/nhtsa.gov/files/2025-04/third-amended-SGO-2021-01_2025.pdf
[6] *Available at* https://www.nhtsa.gov/sites/nhtsa.gov/files/2025-04/automated-vehicle-exemption-program-domestic-exemptions-2025.pdf

the agency to effectively oversee ADS-equipped vehicles from development through full maturity.

Federal Motor Vehicle Safety Standards (FMVSS) Conformance

Description: This research area informs potential regulatory adaptations that would enable innovative, ADS-specific designs to demonstrate conformance with existing safety standards.

Status Update: NHTSA carried out a multi-phased research project that evaluates 81 FMVSS for their applicability to innovative vehicle designs, especially those with ADS. Volume 1 analyzes 12 FMVSS (six crash avoidance and six crashworthiness) and Volume 2 expands to 18 additional FMVSS (nine in each category) and are published. NHTSA continued to ready Volume 3 for publication that reviews 28 additional FMVSS, including crash avoidance, crashworthiness for conventional and unconventional seating, and a low-speed standard. Volume 4 (also unpublished) examines the remaining 23 FMVSS, focusing on braking, electronic stability control test procedures, technical translations, and unconventional seating challenges across several standards. NHTSA also continues to ready this Volume for publication.

System Safety Performance Assessment

Description: The ADS safety research program focuses on developing methods, tools, and metrics to assess system-level safety performance. This includes advancing assessment approaches such as simulation, closed-course testing, and on-road evaluations. NHTSA is also interested in objective methods for selecting relevant test scenarios that reflect the operational boundaries and safety needs of different ADS applications.

Status Update: NHTSA continued to assess different ADS testing, validation, and system safety assessment methods. Recently, NHTSA conducted research to assess ADS sensing modalities with augmented reality objects in ADS performance testing, with the aim of developing test methods that can integrate virtual and real-world elements. Additional research continued to examine how simulation can be used as a tool to support ADS-equipped vehicle safety evaluations. Research on independent ground-truth trip recorders for light and heavy-duty vehicles continued to explore how high-fidelity data collected on ADS-equipped vehicles during on-road evaluations can provide real-world driving assessments.

Component and Subsystem Testing and Functional Safety

Description: NHTSA is studying the performance, reliability, and failure modes of components and subsystems in ADS to better understand safety considerations throughout vehicle design, development, and deployment. A typical ADS is structured into three main subsystems: perception, decision/path planning, and execution. Gaining insight into the performance of each subsystem can improve overall confidence in ADS safety. NHTSA's research aims to evaluate these subsystems individually and collectively to identify potential risks and support the development of safety benchmarks.

Status Update: The work continued to focus on characterizing system performance, identifying failure modes, and exploring methods to evaluate and mitigate risks associated with ADS-equipped vehicles. NHTSA is also investigating broader artificial intelligence (AI) applications within ADS technologies and assessing AI training and validation strategies to validate and assess the benefits and limitations of AI/machine learning (ML) models.

Crashworthiness, Alternative Cabin Design

Description: While automated driving systems may not directly alter vehicle crash mechanics, they introduce new challenges for occupant crash safety. Without the need for manual driving, passengers in ADS-equipped vehicles may be offered a broader range of seating positions and orientations, such as reclining seats or rear-facing arrangements. These variations necessitate a re-evaluation of crash safety standards. NHTSA is exploring how these evolving design elements impact occupant protection and how to adapt safety systems to accommodate new seating configurations.

Status update: NHTSA continued to refine the understanding of human response and injuries for various-sized occupants in forward- and rear-facing reclined seating conditions. Efforts used Human Body Models for both males and females to evaluate occupant restraints for the range of seating conditions expected in new ADS-equipped vehicle designs. Advanced Crash test dummies were adapted under this effort for use in forward- and rear-facing reclined seating configurations. Research also included assessments of the injury risk posed to children by a deploying air bag when seated in the traditional driver's seating position in an ADS-equipped vehicle. Finally, research continued to evaluate best practices for safe interaction of non-occupied ADS-equipped vehicles with existing vehicles, roadside hardware, pedestrians, cyclists, and motorcyclists.

ADS Human Factors and Unique User Needs

Description: The research explores how changing seating configurations and lack of a human driver may affect safety standards, occupant awareness, and system communication. These include human-machine interfaces, telltales, and warnings for Level 4–5 automation, remote operation methods, and their impact on both teleoperators and vehicle occupants.

Status update: The Agency continued to investigate emerging ADS human factors topical areas (e.g., transition of control between human and ADS drivers, issues related to telltales, controls, and indicators for ADS-equipped vehicles, driver vigilance). NHTSA continued human factors research to better understand mobility and the information needs of all people, including those with varying disabilities riding in ADS-equipped vehicles and how such information can be provided effectively through a human-machine interface to establish necessary situational awareness. Continued research also covered improved securement options for people who use wheelchairs.

Updates on NHTSA's ADS Rulemakings

The following list provides a status report on NHTSA's current ADS rulemaking actions, as reflected in the Fall 2024 Unified Agenda of Regulatory and Deregulatory Actions.[7] NHTSA will be making updates to the Spring 2025 Agenda consistent with the new announcements of the agency related to the establishment of an AV Regulatory framework. Those updates will be discussed in the next biannual report.

(1) Pilot Program for Collaborative Research on Motor Vehicles with High or Full Driving Automation (RIN 2127-AL99) - NHTSA issued an advance notice of proposed rulemaking (ANPRM) in 2018 seeking comment and advice on key elements for the design and implementation of a potential pilot program for highly automated vehicles. The purpose of the program was to facilitate the safe deployment and testing of vehicles equipped with ADS while providing valuable operational and safety data to NHTSA to inform potential future rulemaking. NHTSA leveraged insights gained from this ANPRM in developing the Exemption and Demonstration Framework for Automated Driving Systems NPRM (AV STEP, see item #5 below). In the Fall 2024 agenda, NHTSA indicated plans to withdraw this rulemaking.

(2) Facilitating New ADS Vehicle Designs for Crash Avoidance Testing (RIN 2127-AM00) – The May 2019 ANPRM sought comment on revising the crash avoidance FMVSS to identify opportunities to support the safe introduction and certification of new ADS-equipped vehicle designs. As reported previously, NHTSA already completed a rulemaking related to ADS-equipped vehicles and the crashworthiness FMVSS. NHTSA is assessing what requirements may be necessary for the crash avoidance FMVSS.

(3) Considerations for Telltales, Indicators, and Warnings in Vehicles Equipped with ADS (RIN 2127-AM07) - This ANPRM would seek comments on amending the FMVSS to address the applicability and appropriateness of safety messaging (telltales, indicators, and warnings) in new vehicle designs without conventional driver controls. The ANPRM discussion could include a focus on the existing telltales and displays listed in FMVSS No. 101, "Controls and displays," as well as what new vehicle messaging might be merited for ADS-equipped vehicles.

(4) Expansion of Temporary Exemption Program to Domestic Manufacturers for Research, Demonstrations, and Other Purposes (RIN 2127-AM14) – This Notice of Proposed Rulemaking (NPRM) would set a new regulation for domestic entities to request exemptions to operate nonconforming vehicles, on public roads for

[7] Office of Information and Regulatory Affairs, "Fall 2024 Unified Agenda of Regulatory and Deregulatory Actions." *Available at* https://www.reginfo.gov/public/do/eAgendaMain .

purposes of research, investigations, demonstrations, training, competitive racing events, show, or display, but not sale or lease subject to terms and conditions, mirroring those applicable to exempted imported vehicles. NHTSA is now developing an NPRM.

(5) Framework for ADS Safety (RIN 2127-AM15) - This December 2020 ANPRM requested comment on the development of a framework to objectively define, assess, and manage ADS safety performance while ensuring the needed flexibility to enable further innovation. The notice posed a number of questions related to the substance of a safety framework, its administration and interaction with NHTSA's authorities, and what additional research could support its development. NHTSA is using its analysis of comments, among other inputs, to inform the agency's next steps.

(6) Exemption and Demonstration Framework for Automated Driving Systems (RIN 2127-AM60) - NHTSA issued a Notice of Proposed Rulemaking (NPRM) in January 2025 to propose a program (i.e., the ADS-equipped Vehicle Safety, Transparency, and Evaluation Program, or AV STEP) that would enhance the agency's review, monitoring, and reporting of participating ADS operations while informing the agency's approach to future rulemaking and oversight. This notice contained many concepts put forth in the 2018 ANPRM, "Pilot Program for Collaborative Research on Motor Vehicles with High or Full Driving Automation."[8] NHTSA is currently analyzing NPRM comments and considering next steps.

(7) Incident Reporting Requirements for Automated Driving Systems and Level 2 Advanced Driver Assistance Systems (RIN 2127-AM63) - NHTSA is developing an NPRM that would propose to require manufacturers and operators of vehicles equipped with ADS and Level 2 advanced driver assistance systems to report specified information about certain safety-related incidents that occur on publicly accessible roads. This proposal would largely codify a streamlined set of the requirements imposed by NHTSA's Third Amended Standing General Order 2021-01.[9]

[8] *See* 83 FR 59353.
[9] NHTSA, "Third Amended Standing General Order 2021-01" (April 2025). *Available at* https://www.nhtsa.gov/sites/nhtsa.gov/files/2025-04/third-amended-SGO-2021-01_2025.pdf .

Appendix – Published NHTSA ADS Research Reports

System Safety Performance

- Advanced Test Tools for ADAS and ADS
- A Framework for Automated Driving System Testable Cases and Scenarios
- Review of Simulation Frameworks and Standards Related to Driving Scenarios
- An Approach for the Selection and Description of Elements Used to Define Driving Scenarios

Component & Subsystem Testing and Functional Safety

- Safety of the Intended Functionality of Lane-Centering and Lane-Changing Maneuvers of a Generic Level 3 Highway Chauffeur System
- Foundations of Automotive Software

Crashworthiness ADS Research

- Automated Vehicle Occupant Kinematics Phase 1: Upright and Reclined Frontal Impacts with Male PMHS
- Development of Pelvis Injury Risk Curves for Iliac Bone Fracture Due to Lap Belt Loading in Female PMHS Sled Tests
- Crash Safety Consideration for Speed-Limited ADS Shuttles
- Crash Compatibility for Occupantless Delivery Vehicles
- Biomechanical Responses and Injury Assessment of Post Mortem Human Subjects in Various Rear-facing Seating Configurations
- Head Trajectories of Post Mortem Human Surrogates in Moderate-Speed Rear Impacts
- Rear-Seat Frontal Crash Protection Research with Application to Vehicles with Automated Driving Systems
- Occupant Safety in Vehicles Equipped with Automated Driving Systems, Part 1: Initial Evaluation of Usability, Stability, and Injury Prediction Capabilities
- Occupant Safety in Vehicles Equipped with Automated Driving Systems, Part 2: Crash Safety Considerations for Out-of-Position Occupant Posture in Vehicles with Automated Driving Systems - Field Data Investigation
- Occupant Safety in Vehicles Equipped with Automated Driving Systems, Part 3: Biofidelity Evaluation of GHBMC M50-OS Against Laboratory Sled Tests
- Crash Simulations Between Non-Occupied Automated Driving Systems and Roadside Hardware

Human Factors ADS Research

- Automated Driving Systems' Communication of Intent with Shared Road Users
- Development of an Automated Wheelchair Tiedown Restraint System

Federal Motor Vehicle Safety Standard (FMVSS) Conformance Research

- Final Report - FMVSS Considerations for Vehicles with Automated Driving Systems: Volume 1

- Final Report - FMVSS Considerations for Vehicles with Automated Driving Systems: Volume 2

Cybersecurity

- Cybersecurity Best Practices for the Safety of Modern Vehicles 2022
- Cybersecurity of Firmware Updates

Recent Presentations:

- NHTSA Safety Research Portfolio Public Meeting: Fall 2024. Automated Driving Systems. October 29, 2024.
- "Federal Data Collection for ADS Incidents," Dold, Neil, NHTSA. July 31, 2024. National Academies Transportation Research Board. Automated Road Transportation Symposium.