



Report to
Congress

January
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 (P.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).

Report on NHTSA’s Automated Driving System (ADS) Research

NHTSA’s ADS research portfolio aims to advance the body of knowledge on ADS-equipped vehicle safety. ADS-equipped vehicles are vehicles for which there may be no human driver, or for which the human driver can give up driving control to the ADS and are not expected to perform any driving-related tasks while the ADS is engaged. NHTSA’s research works toward identifying safety assessment methods for the agency to effectively oversee the safety of ADS-equipped vehicles during development and at full maturity. The scope of NHTSA’s ADS Research is focused on SAE International (SAE) driving automation Levels 3-5.¹ The program includes the following high-level areas: system-level safety, safety metrics, and safety assessment methods; crashworthiness considerations for alternative vehicle designs; and ADS-equipped vehicle human factors research, including accessibility considerations.

The program objectives focus on building knowledge to support Agency decisions with respect to regulatory updates that could enable innovative concepts without compromising safety, developing necessary tools and knowledge to evaluate the safe performance of ADS-equipped vehicles and systems, and performing necessary research to understand risks

¹ SAE International, Recommended Practice J3016, “Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles,” J3016_202104.

and unanticipated consequences of ADS performance and associated new vehicle designs (from passenger vehicles to commercial motor vehicles). NHTSA works in close coordination with other Federal agencies on motor vehicle cybersecurity issues. NHTSA conducts vehicle cybersecurity research to support the industry's safe testing, development, and deployment of vehicles, including those equipped with ADS.

ADS Safety Performance (system-level safety, safety metrics, and safety assessment methods).

In FY 2024, NHTSA continued research to build knowledge of the capabilities and limitations of ADS-equipped vehicles with respect to their safe operation. Companies developing vehicles equipped with ADS are continuing their research and testing across several use-cases, including ride-hailing, transit, interstate freight, and local delivery, with limited driverless deployments. The ADS system-level safety performance research program explored methods, metrics, and tools for assessing the safety of ADS-equipped vehicles as a complete system, as well as operational maintenance characteristics. NHTSA further considered metrics and strategies under development by industry standards bodies and international partners. Through system-level research, NHTSA advanced multiple assessment methods, including the initiation of new simulation studies and advancement of on-road evaluation tools. In its research, NHTSA additionally considered the performance, reliability characteristics, and failure modes of ADS components and subsystems. This was pursued as a means of establishing a more complete understanding of the safety considerations within the emerging ADS-equipped vehicle use-cases throughout their design, development, and deployment stages. These sub-systems include sensors, the perception stack, including machine learning and artificial intelligence components, decision/path planning, localization, and execution. NHTSA focused on understanding the performance characteristics of sub-systems that could enhance overall confidence in ADS-equipped vehicle safety performance.

Crashworthiness and Alternative Cabin Design.

Without the need for a human to operate a vehicle manually, occupant crash safety must consider alternative seating positions, as ADS-equipped vehicle developers and manufacturers may adopt a wider range of seating postures for occupants (e.g., increased seat recline angles) and orientations with respect to the vehicle's travel direction (e.g., campfire seating). In FY 2024, NHTSA research continued to refine the understanding of human response and injuries for various-sized occupants in forward- and rear-facing reclined seating conditions and consider side-facing seating, as currently available in limousines. 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, while also evaluating effects of restraint type on occupant injury outcomes in crashes when there is a side-facing configuration. Anthropomorphic Test Devices, including the THOR-50M, 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.

Human Factors, including Accessibility.

ADS-equipped vehicles, including vehicles purpose-built for ADS operations, will likely influence humans' interactions with vehicles. In FY 2024, 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). Other activity focused on safety research for accessible design to improve securement for people who use wheelchairs. Research initiated tasks for the commercial development of wheelchair securement systems for future ADS-equipped vehicle and public transit applications. ADS-equipped vehicles may provide mobility options not previously afforded to people with physical, sensory, and/or cognitive disabilities, if purposely designed to do so. NHTSA conducted human factors research to better understand mobility and the information needs of people 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. Additionally, several research questions stemmed from potential seating preference changes in future ADS-equipped vehicle designs, as many of NHTSA's federal motor vehicle safety standards (FMVSS) focus on the safety of particular seating positions when crashes occur. NHTSA completed a study on how seating preference may change in future ADS-equipped vehicle designs.

Vehicle Cybersecurity.

As noted above, NHTSA works in close coordination with other Federal agencies on cybersecurity issues. As part of its research program, NHTSA conducted targeted research on how the auto industry addresses the full lifecycle of cybersecurity risks including identifying, protecting, detecting, responding, and recovering from cybersecurity threats. Further, NHTSA's research continued to support the interpretation and application of automotive-focused cybersecurity standards by vehicle manufacturers and suppliers. In FY 2024, NHTSA's research focused on cybersecurity considerations for modern electric vehicle battery management systems; cybersecurity zero trust methods; and software and firmware over-the-air updates.

Report on NHTSA's ADS Rulemakings

The following section provides a report on NHTSA's current ADS rulemaking actions, as reflected in the Spring 2024 Unified Agenda of Regulatory and Deregulatory Actions.² Of NHTSA's five in-progress rulemakings related to ADS, two focus on adapting current requirements to the unique vehicle designs expected in ADS-equipped vehicles to maintain the current level of safety afforded by FMVSS. The other three rulemakings look toward the future of evaluating ADS-equipped vehicle safety.

² Office of Information and Regulatory Affairs, "Spring 2024 Unified Agenda of Regulatory and Deregulatory Actions", available at <https://www.reginfo.gov/public/do/eAgendaMain>.

1. Facilitating New ADS Vehicle Designs for Crash Avoidance Testing (RIN 2127-AM00) - NHTSA is currently analyzing comments received on the May 2019 Advance Notice of Proposed Rulemaking (ANPRM), conducting continued research, and considering next steps. NHTSA already completed a rulemaking related to ADS-equipped vehicles and the 200-series crashworthiness FMVSS;³ this notice focused instead on the 100-series crash-avoidance FMVSS. Through the ANPRM, NHTSA sought comment on crash avoidance requirements and test procedures to facilitate the safe introduction and certification of new ADS-equipped vehicle designs. NHTSA is assessing what requirements may be necessary to maintain (or exceed) existing levels of safety while enabling innovative vehicle designs and removing or modifying those requirements that would no longer be appropriate if a human driver will not be operating the vehicle.
2. Considerations for Telltales, Indicators, and Warnings in Vehicles Equipped with ADS (RIN 2127-AM07) - NHTSA is currently performing additional research to further develop this ANPRM. 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 designed without conventional driver controls. The ANPRM discussion could include a focus on the existing telltales and displays listed in FVMSS No. 101, "Controls and displays," (which provide a driver with information relating to, for example, the current transmission gear, electronic stability control system status, low tire pressure, door closure status, and air bag systems), as well as what new vehicle messaging might be merited for ADS-equipped vehicles.
3. Framework for ADS Safety (RIN 2127-AM15) - NHTSA is currently analyzing comments received on the December 2020 ANPRM and considering next steps. This 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.
4. Exemption and Demonstration Framework for Automated Driving Systems (RIN 2127-AM60) - NHTSA is developing a Notice of Proposed Rulemaking (NPRM) to propose a program (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 to ensure safety in this evolving industry. AV STEP would consist of a voluntary review and reporting framework that would facilitate both participation by ADS-equipment manufacturers and developers, and exemptions for eligible ADS-equipped vehicles. This NPRM is under review by the Office of Information and Regulatory Affairs.⁴

³ Occupant Protection for Vehicles With Automated Driving Systems, 87 FR 18560 (March 30, 2022).

⁴ Office of Information and Regulatory Affairs, "List of Regulatory Actions Currently Under Review," available at <https://www.reginfo.gov/public/jsp/EO/eoDashboard.myjsp>.

5. 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 or Level 2 driver assistance systems to report specified information about certain safety-related incidents that occur on publicly accessible roads, in order to inform future safety actions. This proposal would largely codify the requirements imposed by NHTSA's Second Amended Standing General Order 2021-01.⁵

⁵ NHTSA, "Second Amended Standing General Order 2021-01" (April 2023), available at https://www.nhtsa.gov/sites/nhtsa.gov/files/2023-04/Second-Amended-SGO-2021-01_2023-04-05_2.pdf.

Appendix –Published NHTSA ADS Research⁶ 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

- [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 GHBMCM50-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](#)

⁶ In addition to the published reports listed here, NHTSA provided project updates during the NHTSA Safety Research Portfolio Public Meeting: Fall 2024, held in October 2024. Recordings of the sessions, including one on ADS, are available at <https://www.nhtsa.gov/events/nhtsa-safety-research-portfolio-public-meeting-fall-2024>.

- [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](#)