

Overview of Automation Activities at U.S. DOT: December 2020

Within the United States Department of Transportation (U.S. DOT), several operating administrations and the Office of the Secretary (OST) have complementary roles and responsibilities related to automation in surface transportation. This document provides an illustrative—but not exhaustive—overview of current Departmental activities.

Illustrative Automation Activities

The Office of the Secretary of Transportation (OST)

Background and Goals

OST oversees the formulation of national transportation policy and promotes intermodal transportation. Within OST, the Office of Transportation Policy, the Office of the Assistant Secretary for Research and Technology, the Office of the Assistant Secretary for Aviation and International Affairs, and the Intelligent Transportation Systems Joint Program Office play key roles in managing automation-related initiatives across the Department.

OST prioritizes safety and security, promotes innovation, and ensures a consistent, technology-neutral, and science-based regulatory approach suitable for rapidly changing and evolving technologies. Recognizing that the interoperability of all elements of transportation systems is key to supply-chain efficiency and security, as well as maximizing benefits of new technologies, OST collaborates on research to improve interoperability. OST's efforts increase economic competitiveness and improve access to foreign markets for U.S. industry using and producing automation and related vehicle technologies. These efforts also reduce barriers to trade, including unneeded, insufficiently flexible, and/or non-compatible standards-related measures and other divergences in regulatory and policy measures.

Activities

Goal: Promote Transparency

International Engagement

OST maintains strong bilateral ties across North America, Europe, and Asia. This includes regulatory cooperation with Canada and Mexico to promote a North American approach to governing automated vehicles. Future activities will focus on increased regulatory alignment and policy approaches improving cross-border interoperability and efficiencies for automated vehicles.¹ Additional bilateral activities include participation in the EU–U.S. Transportation Research Symposium series, which is jointly sponsored by U.S. DOT, the Transportation Research Board, and the European Commission. This event focuses on innovation topics and has been held six times since 2013. OST also monitors the development of automated vehicle standards and regulations (safety and cybersecurity) in certain countries and engages as appropriate to exchange information and resolve issues that may create trade barriers.

¹ International Trade Administration. (n.d.). U.S.-Canada Regulatory Cooperation Council. Retrieved from <https://www.trade.gov/rcc>

OST also coordinates U.S. DOT participation in multilateral events and forums, including the International Transportation Forum,² the United Nations and its regional economic commissions, the World Economic Forum, the G7 Expert Group on Automated and Connected Driving, and the Association of Southeast Asian Nations (ASEAN). Recurring events include the ITS World Congress,³ Asia Pacific Economic Cooperation (APEC) Transportation Working Group meetings,⁴ the Transportation Research Board (TRB) annual meeting, and the Automated Vehicles Symposium.

Traffic Safety and 5.9 GHz Spectrum Conference

On June 3, 2019, U.S. DOT convened the Traffic Safety and 5.9 GHz Spectrum Conference to highlight the critical role of the Safety Band (5.9 GHz band) to ensure traffic safety, interoperability, and traffic management of automated and connected vehicle technologies.⁵

U.S. DOT Workshop on Consumer Education and Communications around Advanced Vehicle Technologies

This July 15, 2019 workshop brought together a diverse group of stakeholders to discuss current issues around terminology and language regarding automation and how it influences consumer perception of these innovative technologies. Confusing or vague terminology—and lack of accessible information—about Advanced Driver Assistance System (ADAS) available to the public for purchase and Automated Driving Systems (ADS) being tested on public roads may lead the public to confuse the two concepts. The report published following this event summarized workshop discussions and the views that participants provided, which informed the U.S. DOT’s messaging and communications efforts pertaining to automation.⁶

Access and Mobility for All Summit

On October 29, 2019, U.S. DOT hosted the Access and Mobility for All Summit to raise awareness of U.S. DOT and government-wide efforts to improve access and mobility for people with disabilities, older adults, and individuals of low income, and identify priority Federal and non-Federal activities and innovations that can provide more efficient, affordable, and accessible vehicles and mobility services, such as transit and ridesharing.⁷ That same day, U.S. DOT and 10 other Federal agencies approved the strategic plan for the Coordinating Council on Access and Mobility (CCAM), an interagency partnership to coordinate the efforts of Federal agencies funding transportation services for targeted populations.⁸

² *International Transport Forum*. (n.d.). Retrieved from <https://www.itf-oecd.org/>

³ Intelligent Transportation Society of America. (n.d.). ITS World Congress 2020. Retrieved from <https://www.itsworldcongress2020.com/en-us.html>

⁴ Asia-Pacific Economic Cooperation. (2020, January). SOM Steering Committee on Economic and Technical Cooperation, Transportation Working Group. Retrieved from <https://www.apec.org/Groups/SOM-Steering-Committee-on-Economic-and-Technical-Cooperation/Working-Groups/Transportation>

⁵ United States Department of Transportation. (2019). Traffic Safety and the 5.9 GHz Band. Washington. Retrieved from <https://www.transportation.gov/content/traffic-safety-and-59-ghz-band-0>

⁶ United States Department of Transportation. (2019, November). U.S. DOT Workshop on Consumer Education and Communications around Advanced Vehicle Technologies: Summary Report. Retrieved from <https://www.transportation.gov/sites/dot.gov/files/docs/policy-initiatives/automated-vehicles/357911/adsccommunicatorsreport11-13-19finalweb.pdf>

⁷ United States Department of Transportation. (2020, April 17). Access and Mobility for All Summit. Retrieved from <https://www.transportation.gov/accessibility>

⁸ United States Department of Transportation. (2020, October 1). Coordinating Council on Access and Mobility. Retrieved from <https://www.transit.dot.gov/coordinating-council-access-and-mobility>.

In July 2020, U.S. DOT celebrated the 30th anniversary of the Americans with Disabilities Act by awarding a new University Transportation Center (UTC) grant to the University of Pittsburgh, in consortium with the Uniformed Services University of Health Sciences and the Catholic University of America, to research the implications of automated vehicles and mobility services for people with disabilities. The Department also announced a commitment to establish a library of resources for accessibility in automation and to work with outside experts to study voluntary best practices for ensuring accessibility in automated vehicles.⁹

[Public Listening Summit on Automated Vehicle Policy](#)

On March 1, 2018, U.S. DOT hosted a Public Listening Summit on Automated Vehicle Policy. Stakeholders and the public were invited to attend a summit with senior leadership from U.S. DOT, State and local partners, industry, academia, and safety advocates at U.S. DOT Headquarters. The event focused on key cross-modal issues that are important to the successful integration of automated vehicles into our Nation's surface transportation system. The event was webcast live and hosted alongside a docket in the *Federal Register* (Docket No. DOT-OST-2018-0017) to allow stakeholders and the public to submit information both before and after the event.¹⁰

[ITS Professional Capacity Building Program](#)

The Intelligent Transportation Systems Professional Capacity Building (ITS PCB) Program¹¹ is the Department's primary mechanism for educating the transportation workforce about ITS. Housed within the U.S. DOT's ITS Joint Program Office (ITS JPO), the program has provided the transportation workforce with flexible, accessible ITS learning and support through live and on demand training, technical assistance, and educational resources for over two decades. The program assists current and future transportation professionals in developing their knowledge, skills, and abilities to build technical proficiency while furthering their careers. In addition, the program focuses on community building where coalitions, centers, cohorts, and awareness/education/training on automation and emerging technologies will play a significant role in ITS deployment.

[Data for Automated Vehicle Integration](#)

Access to data is a critical enabler for the safe, efficient, and accessible integration of automated driving systems (ADS) into the transportation system. Lack of access to data could impede ADS integration and delay its safe introduction. U.S. DOT, through the ITS JPO, launched the Data for Automated Vehicle Integration (DAVI) as a multimodal initiative to identify, prioritize, monitor, and—where necessary—address data exchange needs for ADS integration across the modes of transportation.

The Department continues to identify potential data exchange priorities via various stakeholder engagement activities.¹²

⁹ <https://www.transportation.gov/briefing-room/us-department-transportation-celebrates-30th-anniversary-americans-disabilities-act>

¹⁰ United States Department of Transportation. (2018, August 18). *U.S. DOT Public Listening Summit on Automated Vehicle Policy*. Retrieved from <https://www.transportation.gov/AV/avsummit>

¹¹ United States Department of Transportation Intelligent Transportation Systems Joint Program Office. (n.d.). ITS Professional Capacity Building Program. Retrieved from <https://www.pcb.its.dot.gov/>

¹² Additional information on previous projects and opportunities to engage is available at U.S. Department of Transportation. (n.d.). Data for Automated Vehicle Integration (DAVI). Retrieved from <https://www.transportation.gov/av/data>.

Goal: Modernize the Regulatory Environment

Preparing for the Future of Transportation: Automated Vehicles 3.0 (AV 3.0)

This document builds upon *ADS 2.0* and expands the scope to provide a systematic framework and multimodal approach to the safe and full integration of automated vehicles into the Nation's broader surface transportation system.

Ensuring American Leadership in Automated Vehicle Technologies (AV 4.0)

U.S. DOT and the White House Office of Science and Technology Policy, Executive Office of the President developed this report. This document presents the USG's posture for surface transportation automated vehicles based on a future vision in which American innovators are global leaders, implementing this technology in the United States and around the world in a safe and secure manner.

Non-Traditional and Emerging Transportation Technology (NETT) Council

The NETT Council is an internal deliberative body within U.S. DOT tasked with identifying and resolving jurisdictional and regulatory gaps that may impede the deployment of new multimodal technology, such as tunneling, hyperloop, automated vehicles, and other innovations.¹³

Regulatory Reform Task Force

Established in response to Executive Order 13777, "Enforcing the Regulatory Reform Agenda" (February 24, 2017), the Regulatory Reform Task Force is the Department's internal body tasked with evaluating proposed and existing regulations and making recommendations to the Secretary of Transportation regarding their promulgation, repeal, replacement, or modification, consistent with applicable law.¹⁴

Goal: Prepare the Transportation System

Accessibility Research

U.S. DOT is conducting research into the current state of the market for accessible passenger vehicles, particularly those geared toward personal use, as well as the opportunities introduced by ADS to expand access to shared and personally owned vehicles. In addition to identifying existing standards and best practices for building accessible passenger vehicles, U.S. DOT is exploring how the introduction of Level 4 and 5 ADS affects the business case for accessible vehicles.

Highly Automated Safety Systems Center of Excellence (HASS COE)

Fiscal year 2020 U.S. DOT appropriations provided \$5 million for the establishment of a new Highly Automated Safety Systems Center of Excellence (HASS COE) to review, assess, and validate the safety of automated technologies. DOT has recently filled the director position for the HASS COE and is in the process of standing up the Center as part of the Office of the Assistant Secretary for Research and Technology. The Center's mission is to help assure that advancing automation in transportation functions safely, can be integrated safely into existing traffic streams, and that any underlying

¹³ United States Department of Transportation. (2020, March 5). Overview - Non-Traditional and Emerging Transportation Technology (NETT) Council. Retrieved from <https://www.transportation.gov/nettcouncil>

¹⁴ United States Department of Transportation, Office of the Secretary. (2019, December 27). Administrative Rulemaking, Guidance, and Enforcement Procedures: Final Rule. Federal Register, 84(248), 71714-71734. Retrieved from <https://www.transportation.gov/sites/dot.gov/files/2020-03/Fed%20Reg%20Published%20Final%20Admin%20Rule.pdf>

navigational infrastructure is reliable. The HASS COE will have a multimodal workforce of experts in fields such as big data, machine learning, artificial intelligence, and in other disciplines as needed.¹⁵

University Transportation Center (UTC) Grants

In 2019, U.S. DOT announced more than \$60 million in funding, a portion of which is for automated vehicles, to 32 UTCs¹⁶ and added two new UTCs to the program.¹⁷ In the past year, 19 UTCs conducted more than 30 research projects related to automated vehicles. The UTCs advance research, education, and technology transfer programs that address the Nation’s critical transportation challenges. Fiscal Year 2020 U.S. DOT appropriations included \$5 million for the support of new UTCs (without multiyear funding commitments). U.S. DOT issued awards to four UTCs aimed at specific research needs, including one on “Highly Automated Transportation Systems Research” to complement the HASS COE’s work, and one on “Implications of Accessible Automated Vehicles and Mobility Services for People with Disabilities.”¹⁸

Annual Modal Research Plans (AMRP)

The Fixing America's Surface Transportation (FAST) Act requires that each operating administration and the ITS JPO submit a comprehensive annual research plan for the upcoming fiscal year and a detailed outlook for the following fiscal year to OST.

OST actively continues to coordinate research activities across all modes to ensure that there is no duplication of research efforts. The office is also developing a new performance management tool to facilitate research management and promote consistency and efficiency across modal research plans.¹⁹

Driving Automation Systems in Long-Haul Trucking and Bus Transit: Preliminary Analysis of Potential Workforce Impacts

The 2018 Consolidated Appropriations Act provided funding to the Secretary of Transportation, in consultation with the Secretary of Labor, to “conduct a comprehensive analysis of the impact of ADAS (Advanced Driver-Assistance Systems) and HAV (Highly Automated Vehicles) technologies on drivers and operators of commercial motor vehicles, including labor displacement.” The U.S. DOT is preparing a forthcoming Report to Congress addressing this requirement.²⁰

¹⁵ <https://www.transportation.gov/utc/highly-automated-systems-safety-center-excellence>

¹⁶ United States Department of Transportation. (2019, February 5). U.S. Department of Transportation Announces More than \$60 Million in Funding for Leading Transportation Research. Washington, DC. Retrieved from <https://www.transportation.gov/briefing-room/dot0119>

¹⁷ United States Department of Transportation. (2019, June 5). U.S. Department of Transportation Announces Selection of Two New University Transportation Centers. Washington, DC. Retrieved from <https://www.transportation.gov/briefing-room/us-department-transportation-announces-selection-two-new-university-transportation>

¹⁸ United States Department of Transportation. (2020, July 31). U.S. Department of Transportation Announces Competitive Grant Solicitation for Nearly \$5 Million to 4 New University Transportation Research Centers. Retrieved from <https://www.transportation.gov/briefing-room/us-department-transportation-announces-nearly-5-million-4-new-university-0>

¹⁹ <https://www.transportation.gov/administrations/assistant-secretary-research-and-technology/rdt-annual-modal-research-plans> <https://www.transportation.gov/administrations/assistant-secretary-research-and-technology/rdt-annual-modal-research-plans>

²⁰ <https://www.transportation.gov/av/workforce>

[Inclusive Design Challenge](#)

On April 21, 2020, Secretary Chao announced the opening of Stage I of the Inclusive Design Challenge (Challenge). The Challenge seeks innovative design solutions that can enable people with physical, sensory, and cognitive disabilities to use ADS-equipped vehicles to access jobs, healthcare, and other critical destinations. Participants will compete in two stages for an overall prize purse of up to \$5 million. U.S. DOT expects the Challenge to run through summer 2022.²¹

[Better Utilizing Investments to Leverage Development, or BUILD Transportation Discretionary Grant Program \(BUILD Grants\)](#)

The BUILD Transportation Discretionary Grant program provides a unique opportunity for U.S. DOT to invest in road, rail, transit, and port projects that promise to achieve national objectives. Previously known as Transportation Investment Generating Economic Recovery, or TIGER Discretionary Grants, Congress has dedicated nearly \$7.9 billion for 11 rounds of National Infrastructure Investments to fund projects that have a significant local or regional impact. In each competition, U.S. DOT receives hundreds of applications to build and repair critical pieces of the Nation's freight and passenger transportation networks, including infrastructure projects related to automation. In the 2018 BUILD round, three ADS deployments were selected: Youngstown, Ohio; Jacksonville, Florida; and Las Vegas, Nevada. The 2019 BUILD round supported infrastructure improvements to facilitate local adoption of automated vehicles in Orange County, Florida.²²

[ADS Demonstration Grants](#)

On September 18, 2019, Secretary Chao announced nearly \$60 million in Federal grant funding to eight projects in seven States across the country as part of the ADS Demonstration Grants Program. This program appropriates funding for a "highly automated vehicle research and development program" to fund planning, direct research, and demonstration grants for ADS and other driving automation systems and technologies. The Department prioritizes data collection and sharing to make informed decisions and collectively strive for increased safety of ADS. These grants include activities aimed at gathering significant safety data to inform rulemaking and foster collaboration among State and local government and private partners.²³ Through this grant program, and planned initiatives, the Department aims to achieve data transparency and make data more accessible to relevant stakeholders.²⁴

[ITS JPO Automation Research and Standards Programs](#)

ITS JPO collaborates across the Department to conduct research on ADS safety, mobility and policy issues related to transportation system management and operation, highway infrastructure, and vehicles; to develop and test cooperative driving automation; and to guide safe, secure, and efficient

²¹ United States Department of Transportation. (2020, May 6). *Inclusive Design Challenge*. Retrieved from <https://www.transportation.gov/accessibility/inclusivedesign>

²² United States Department of Transportation. (2020, April 15). About BUILD Grants. Retrieved from <https://www.transportation.gov/BUILDgrants/about>

²³ United States Department of Transportation. (2019, September 18). U.S. Secretary of Transportation Announces Automated Driving System Demonstration Grant Winners. Washington, DC. Retrieved from <https://www.transportation.gov/briefing-room/us-secretary-transportation-announces-automated-driving-system-demonstration-grant>

²⁴ <https://www.transportation.gov/av/grants>

interoperable deployment of infrastructure, connected, and automated ITS technologies. Examples of ITS JPO-funded research include policy studies, white papers, and benefit assessment framework tools.²⁵

The ITS Architecture and Standards Programs provide a reference system architecture framework along with software tools and deployment support and supports development and adaptation of voluntary technical standards for interoperable ITS deployment support. This reference architecture identifies interfaces for standardization and identifies suitable information and communication technologies (ICT) and ITS standards—identifying and enabling multiple suitable technology choices whenever viable. The standards portion of the program supports the development of needed ITS-specific standards in cooperation with well-known Standards Development Organizations via their stakeholder consensus processes; as well as evaluation, and, when beneficial, adaptation of ICT standards to most effectively meet ITS deployment needs. For example, ITS JPO has partnered with the Federal Highway Administration (FHWA) and SAE International to quickly develop *SAE J3216: Taxonomy and Definitions for Terms Related to Cooperative Driving Automation for On-Road Motor Vehicles*.²⁶ Additionally, work is underway to update ITS infrastructure standards, including the National Transportation Communications for ITS Protocol (NTCIP), Traffic Management Data Dictionary (TMDD) and others to accommodate the interoperable integration of automation into the ITS infrastructure.

National Highway Traffic Safety Administration (NHTSA)

Background and Goals

NHTSA is committed to saving lives while enabling the safe testing and development of innovative safety vehicle technologies.

NHTSA has broad authority to address the safety of motor vehicles and motor vehicle equipment, including new concepts and technologies.²⁷ NHTSA is responsible for protecting the safety of the driving public against unreasonable risks of harm that may arise because of the design, construction, or performance of a motor vehicle or motor vehicle equipment, and using its regulatory and enforcement authorities, as appropriate, to mitigate unreasonable risks to safety. NHTSA's role with respect to ADS is to explore objective and practical performance metrics and evaluative methods to assess the safety and benefits of ADS-equipped vehicles, and investigate and take enforcement action if any innovative technologies present an unreasonable risk to safety.

²⁵ U.S. Department of Transportation. (2019, June 1). Meta-Analysis of Adaptive Cruise Control Applications: Operational and Environmental Benefits. Retrieved from <https://rosap.nhtl.bts.gov/view/dot/41929>; U.S. Department of Transportation. (2018, January 1). Benefits Estimation Model for Automated Vehicle Operations: Phase 2 Final Report. Retrieved from <https://rosap.nhtl.bts.gov/view/dot/34458>; U.S. Department of Transportation Intelligent Transportation Systems Joint Program Office. (2019, November 1). Understanding Surveys of Public Sentiment Regarding Automated Vehicles: Summary of Results to Date and Implications of Past Research on the Dynamics of Consumer Adoption. Retrieved from <https://rosap.nhtl.bts.gov/view/dot/43628>; U.S. Department of Transportation Intelligent Transportation Systems Joint Program Office. (n.d.). ITS Professional Capacity Building Program. Retrieved from <https://www.pcb.its.dot.gov/>

²⁶ https://www.sae.org/standards/content/j3216_202005/

²⁷ Motor Vehicle Safety, 49 United States Code Chapter 301.

Activities

Goal: Promote Transparency

Public Awareness and Confidence

NHTSA seeks to increase public awareness and transparency around ADS technologies and their testing and development. NHTSA established the voluntary safety self-assessment (VSSA) as a mechanism for entities that are developing and testing ADSs to communicate how they are prioritizing safety. As companies release a VSSA, NHTSA links to these materials on its VSSA Disclosure Index on its website.

More generally, NHTSA has issued or is developing 10 different *Federal Register* notices (listed later in this document), seeking public input on a wide variety of issues related to the accommodation and safety of ADS-equipped vehicles.

Understanding Roles

NHTSA is conducting research to inform the public about how ADS-equipped vehicles may interact with them. This would include research related to assessing the necessary controls, telltales, and indicators to convey information to vehicle occupants. For pedestrians and other road users, including people with disabilities, the research includes examining how people with disabilities will communicate and interact with ADS-equipped vehicles to allow these vehicles to convey their intent better.

First Responder Preparedness

NHTSA has always kept the safety of law enforcement, fire services, and emergency medical services personnel as a priority with the testing and operation of advanced technologies. ADS-equipped vehicles may introduce new challenges as the technology progresses to take more control over the driving task and lead to a scenario where a human is not present in a motor vehicle. This presents many unresolved questions and concerns on first responder preparedness to interact with ADS-equipped vehicles to fulfill their responsibilities. When driving to the scene of an emergency, first responders need assurance that the ADS-equipped vehicles they encounter will react appropriately and not put them in further danger. Examples include strict adherence to “Move Over” and Slow Down laws on the books in all 50 States designed to protect first responders. NHTSA is working with its modal U.S. DOT counterparts to explore the topic of ADSs, emergency response, and public safety in order to determine the need for Federal action, if any. Key objectives of this effort are to collect relevant literature, speak with stakeholders, and develop a synthesis describing potential best practices and needs.

Safe Road Users Education

NHTSA is planning to conduct consumer market research to help identify the most effective way to communicate with and educate consumers about the different levels of driving automation. The research will generate a greater understanding of the consumer’s knowledge of the six different levels of automation technology, what types of technologies comprise those levels, and how to communicate functionalities and limitations of these technologies so that consumers are better informed when making vehicle purchasing decisions. These efforts will also further inform NHTSA’s social and paid media to increase consumer familiarity with advanced vehicle technologies, inform outreach efforts at consumer events, and enhance public-facing materials on NHTSA’s website.

Active Monitoring and Engagement with ADS Technologies and Advanced Driver Assistance Systems (ADAS)

NHTSA is preparing for the future deployment of ADS-equipped vehicles and their potential building blocks, ADAS, by focusing on newly deployed technologies in service and gaining understanding about

future technologies. NHTSA has also updated its data collection systems to require and isolate Early Warning Reporting data about ADASs and cybersecurity issues known to vehicle manufacturers.

Goal: Modernize the Regulatory Environment

Advance Notice of Proposed Rulemakings (ANPRM), Pre-Rule Stage²⁸

- **ANPRM on Removing Regulatory Barriers for Automated Driving Systems (ADS):** NHTSA issued an ANPRM on May 28, 2019, to seek comments on existing motor vehicle regulatory barriers in NHTSA's crash avoidance Federal Motor Vehicle Safety Standards to the innovative vehicle designs that often accompany vehicles equipped with ADS. NHTSA previously published a Request for Comments (RFC) in the *Federal Register* requesting public comment on a range of issues on January 18, 2018. In response to comments received from the January notice, the agency initiated this ANPRM to begin the rulemaking process. Additionally, NHTSA is developing the appropriate analysis of requirements that are necessary to maintain the administration's continued focus on safety, while enabling innovative vehicle designs that often accompany vehicles equipped with ADS and removing or modifying those requirements that would no longer be appropriate if a human driver will not be operating the vehicle.
- **ANPRM on the Pilot Program for Collaborative Research on Motor Vehicles with High or Full Driving Automation:** NHTSA issued an ANPRM on October 10, 2018, to obtain comments on creating a national ADS Pilot Program for the testing of ADS-equipped vehicles and associated equipment. NHTSA is currently evaluating comments and developing next steps.
- **ANPRM on Considerations for Telltales, Indicators, and Warnings in ADS Vehicles:** This action will seek comments on amending the Federal Motor Vehicle Safety Standards (FMVSS) to address the applicability and appropriateness of safety messaging (telltales, indicators, and warnings) in vehicles without conventional driver controls. NHTSA is currently doing research to inform the development of the *Federal Register* Notice.
- **ANPRM on Safety Principles for Automated Driving Systems:** This notice will request comment on potential regulatory approaches for ADS. The agency will seek public comments on the creation of a safety framework for defining, assessing, and providing for the safety of ADS, while allowing safety innovations and novel designs to be introduced into commerce more efficiently. NHTSA is currently developing this ANPRM.
- **ANPRM on Occupant-less Delivery Vehicles Equipped with Automated Driving Systems:** This action will seek comment on amending regulations that may be necessary to facilitate the certification of motor vehicles without a passenger compartment. NHTSA published a *Federal Register* notice on January 18, 2018, requesting comment on existing regulatory barriers that may block the introduction and certification of ADS-equipped vehicles, particularly those without human controls. In response to comments received from the January notice, the agency is developing this ANPRM to seek public input.

²⁸ Office of Information and Regulatory Affairs. (n.d.). Agency Rule List - Fall 2019: Department of Transportation. Retrieved from https://www.reginfo.gov/public/do/eAgendaMain?operation=OPERATION_GET_AGENCY_RULE_LIST¤tPub=true&agencyCode=&showStage=active&agencyCd=2100&Image58.x=48&Image58.y=3

- **ANPRM on Specialized Motor Vehicles with Automated Driving Systems:** This notice will seek comment on establishing regulatory requirements specific to classes of specialized motor vehicles equipped with ADS.

Notice of Proposed Rulemakings, Proposed Rule Stage

- **NPRM on Expansion of Temporary Exemption Program to Domestic Manufacturers for Research, Demonstrations, and Other Purposes:** The NPRM will propose a new regulation allowing entities to request exemptions to operate nonconforming vehicles, on public roads for purposes of research, investigations, demonstrations, training, competitive racing events, show, or display, but not sale or lease.
- **NPRM on Updating the Process for Temporary Exemptions:** This action will seek comment on existing motor vehicle regulatory barriers to the introduction and certification of innovative motor vehicle technologies. This action proposes to update 49 CFR part 555, "Temporary Exemption from Motor Vehicle Safety and Bumper Standards." NHTSA will seek to make the temporary exemption process more streamlined and efficient to accommodate the introduction of innovative technologies, as well as seek comment on strategies to update the temporary exemption process.
- **NPRM on Occupant Protection for ADS:** This action proposes to amend crashworthiness regulations that may be necessary to facilitate the certification of motor vehicles equipped without driver controls. This NPRM was developed in response to an RFC published on January 18, 2018, which focused on existing regulatory barriers that may block the introduction and certification of ADS-equipped vehicles, particularly those without human controls. This notice was published in the *Federal Register* on March 30, 2020. NHTSA is currently evaluating comments and developing a final rule.

International Engagement

NHTSA is actively engaged in the UNECE Global Forum for Road Traffic Safety (WP.1) and World Forum for the Harmonization of Vehicle Regulations (WP.29).

Under WP.1, NHTSA is monitoring and guiding the development of a non-binding legal resolution serving as a guide for the countries which are Contracting Parties to the 1949 (Geneva) and 1968 (Vienna) Conventions on Road Traffic in relation to the safe deployment of highly and fully automated vehicles in road traffic consistent with U.S. policy. The resolution offers recommendations to ensure the safe interaction between automated vehicles, other vehicles and—more generally—all road users, and stresses the key role of human beings, be they drivers, occupants, or other road users. WP.1 intends to amend the resolution as the technology develops and as experience accumulates.

Under WP.29, NHTSA proposed the development of a framework on automated vehicles modeled after *ADS 2.0* and *AV 3.0* voluntary guidance on the subject. This framework, which was adopted by WP.29, included working principles, and key safety aspects to be considered by all bodies. NHTSA also proposed the establishment of a Working Party (Groupe de R Rapporteurs – GR) on Automated/Autonomous and Connected Vehicles (GRVA) to work on safety and cybersecurity matters. GRVA recently formed four sub-groups to address specific topical areas related to automated vehicles each co-chaired from North America, Europe, and Asia. The groups are tasked to identify a series of technical elements/requirements that could be later incorporated into a regulation, voluntary guidelines, or a global technical regulation.

Other Activities

Temporary Importation of Motor Vehicle or Equipment

Under Part 555 of 49 U.S.C. 30114, temporary exemptions are permitted for vehicles for the purpose of research, investigations, demonstrations, training, competitive racing events, show, or display. This exemption authority is not limited to vehicle manufacturers, but currently implemented only for imported vehicles where NHTSA is actively engaged in the approval and monitoring of these ADS-equipped vehicle pilot projects. These activities require project and route reviews, agreements on operating conditions, and in-depth exchanges between NHTSA and the technical staff of the vehicle owners and operators relating to the technologies employed in the vehicles and their limitations. See “NPRM on Expansion of Temporary Exemption Program to Domestic Manufacturers for Research, Demonstrations, and Other Purposes,” where NHTSA announced intent to expand implementation to include domestically produced motor vehicles.

Goal: Prepare the Transportation System

Unintended Regulatory Barriers

Historically, Federal Motor Vehicle Safety Standards (FMVSS) have been developed and drafted based on the concept of assumption that each vehicle will have a human driver operating the vehicle. With the introduction of ADSs, the driving tasks are increasingly shifted to the vehicle. The absence of a human driver creates opportunities for vehicle manufacturers to design new vehicle architectures that may remove driving controls, change seating configurations, and establish new interfaces for passengers. Existing FMVSS may present unintended barriers for vehicles without drivers, in some instances by referring to the driver for reference purposes, and in others by tying test performance to human-performed actions and controls. The objective of this research area is to gather data and evidence that could support decisions about potential adaptation of regulations to address unnecessary barriers for such innovative designs while ensuring equivalent levels of safety and performance of systems and components covered by FMVSS regulations.

Safety Metrics and Safety Assessment Models

This research will explore the evaluative methods, performance metrics, and test devices to assess how the ADS-equipped vehicle performs at a system level to operate safely in normal driving situations, comply with traffic laws and regulations, and avoid crashes. This includes system performance and behavior relative to the system’s operational design domain (ODD) and stated Object and Event Detection and Response (OEDR) capabilities. Research will be conducted to explore the safety performance of ADS-equipped vehicle implementations. Additionally, research will be performed to study the feasibility and methods to assess normal driving capabilities of an ADS-equipped vehicle, which treats the dynamic driving tasks (previously undertaken by the human driver) as behavioral competencies or maneuvers that can be measured and tested much in the way a human driver is evaluated to ensure driving competency. The objective of this research area is to identify the methods, metrics, and tools to measure, test, and assess the system performance of ADS-equipped vehicles.

Functional Safety and ADS Subsystems

The safe operation and reliable performance of ADS are critical to public acceptance and successful deployment of future ADS-equipped vehicle. As the dynamic driving tasks are transferred from the human driver to the driving system, human sensing and cognition functions are essentially relegated to the machine through a collection of integrated hardware and software subsystems. Accordingly, methods and tools are necessary to assess the functional safety of ADS subsystems and their building block components. In addition, it can be predicted that a collection of new failure modes will surface

through the introduction of these subsystems into the automotive system architecture. Robust methods will be needed by stakeholders to identify causality of failures rooted in these software-intensive subsystems. The objective of this research area is to establish the capability to assess the functional safety of components and subsystems of ADSs, which can augment the system-level safety assessment.

Crashworthiness in Alternative Vehicle Designs

Vehicle crash mechanics and occupant restraint systems are not directly affected by vehicle automation. However, occupant behavior and the enhanced sensor systems will affect priorities for a vehicle's safety in the event of a crash. ADS technology will affect occupant crash protection in several ways. First, ADS-equipped vehicles are projected by numerous forecasts to generally result in lower-frequency and lower-severity crashes. However, until the U.S. fleet is predominantly equipped with effective ADSs, vehicle crashworthiness will remain an important design concern. The relative frequency of different crash types is likely to change for ADS-equipped vehicles. Fewer single-vehicle and run-off-road crashes could be anticipated. Crashes with manually operated vehicles will inevitably occur during the transition period, and crashworthiness design choices should anticipate this. ADS may be implemented in some vehicle segments sooner than others. This uneven deployment should be reflected in research priorities. ADS-equipped vehicle users will be less accepting of crash risk due to lack of control. This will enhance expectations of safety performance for crashes that still occur. ADS-equipped vehicle users will be less aware of traffic conditions. Their lack of awareness will enhance the need for occupant notification for crash avoidance or mitigation maneuvers.

Occupant crash safety must consider all seating positions, as ADS-equipped vehicle users will not preferentially occupy the left front position. ADS-equipped vehicle users can be expected to adopt a wider range of seating postures, so increased seat recline angles should be anticipated. ADS-equipped vehicles may incorporate novel occupant compartment designs and seating conditions. Side- and rear-facing seat positions are common for transit buses and may be considered for smaller, higher-speed ADS-equipped vehicles. Occupant restraint systems may have to be redesigned to meet safety expectations for new vehicle designs. A major benefit of ADS involves greater access to mobility for people with disabilities. Novel interior configurations for ADS-equipped vehicles are anticipated to accommodate this critical stakeholder community. Changes in occupant seating and restraint systems will affect the injury mechanisms and risk factors. Research should consider injury potential and enhance best practices where appropriate. Occupant-less ADS-equipped vehicles will present new challenges to ensure that these new vehicle types interact well with existing vehicles and roadside hardware. Based on these anticipated changes to occupant safety in ADS-equipped vehicles, three main areas of crashworthiness research are planned: 1) occupant protection—alternative interior designs, 2) occupant-less vehicles, and 3) field data analysis.

Human Factors Research for ADS-Equipped Vehicles

For ADS-equipped vehicles meeting SAE level 3 definition, as well as some SAE Level 4 vehicles having human operator controls, there will be instances involving control handoff between drivers and ADSs in certain circumstances. A driver's readiness to resume control is critical to safety. NHTSA is engaged in human factors research related to assessing and evaluating various methods for notifying and engaging the human driver in the driving task as needed to maintain safe operation of the vehicle.

Accessibility Considerations for ADS-Equipped Vehicles

Driving automation is expected to provide mobility options not previously afforded to people with physical, sensory, and/or cognitive disabilities. ADS-equipped vehicles that are accessible to persons with disabilities will be expected to provide information through appropriate methods to interact with

the occupants. Research will be initiated to explore the information needs of persons with disabilities and how these needs could be implemented effectively within a human-machine interface (HMI).

ADSs and Human Interaction

The introduction of ADS-equipped vehicles and vehicles without a human driver in particular may change or influence the behavior of pedestrians, bicyclists, passengers, and other humans using the roadway. Research is needed to understand human behavior in response to automation and the new challenges such interactions will bring.

Vehicle Cybersecurity Research

Cybersecurity challenges and concerns are not unique to emerging/future ADS-equipped vehicles.²⁹ Rather, cybersecurity is already a major consideration for modern vehicles built and sold today given that they include many of the building blocks for ADS-equipped vehicles such as perception systems, wireless connectivity to off-board systems, and limited automatic vehicle control systems (e.g., automatic emergency braking). Cybersecurity considerations for ADS-equipped vehicles will build upon the vehicle cybersecurity protections and processes designed to address modern vehicle cybersecurity issues broadly.

Federal Motor Carrier Safety Administration (FMCSA)

Background and Goals

FMCSA's goal is to facilitate the safe introduction of ADS-equipped commercial motor vehicles (CMVs) onto our Nation's roadways. The agency plays a critical role in understanding and addressing barriers for the safe deployment of ADS in CMV applications as outlined in *AV 3.0* and further emphasized in *AV 4.0*. While NHTSA has broad authorities regarding the safety of motor vehicles and motor vehicle equipment—thus the performance of the vehicle components that enable automated driving—FMCSA has broad authority over the safe operations of commercial motor vehicles, including those equipped with ADS. Specifically, FMCSA's mission is to reduce crashes and fatalities associated with CMVs and its regulatory jurisdiction encompasses CMV operators, certain CMV safety components, and interstate CMV operations. This uniquely positions FMCSA to leverage its existing relationships with industry, labor, safety advocacy, and enforcement stakeholders to understand automation's impact across the commercial vehicle and freight ecosystem.

Trucking, a nearly \$800 billion industry,³⁰ is central to the American economy. The industry's resilience has been demonstrated in response to the COVID-19 Public Health Emergency, as drivers move critical medical supplies, food, and household products to Americans in need. ADS technology offers the potential to drive the industry and the Nation's economic competitiveness further, while making our roads safer for drivers and passengers. The trucking industry is expected to be an early adopter of ADS, and, as highlighted in *AV 4.0*, automation is expected to offer significant supply-chain management efficiencies.

In *AV 3.0*, FMCSA made clear that the operator of a CMV could either be a human or machine. Based on this overarching determination, FMCSA outlined, and has since executed upon, several additional steps to help advance the safe development and deployment of ADS-equipped CMVs, including: (1) publishing an ANPRM to solicit feedback on specific regulatory questions and identify regulatory gaps; (2) hosting public listening sessions to gather feedback on the ANPRM, as well as to seek input on issues related to

²⁹ <https://www.nhtsa.gov/technology-innovation/vehicle-cybersecurity#resources>

³⁰ American Trucking Association. (n.d.). Economics and Industry Data. Retrieved from <https://www.trucking.org/economics-and-industry-data>

the design, development, testing, and integration of ADS; and (3) developing policy recommendations on ADS technology. FMCSA used findings from these activities to further refine and inform its regulatory, research, and stakeholder engagement and education strategies.

To continue driving toward a future that improves safety outcomes and enables innovation, FMCSA will focus on identifying areas for regulatory modernization, educating the trucking community and motoring public on ADAS and ADS technologies, and engaging in critical ADS research specific to CMVs. Through this, FMCSA will prioritize safety, proactively prepare for automation, enable innovation by remaining technology-neutral, encourage a consistent regulatory and operational environment, and promote collaboration and a shared understanding of the current state of the technology.

Activities

Goal: Promote Transparency

Multimodal Panel and Listening Session

In July 2019, FMCSA leadership attended the Automated Vehicles Symposium 2019 to learn more about automated vehicle technology development, share FMCSA's perspective by participating in panel discussions and delivering a keynote address, and convene stakeholders including government officials, law enforcement representatives, first responders, researchers, technologists, and more, for a Multimodal Panel and Listening Session. Notable themes that emerged during the listening session from commenters included a desire for continued industry-government collaboration to ensure the safe testing and deployment of automated vehicles and the need for coordinated public education and outreach efforts to promote public acceptance and trust. At the July 2020 Automated Vehicles Symposium virtual online conference, FMCSA participated on automated trucking panels and breakout sessions. FMCSA discussed its research activities and future plans related to both ADAS and ADS.

Truck Safety Summit Technology Panel and Listening Session

FMCSA hosted a safety summit to solicit information on improving the safe operation of property-carrying CMVs. The conference brought together stakeholders from across the CMV ecosystem to share suggestions, ideas, and strategies for improving trucking safety. As part of the conference, FMCSA hosted panel discussions on ADAS applications in CMVs and their safety implications for drivers and the motoring public. At the conclusion of the conference, FMCSA hosted a brief public comment period that allowed attendees to share their perspectives.

Additional Educational Events and Listening Sessions

FMCSA anticipates that it will schedule listening sessions following the publication of its upcoming NPRM, to further solicit input from across the ecosystem and refine as necessary. Additionally, FMCSA intends to expand its current educational campaigns on how the motoring public should interact with CMVs to incorporate ADAS, ADS, and other possibly lifesaving technologies.

FMCSA will continue to engage with key stakeholder groups on the safety benefits of ADAS and ADS technologies that are currently being developed, tested, and deployed for CMVs. Planned outreach will include facilitating collaborative sessions with industry for development of industry-based consensus standards for the operation of ADS-equipped CMVs; hands-on technology demonstrations and trainings to provide exposure for the trucking and law enforcement communities; and a knowledge-sharing program on communicating capabilities and limitations to both CMV operators and the public, to improve awareness and safety outcomes.

Goal: Modernize the Regulatory Environment

Notice of Proposed Rulemaking (NPRM) on ADS

FMCSA intends to publish a forthcoming Notice of Proposed Rulemaking (NPRM) regarding ADS that will propose changes to CMV operations, inspection, repair, and maintenance regulations to prioritize safety and security; promote innovation; and foster a consistent regulatory approach to ADS-equipped CMVs. This NPRM will build on the ANPRM published in 2019 and will incorporate findings from stakeholder feedback and additional research.

Goal: Prepare the Transportation System

CMV-Focused Research on ADS and Workforce Impacts

FMCSA is currently leading or participating in several significant research demonstration initiatives that will help inform its future guidance, education, and regulatory activities. Notable examples include:

- **ADS Performance Research:** FMCSA's Office of Analysis, Research, and Technology has funded several ADS research projects, including the Development of Baseline Safety Performance Measures for Highly Automated Commercial Vehicles,³¹ Research on Sensor Performance for Automated CMV Applications,³² and the Automated CMV Evaluation (ACE) program, in partnership with FHWA's CARMA platform.³³ The ACE program is currently focusing on testing roadside inspections for ADS-equipped CMVs, work zone scenarios, emergency response, post-crash investigations, and international border crossing situations in partnership with both FHWA and NHTSA. Working closely with the Commercial Vehicle Safety Alliance (CVSA),³⁴ FMCSA organized and supported the CVSA member State enforcement agencies to develop an inspection framework for ADS-equipped CMVs.
- **Human Factors Research:** As FMCSA begins to consider the use of automation by motor carriers and commercial drivers, it will be critical to understand the parameters under which these systems can be used safely in light of human factors limitations. "Understanding Limitations for Drivers of ADS-Equipped CMVs"³⁵ is a research study led by FMCSA's Office of Analysis, Research, and Technology that will develop an understanding of human factors challenges for automated CMV applications and provide data to address future policy questions from emerging automated business cases (e.g., human-automated team driving).

³¹ Federal Motor Carrier Safety Administration. (2020, March 10). Development of Baseline Safety Performance Measures for Highly Automated Commercial Vehicles. Retrieved from <https://www.fmcsa.dot.gov/research-and-analysis/technology/development-baseline-safety-performance-measures-highly-automated>

³² Federal Motor Carrier Safety Administration. (2019, March 7). Research on Sensor Performance for Automated Commercial Motor Vehicle (CMV) Applications. Retrieved from <https://www.fmcsa.dot.gov/research-and-analysis/technology/research-sensor-performance-automated-commercial-motor-vehicle-cmv>

³³ Federal Motor Carrier Safety Administration. (2020, January 14). FMCSA's Automated Vehicle Research. Transportation Research Board 99th Annual Meeting. Washington. Retrieved from <https://www.fmcsa.dot.gov/sites/fmcsa.dot.gov/files/2020-01/Advanced-Driving-Assistance-Systems-and-Automated-CMV-Evaluations-1-14-2020-508c.pdf>

³⁴ Commercial Vehicle Safety Alliance. (n.d.). *About the Alliance*. Retrieved from <https://www.cvsa.org/about-us/page/about-cvsa/overview-of-cvsa/about-the-alliance/>

³⁵ Federal Motor Carrier Safety Administration. (2020, March 6). Understanding Limitations for Drivers of ADS-Equipped CMVs. Retrieved from <https://www.fmcsa.dot.gov/safety/research-and-analysis/understanding-limitations-drivers-ads-equipped-cmvs>

- **Consumer Adoption Research:** *AV 4.0* acknowledges that ADAS is a critical building block for ADS along the path to full integration and consumer acceptance. FMCSA’s Office of Analysis, Research, and Technology’s research project, “Tech-Celerate NOW—Accelerating the Adoption of Advanced Driver Assistance Systems (ADAS),”³⁶ aims to accelerate the adoption of ADAS by the trucking industry to progress towards safety benefits of ADAS. Since it began in October 2019, the project has provided ADAS information (e.g., meetings, presentations, webinars, and emailings) to over 140,000 contacts and in June 2020 participated in an hour-long feature on a trucker satellite radio show that reached over 1 million commercial drivers and other listeners nationwide.
- **ADS Demonstration Grants:** In September 2019, U.S. DOT announced the award of eight ADS Demonstration Grants. In March 2020, FMCSA held kickoff meetings for two of these grants: one of which specifically focuses on trucking and another that includes truck platooning and rural road applications. Several other awarded grants also include elements that are applicable to CMVs, such as those that explore ADS-equipped vehicles in work zones.
- **Driving Automation Systems in Long-Haul Trucking and Bus Transit: Preliminary Analysis of Potential Workforce Impacts:** Last year, U.S. DOT, in collaboration with the Department of Labor (DOL), Department of Commerce (DOC), and the Department of Health and Human Services (HHS) conducted a comprehensive analysis of the impact of ADAS and ADS technologies on the long-haul trucking and bus transit workforces.

FMCSA will continue to identify topic areas and open questions that may warrant additional research and fund cutting-edge projects that will help inform policy recommendations with data. FMCSA will also engage closely with academic and research institutions, to identify opportunities to collaborate and coordinate on CMV-specific ADS research. For example, FMCSA is one of several U.S. DOT agencies working with the National Institute of Standards and Technology on developing safety measurements for automated vehicles. Through continued stakeholder engagement and research, and collaboration with the U.S. DOT modes and Federal agencies, FMCSA will develop a better understanding around needs for additional driver, inspector, and law enforcement training on new ADAS and ADS technologies, workforce development opportunities, the long-term impact on the driver workforce, human factors and interactions with ADS-equipped CMVs, and more.

Federal Highway Administration (FHWA)

Background and Goals

FHWA is responsible for providing stewardship over the construction, maintenance, operations, and preservation of the Nation’s highways, bridges, and tunnels. Through financial and technical assistance and research, FHWA supports its partners in Federal, State, and local agencies to accelerate innovation and improve safety and mobility.

ADS are increasingly being tested and operated on the Nation’s roads. These innovative technologies have the potential to introduce both opportunities in safety and mobility, as well as significant uncertainty regarding the potential impacts to the transportation system. FHWA supports the

³⁶ Federal Motor Carrier Safety Administration. (2020, March 18). Accelerating the Adoption of Advanced Driver Assistance Systems (ADAS). Retrieved from <https://www.fmcsa.dot.gov/safety/research-and-analysis/accelerating-adoption-advanced-driver-assistance-systems-adas-0>

integration of ADS on our Nation's roads in a manner that ensures safe, reliable, efficient, and sustainable mobility for people and goods. Working closely with Federal, State, regional, local, and industry partners, FHWA has established an agency approach to address the emerging opportunities and challenges associated with the use of ADS on the Nation's roadway infrastructure.

Activities

Goal: Promote Transparency

Communication

FHWA is establishing clear communication channels with partners, industry, and the public on ADS. These efforts support the development of a shared understanding of ADS across all audiences and provide opportunities to enable a two-way exchange of information for FHWA projects, research, and activities among all ADS stakeholders. The FHWA web page is a portal for FHWA's automated vehicle programs, initiatives, activities, and resources.³⁷

Broad Outreach

FHWA continues to conduct broad stakeholder outreach and engagement with State and local partners, associations, research institutions, and the transportation community on the topic of ADS and emerging transportation technologies. FHWA conducted a series of national workshops to listen to stakeholders, facilitate information sharing, and understand needs and priorities.³⁸

Community Building

FHWA leverages existing forums and is exploring opportunities for expanding collaborative forums to enable community building and partnership around ADS. FHWA partners with the Cooperative Automated Transportation Coalition, which includes both public and private sector stakeholders to foster continued and expanding stakeholder engagement. This engagement will facilitate the establishment of a collaborative ADS-Roadway system research, development, and deployment environment.

Cooperative Driving Automation Research

The FHWA CARMASM Program³⁹ was established to develop, test, and evaluate cooperative driving automation (CDA) concepts intended to improve the ability of automated vehicles to negotiate traffic issues, such as work zones and adverse weather. The research program is based on the use of freely available open source software, and publicly shared data and analyses. The CARMA CollaborativeSM is a community of practice that includes participation by industry, government, and academia, to develop CDA through the use of CARMA products and tools.

³⁷ Federal Highway Administration. (2020, March 2). Automated Vehicle Activities and Resources. Retrieved from <https://highways.dot.gov/automation>

³⁸ Federal Highway Administration. (2020, April 10). National Dialogue on Highway Automation. Retrieved from <https://ops.fhwa.dot.gov/automationdialogue/>

³⁹ Federal Highway Administration. (2020, September 17). Cooperative Driving Automation. Retrieved from <https://highways.dot.gov/research/operations/Cooperative-Driving-Automation>

Goal: Modernize the Regulatory Environment

Manual on Uniform Traffic Control Devices (MUTCD)

The MUTCD defines the standards used by road managers nationwide to install and maintain traffic control devices on all public streets, highways, bikeways, and private roads open to public travel. The MUTCD is published by FHWA under 23 Code of Federal Regulations (CFR), Part 655, Subpart F.

FHWA is assessing how ADS-equipped vehicles and other transportation technologies should be considered in the MUTCD. This work involves investigating whether greater standardization and consistency in traffic control devices, particularly lane markings and signage, could be beneficial to support safe interaction between ADS equipped vehicles and the roadway infrastructure. In December 2020, FHWA released a Notice of Proposed Amendment (NPA) to gather input and address these issues.

Goal: Prepare the Transportation System

Agency Preparedness and Policy Development

- **Mainstreaming of ADS into Programs and Policies:** FHWA continues to adapt agency policies, programs, and research to remain responsive to the opportunities and challenges presented by ADS-equipped vehicles and emerging technologies so FHWA programs continue to be delivered consistently and effectively. This includes assessing necessary modifications to policies and regulations, including current funding structures, such as Federal-aid funding and eligibility to support ADS integration. FHWA is also involved in strategic planning activities, including the development of agency wide research plans, and program integration plans.
- **Knowledge Building and Communications:** FHWA staff are responsible for providing technical assistance and support to its State and local partners. To support these efforts, the agency is enhancing its knowledge building and communications activities around ADS and emerging transportation technologies. This includes the implementation of a staff training plan to raise awareness and to provide credible information to its staff on ADS and emerging technologies. These initiatives are being conducted in coordination with ITS JPO and other modal agencies.

Additionally, FHWA is facilitating strong internal agency coordination and information-sharing regarding ADS research and activities. Improved coordination can support project planning, resource allocation, and engagement of external stakeholders. FHWA has established an internal Automation Working Group to facilitate collaboration by leveraging representatives from various program disciplines across the agency.

- **Supporting Policy Development:** Developing policies to support safe and efficient integration of ADS into the roadway system requires an understanding of how ADS-equipped vehicles impact communities and users. FHWA is conducting foundational policy research to evaluate potential changes to travel demand, mobility, accessibility, and other policy issues related to ADS. Additional activities include assessing how ADS influence other roadway users (e.g., pedestrians, bicyclists, motorcyclists) and their need to co-exist safely with ADS on the same roadway system.

This activity will also focus on the relationship between socio-economics, infrastructure, and travel behavior to better understand the travel needs of different types of communities, the cost of current unmet needs, and potential applications of emerging modes and technologies to improve individual and collective mobility and safety.

Testing and Evaluation for Safe and Full Integration of ADS into Roadway Operations

- **Human Factors:** FHWA is conducting research to address critical human factors safety issues for cooperative automation applications related to the abilities and limitations of the ADS-Roadway interface. It is also conducting research to prioritize key human factors safety issues related to operating ADS in transportation systems management and operations (TSMO) use cases, including driver engagement/disengagement, transfer of control, or other performance-DVI (driver vehicle interface) interactions.
- **Driver Acceptance:** FHWA is conducting research to evaluate driver acceptance criteria and other human factors issues related to the deployment of cooperative automation. This research will support safe interactions between ADS and other users, such as pedestrians and bicyclists.
- **Traffic Simulation and Modeling:** FHWA is conducting research on improved analysis, modeling, and simulation capabilities to estimate the potential benefits and impacts of ADS and specific ADS-enabled TSMO strategies on highways. This effort involves assessing how modeling and simulation methods may change in order to adapt to new factors introduced by ADS-equipped vehicles. FHWA is also looking at opportunities to integrate ADS with TSMO strategies and applications to improve system operations and performance.

As a related effort, FHWA is enabling the development of collaborative testing and evaluation capabilities. FHWA is producing a test and evaluation framework that will provide stakeholders the information to plan, design, and execute collaborative ADS-Roadway system test and evaluation activities.

Infrastructure System Readiness and Roadway Operations

- **Concept of Operations Development:** FHWA is developing a National Highway Automation Concept of Operations (ConOps) to describe the integration of ADS-equipped vehicles into the roadway environment, including their interaction with roadway infrastructure and, at this initial stage of deployment, with non-automated traffic. The ConOps will serve as a basis for identifying future actions that infrastructure-owner operators may take in order to ready their organizations, physical assets, and policy for the integration of automated vehicles. The ConOps aims to facilitate identification of the nexus of capabilities that will support an ADS-Roadway system and identify the relationships and roles among Government agencies and industry needed to implement the ADS-Roadway system.
- **Assessing Infrastructure Needs and Impacts from ADS:** FHWA is conducting research to address the potential impacts and requirements of the infrastructure system to support safe and efficient ADS operations. These efforts aim to help State and local transportation agencies to identify infrastructure needs, particularly around infrastructure consistency and condition. FHWA seeks to establish tools and applications to assess the impacts of ADS on the roadway system and to support infrastructure and transportation planning decisions for the future. These tools can support State and local agencies as they develop infrastructure investment plans to enable continued advancements in improving safety, mobility, and efficiency.

Additional research involves investigating how the MUTCD and traffic control device maintenance practices might be adapted to support the ADS in accurately perceiving the roadway environment and to interact safely with other roadway users. This activity involves

assessing the roadway infrastructure and its ability to support ADS, while also evaluating the impacts of ADS on the infrastructure system and its performance.

In addition, FHWA intends to investigate the feasibility of a changeable roadway capability. A changeable roadway capability will facilitate depiction of various realistic roadway scenarios that enhance collaborative investigation and development of the ADS-Roadway system.

- **ADS Systems Data:** FHWA is pursuing a range of initiatives addressing how ADS-related data and infrastructure-based data are important to enabling safe and efficient operations of the roadway network. These activities involve conducting a gap analysis of data needs in relation to different integration scenarios, identifying possible data element definitions and formats, and determining access and exchange needs.

FHWA is partnering with ITS JPO to conduct the Work Zone Data Initiative.⁴⁰ This initiative aims to enable infrastructure owners and operators (IOOs) to make harmonized work zone data available for third party use. The intent is to make travel on public roads safer and more efficient through ubiquitous access to data on work zone activity. Specifically, the project aims to get data on work zones into vehicles to help ADS and human drivers navigate more safely.

In addition to work zone data, FHWA is investigating ADS Operational Behavior and Traffic Regulation Information (FHWA). This research assesses existing traffic laws and their applicability to ADS-equipped vehicles. It will identify needs regarding the development of a traffic regulations database and assess the challenges associated with translating traffic regulations meant for human interpretation and consumption to traffic regulations that can be consumed and interpreted by an ADS-equipped vehicle. This project will complement the integration of other USDOT data and digital infrastructure initiatives pertaining to traffic operations aspects of Infrastructure System Readiness and Roadway Operations.

Planning Process Capabilities

- **Adapting Planning Processes:** FHWA is conducting research to determine how to incorporate ADS into planning models and scenario planning practices to address potential impacts and uncertainties. FHWA will further develop planning methodologies and processes to support assessment of infrastructure investment and management approaches.⁴¹
- **Technology Monitoring and Assessment:** FHWA is exploring and evaluating potential communications technologies that could support effective information exchange between ADS and the roadway infrastructure. This type of information can facilitate ADS's ability to develop an accurate interpretation of the roadway environment, including work zones and weather, and ultimately support safe and efficient ADS operation. This activity also includes assessment of required cybersecurity protections for ADS interacting with the infrastructure, including identification of potential new risks introduced from ADS integration and connected roadway

⁴⁰ United States Department of Transportation. (2020, May 21). Work Zone Data Exchange (WZDx). Retrieved from <https://www.transportation.gov/av/data/wzdx>

⁴¹ Federal Highway Administration/Federal Transit Administration. (n.d.). Connected and Automated Vehicles. Retrieved from Transportation Planning Capacity Building: https://www.planning.dot.gov/planning/topic_CVAV.aspx

infrastructure. Additionally, FHWA will explore how emerging transportation trends, such as Mobility as a Service, can influence ADS integration and the broader transportation system.

Federal Transit Administration (FTA)

Background and Goals

The Federal Transit Administration's (FTA) mission is to improve public transportation for America's communities. FTA provides technical assistance and financial support to local public transit systems to improve/advance, purchase, lease and operate buses, subways, light rail, commuter rail, trolleys, and ferries. FTA also oversees safety measures and helps develop next-generation technology research.

FTA's research vision is to advance public transportation by accelerating **innovation** that improves peoples' mobility, enhances **public transportation operations**, and ensures everyone's **safety**. Transit automation research falls under FTA's mobility innovation research priority. FTA developed a comprehensive automation plan (the Strategic Transit Automation Research – STAR Plan) to establish a foundation and roadmap for future public transportation automation research.

The STAR Plan outlines FTA's automation research agenda to move the bus transit industry forward with regard to automation technologies.⁴² The plan was built upon extensive stakeholder consultation and use case analysis, and it is informed by a rigorous literature review. The goal of the STAR Plan was to advance transit bus readiness for automation by:

- Conducting enabling research to achieve safe and effective transit bus automation deployments
- Identifying and resolving barriers to deployment of transit automation
- Leveraging technologies from other sectors to move the transit bus automation industry forward
- Demonstrating near market-ready and market-ready technologies in real-world settings
- Transferring knowledge to the transit bus stakeholder community

Activities

Goal: Promote Transparency

Requests for Comment

FTA issued two RFCs in January 2018 (FTA-2017-0024: Research Program: Automated Transit Buses⁴³ and FTA-2017-0025: Removing Barriers to Transit Bus Automation⁴⁴). The first RFC (Automated Transit Buses Research Program) sought comments and information from industry for determining the current state of transit bus automation technology in order to make more informed decisions regarding future areas of research. The second RFC (Removing Barriers to Transit Bus Automation) sought comments to better understand regulatory, institutional, and policy barriers and challenges to development, demonstration, deployment, and evaluation of automation systems in the transit bus industry.

⁴² Federal Transit Administration. (2018). Strategic Transit Automation Research Plan. Retrieved from https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/research-innovation/114661/strategic-transit-automation-research-report-no-0116_0.pdf

⁴³ Federal Transit Administration. (2018, January 16). Research Programs: Automated Transit Buses. Retrieved from https://www.regulations.gov/document?D=FTA_FRDOC_0001-0784

⁴⁴ Federal Transit Administration. (2018, January 16). Removing Barriers to Transit Bus Automation. Retrieved from https://www.regulations.gov/document?D=FTA_FRDOC_0001-0783

Knowledge Transfer

FTA conducts stakeholder engagement, knowledge transfer, and technical assistance to disseminate transit bus automation information and research results to stakeholders, ultimately facilitating deployment and gaining feedback from the community to update and maintain its transit bus automation research agenda. Activities include a community of practice, fact sheets, webinars, presentations at relevant conferences and meetings, and other items. Resources are available through FTA's Transit Automation Research website.⁴⁵

Transit Bus Automation Policy Frequently Asked Questions (FAQs)

As the transit industry begins to explore the use of automated transit buses, many stakeholders have questions about the impact of new technologies on transit agencies, employees, riders, and the general public. In response, FTA has developed frequently asked questions (FAQs) for key areas of interest. Areas of interest include, but are not limited to, vehicle accessibility and the Americans with Disabilities Act (ADA), Title VI regulations, procurement and Buy America, FMVSS, bus testing, and data.⁴⁶

Goal: Prepare the Transportation System

Policy Research

The policy environment for automation is rapidly advancing, and it is necessary to understand the impacts of Federal, State, and local regulations and policies on demonstrating and deploying transit bus automation. FTA is conducting research to review the set of established laws, regulations, and policies that may delay or prevent the demonstration and deployment of transit bus automation systems and make recommendations for potential policy modifications. Additional research projects are planned to consider issues such as procurement, labor impacts, and voluntary technical standards. This work area also includes the development of a series of policy and guidance documents (e.g., circulars, best practices) for the transit industry, which build on earlier transit bus automation research results and relevant findings from demonstrations.⁴⁷

Safety, Human Factors, and Accessibility

FTA is conducting research in the areas of hazard and safety analysis,⁴⁸ human factors and user acceptance, and security and customer acceptance of automated bus transit vehicles. Future research to better understand the opportunities and challenges of automation for travelers with disabilities more completely is planned.

Transit Bus Automation Market Assessment and Activity Tracking

To provide reliable, up-to-date information on the progress of research and the availability of commercial automation technologies, FTA tracks research, piloting, and commercialization activity in the

⁴⁵ Federal Transit Administration. (2020, April 28). Transit Automation Research. Retrieved from <https://www.transit.dot.gov/automation-research>

⁴⁶ Federal Transit Administration. (2019, November 1). Transit Bus Automation Policy FAQs. Retrieved from <https://www.transit.dot.gov/research-innovation/transit-bus-automation-policy-faqs>

⁴⁷ For example, see Luna, J., Machek, E., & Peirce, S. (2019). *Considerations for Evaluating Automated Transit Bus Programs (Report 0149)*. Washington, D.C.: Federal Transit Administration. Retrieved from <https://www.transit.dot.gov/research-innovation/considerations-evaluating-automated-transit-bus-programs-report-0149>

⁴⁸ Becker, C., Nasser, A., & Brewer, J. (2020). Hazard and Safety Analysis of Automated Transit Bus Applications. Federal Transit Administration. Retrieved from https://www.transit.dot.gov/sites/fta.dot.gov/files/2020-04/FTA-Report-No.-0161_0.pdf

United States, and provides summaries for the transit community in the form of white papers, webinars, and briefings.⁴⁹

Investment Decision Support

The transit industry is increasingly interested in the potential applications and benefits of automation, but investment in automated transit application development and deployment has been relatively slow. To address this issue, a series of projects are identified for the following topics: transit applications of light and commercial vehicle technology, determining requirements for automated transit bus test facilities, business case, finance options, transition costs and planning for deployment, and impact on service patterns and users.⁵⁰

Pilots and Demonstrations

FTA plans to conduct seven demonstrations, organized by use case categories (technology packages), in real-world transit environments as defined in the FTA STAR Plan. The demonstrations will create a testbed for study of technical feasibility, user acceptance, operational and maintenance costs, and institutional issues, and will further assess needs for standards development to ensure interoperability. Several of the automated vehicle demonstrations are included in FTA's Integrated Mobility Innovation (IMI) and Accelerating Innovative Mobility (AIM) Programs, which are discussed below. Knowledge gained from the suite of planned demonstrations will be supplemented with information shared from Strategic Partnerships and capabilities obtained from Transit Bus Automation Research and Development efforts, also discussed below. FTA also plans to provide Public Transportation Innovation funds (49 U.S.C. § 5312) for the development and testing of prototype and near-commercially-ready transit bus automation components and systems to advance domestic commercialization of SAE Level 1–5 vehicle automation in the transit industry. One example is an integrated demonstration project focusing on Level 4 automation in transit maintenance yard settings. Specific use cases may include precision movement for fueling, maintenance, and bus wash, and automated remote parking and recall. This transit maintenance yard automation capability may also enable transit operators to better prepare and respond to public health emergencies, such as COVID-19, to automate bus disinfection and sanitization functions.

Integrated Mobility Innovation (IMI) Demonstration Program

The IMI Demonstration program's primary purpose is to fund projects that demonstrate innovative and effective approaches, practices, partnerships, and technologies to enhance public transportation effectiveness, increase efficiency, expand quality, promote safety, and improve the traveler's experience.⁵¹ The Notice of Funding Opportunity included funding for ADAS for transit buses, which seek to demonstrate market-ready or near-market-ready advanced driver assistance technologies (SAE Levels 0–2) to support partial transit automation in revenue service, and automated shuttles (SAE Level 4) in circulator or feeder bus service.

⁴⁹ Cregger, J., Machek, E., & Cahill, P. (2019). Transit Bus Automation Market Assessment. Federal Transit Administration. Retrieved from <https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/research-innovation/134451/transit-bus-automation-market-assessment-fta-report-no0144.pdf>

⁵⁰ For example, see Naser et al. (2018, September). Transit Bus Automation Project: Transferability of Automation Technologies Final Report. FTA Report 0125. Retrieved from <https://www.transit.dot.gov/research-innovation/transit-bus-automation-project-transferability-automation-technologies-final>

⁵¹ Federal Transit Administration. (n.d.). Integrated Mobility Innovation. Retrieved from <https://cms7.fta.dot.gov/IMI>

Accelerating Innovative Mobility (AIM) Challenge Grants

AIM challenge grant⁵² recipients deploy new transportation technologies and services, including development and testing of FMVSS and ADA-compliant automated electric shuttle buses and demonstrating the accessible buses in the field to augment fixed-route bus and paratransit services. By collaborating with grant recipients, the AIM initiative supports innovators testing nationwide approaches to improve safety, increase access, develop more efficient operations, and enhance the transit experience for all.

Strategic Partnerships

FTA partners with organizations that are currently conducting automated vehicle research on their own, such as pilots, and leverages these opportunities to capture and disseminate early findings to a broader community. Strategic partnerships allow FTA to expand participation of providers and suppliers and accelerate learning about bus automation implementations.

Federal Railroad Administration (FRA)

Background and Goals

The Federal Railroad Administration's (FRA) mission is to enable the safe, reliable, and efficient movement of people and goods for a strong America. FRA is advancing the use of new technology in rail and collaborating with other surface transportation modes and the auto industry to enhance safety around highway grade crossings.

Activities

Goal: Prepare the Transportation System

Rail Crossing Vehicle Warning (RCVW) Phase I

To explore the interaction between automated vehicles and highway-rail grade crossings and identify what information automated vehicles will need in order to negotiate highway-rail intersections, FRA applied a systems engineering methodology to design, develop, test, and evaluate a prototype RCVW application, and demonstrated the potential for leveraging real-time connected vehicle concepts and services to enhance and transform rail crossing safety.⁵³

Rail Crossing Vehicle Warning Phase II

FRA launched Phase II of this research in the fall of 2018 to continue technology research and improve on the Phase I results including prediction algorithm performance improvements, additional functionality (advanced alerts and clear the crossing warning), human machine interface design, optimizing system packaging and interfaces to facilitate field demonstrations, naturalistic driving study, and pilot deployment. A second round of field-testing was initiated at the Transportation Research Center (TRC) in East Liberty, Ohio. It included multiple vehicle types and multiple weather conditions to improve system performance.

⁵² <https://www.transit.dot.gov/AIM>

⁵³ Neumeister, David et al. Prototype Rail Crossing Violation Warning Application Project Report. 2017
<https://rosap.ntl.bts.gov/view/dot/34852>

Maritime Administration (MARAD)

Background and Goals

The Maritime Administration's (MARAD) mission is to foster, promote, and develop the maritime industry of the United States to meet the Nation's economic and security needs. Automation, including automated vehicles, trains, vessels, infrastructure, and equipment, is increasingly being tested and introduced into the transportation system at ports. Various modes of transportation, such as vessels, pipelines, rail, and motor carriers intersect to create a hub of freight transfer in global supply chains. MARAD is engaging in research that may help support strategies to implement automated transportation safely in and around ports.

MARAD advocates for modern and efficient inland and coastal ports that are integrated into the surface transportation system. MARAD, in conjunction with ITS JPO research programs, seeks to increase cargo capacity and reliability of freight moving through ports by identifying appropriate ITS solutions.

MARAD is engaged in a multiyear research program that seeks to achieve two primary goals, to:

- 1) Identify opportunities to conduct research that addresses critical freight movement and ITS infrastructure gaps.
- 2) Identify opportunities for pilot projects and programs to be deployed, including technology transfer.

Activities

Goal: Prepare the Transportation System

ITS MARAD Research Roadmap

MARAD's ITS Program objectives include increasing safety, providing training, improving quality of life, reducing environmental footprint, and streamlining operations.

The Program continues to identify a portfolio of ITS projects, including automation, which agencies, including port authorities, could implement to address port and freight-related challenges. The Program is working toward a long-term outcome of field operational testing of these technology solutions, which may include automated truck queuing at ports. The Program is working with relevant maritime stakeholders to ensure effective technology transfer activities for the completed products and tools, and is developing plans for future evaluation activities to be incorporated into an updated modal research roadmap covering the years 2021 through 2025.

Port Cooperative Driving Automation Drayage Truck Development and Testing

The Port Cooperative Driving Automation Drayage Truck Development and Testing initiative is a demonstration of ADS in a port environment in a multiyear phased project to increase efficiencies and safety, and decrease emissions. The project objective is to further the technology implementation in our Nation's ports to accelerate the adoption of the technologies available and to demonstrate the benefit of automated truck movement in queues at ports and staging areas or warehouses. The project is being conducted in coordination with FHWA and FMCSA and will demonstrate connected vehicles and automated vehicle technology applications with loading and unloading of chassis and containers, customs inspection point passage, gate passage, and short-haul drayage.

Pipeline and Hazardous Materials Safety Administration (PHMSA)

Background and Goals

The Pipeline and Hazardous Materials Safety Administration (PHMSA) oversees a national safety program to protect against the risks to life and property inherent in the transportation of hazardous materials in commerce by all transportation modes. While PHMSA encourages the potential for automated and connected technologies to be used for hazardous materials transportation, safety remains the agency's top priority. Many of these technologies do not yet exist beyond the testing stage and, therefore, cannot be appropriately evaluated for an equivalent level of safety. Although industry has not yet expressed the intent to ship hazardous materials using automated and/or connected technologies, the Secretary of Transportation has spoken extensively on the potential of these technologies to provide safety enhancements, improve logistical efficiencies, and contribute to economic growth. Therefore, PHMSA anticipates future interest in the transport of hazardous materials as these technologies mature, and is preparing proactively to ensure a consistent and cohesive, multimodal approach to automated vehicle integration.

PHMSA's goal is to establish a comprehensive approach to prepare for the safe and full integration of automated and connected technologies into the multimodal hazardous materials transportation sector.

Activities

Goal: Promote Transparency

Request for Information

On March 29, 2018, PHMSA issued a *Request for Information on Regulatory Challenges to Safely Transporting Hazardous Materials by Surface Modes in an Automated Vehicle Environment* [PHMSA-2018-0001; 83 FR 13464].⁵⁴ The RFI sought information on matters related to the development and potential use of automated technologies for surface modes in hazardous materials transportation in anticipation of the development, testing, and integration of ADS and automated vehicle technologies.

External Outreach and Engagement

PHMSA has a long history of engagement with law enforcement and emergency response personnel and is invested in ensuring their continued safety as new technologies are implemented. Since publication of the RFI and AV 3.0, PHMSA has increased outreach specific to the topic of automated and connected technologies for potential use in hazardous materials transportation and is working to identify additional opportunities for further engagement and research investment.

Goal: Prepare the Transportation System

Research into Hazardous Materials Transportation by Unmanned Systems

PHMSA has completed a multiphased research and development effort to identify risks and potential regulatory requirements associated with removing the human in the loop for hazardous materials shipments, while maximizing unmanned and automated transportation technologies to improve safety. Notably, this research sought to identify the most shipped hazardous materials by mode, determine the carrying capacity of unmanned systems in relation to frequently shipped hazardous material

⁵⁴ Pipeline and Hazardous Materials Safety Administration. (2018, March 29). Request for Information on Regulatory Challenges to Safely Transporting Hazardous Materials by Surface Modes in an Automated Vehicle Environment. Retrieved from <https://www.federalregister.gov/documents/2018/03/29/2018-06290/request-for-information-on-regulatory-challenges-to-safely-transporting-hazardous-materials-by>.

commodities, examine potential safety hazards, and identify potential regulatory impediments to the transportation of hazardous materials by unmanned system. The research findings will help PHMSA prepare proactively for the safe and full integration of automated and connected technologies into the multimodal hazardous materials transportation sector.

Internal U.S. DOT Coordination

PHMSA is actively engaging across U.S. DOT to ensure a consistent and cohesive, multimodal approach to research activities and policy development. In close coordination with the other operating administrations, PHMSA will use the information gained from joint research activities and stakeholder engagement to guide potential future regulatory actions for the safe and full integration of emerging transportation technologies into hazardous materials transportation.

Goal: Modernize the Regulatory Environment

E-Manifest System in Coordination with the EPA

PHMSA supported the Environmental Protection Agency (EPA) in the development of a national system for electronically tracking hazardous waste shipments. This system, known as “e-Manifest,” modernizes the Nation’s cradle-to-grave hazardous waste tracking process while saving valuable time, resources, and dollars for industry and States. EPA launched e-Manifest on June 30, 2018.⁵⁵

Special Permits

PHMSA will continue to incorporate technical innovation through its special permit program, which provides a mechanism for testing and using new technologies, promoting increased transportation efficiency and productivity, and ensuring global competitiveness without compromising safety.⁵⁶ PHMSA regularly amends the Hazardous Materials Regulations (HMR) to adopt provisions contained in certain widely used or long-standing special permits that have an established safety record. The proposed revisions provide greater regulatory flexibility and eliminate the need for numerous special permit renewal requests, thus reducing paperwork burdens and facilitating commerce while maintaining an equivalent level of safety.

⁵⁵ United States Environmental Protection Agency. (n.d.). Learn about the Hazardous Waste Electronic Manifest System (e-Manifest). Retrieved from <https://www.epa.gov/e-manifest/learn-about-hazardous-waste-electronic-manifest-system-e-manifest>

⁵⁶ Pipeline and Hazardous Materials Safety Administration. (2020, January 28). Hazardous Materials Approvals and Permits Overview. Retrieved from <https://www.phmsa.dot.gov/approvals-and-permits/hazmat/hazardous-materials-approvals-and-permits-overview>