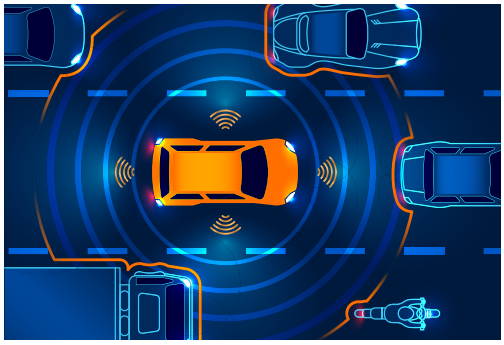
AAMVA

American Association of
Motor Vehicle Administrators

TECHNOLOGY
Partnerships
stakeholders
LEADERSHIP
Education
recommendations



Safe Testing and Deployment of Vehicles Equipped with Automated Driving Systems Guidelines

Edition 3

July 2022

VEHICLE STANDING COMMITTEE
AUTOMATED VEHICLES SUBCOMMITTEE

Contents

Cover photos credit: iStockphoto.com

Executive Summary

The American Association of Motor Vehicle Administrators (AAMVA) is a tax-exempt nonprofit organization developing model programs in motor vehicle administration, law enforcement, and highway safety. AAMVA also serves as an information clearinghouse in these areas and acts as the international spokesperson for these interests.

Founded in 1933, AAMVA represents the state, provincial, and territorial officials in the United States and Canada who administer and enforce motor vehicle laws. AAMVA's programs encourage uniformity and reciprocity among the jurisdictions. The association also serves as a liaison with other levels of government and the private sector. Its development and research activities provide guidelines for more effective public service. In addition to jurisdictions, AAMVA's membership includes associations, organizations, and businesses that share an interest in the association's goals.

AAMVA recognized an opportunity to provide leadership and assistance to the motor vehicle administrative and law enforcement communities by establishing the Automated Vehicles Subcommittee (AVSC) to examine the potential impacts of Automated Driving System (ADS)-equipped vehicle testing and deployment on these communities and to develop guidance. The subcommittee also examined the impact of Advanced Driver Assistance Systems (ADAS) on drivers as well as driver education and driver testing.

ADS-equipped vehicles do not need a human driver to operate but may require a human driver to take control of the vehicle. These vehicle systems consist of Level 3 Conditional Driving Automation, Level 4 High Driving Automation, and Level 5 Full Driving Automation as established by the Society of Automotive Engineers (SAE) International and are outlined in Chapter 2.

A successful path to the safe testing and deployment of technology in vehicles must include appropriate government oversight developed in coordination with strong stakeholder engagement formed through partnerships with the many entities engaged in or affected by these rapidly developing technologies. These partnerships should be formed to address the far-reaching impacts of the technologies and should include representatives from a broad spectrum of government organizations, government support associations, industry, and advocacy groups.

AAMVA is neutral on the topic of jurisdictional regulation of ADS technology. The purpose of these jurisdiction recommendations is for the consideration of jurisdictions choosing to enact some form or level of regulation. If a jurisdiction chooses to adopt these recommendations, most can be appropriately applied to different types of vehicles, including, but not limited to, passenger vehicles, low-speed shuttles, fleet-owned vehicles, and commercial vehicles.

AAMVA will continue to work closely with and coordinate ADS-equipped vehicle initiatives through partnerships with the United States Department of Transportation and the Canadian Council of Motor Transport Administrators.

To keep this report relevant and to provide the best possible guidance to the AAMVA community, it is expected the Automated Vehicles Subcommittee will update this report periodically. The Automated Vehicles Subcommittee is committed to keeping pace

with the evolution of vehicle technology, providing timely information, and sharing its expertise.

Important Notes to the Reader

Edition 3 Replaces Edition 2 of this report and contains global updates. Substantive changes in Edition 3 are outlined below.

Substantive Changes in Edition 3

Executive Summary contains several updates.

Chapter 1. Introduction contains several updates.

Chapter 2. Automated Vehicle Classification, Terms, Acronyms, and Technologies contains updates and some new terms

Chapter 3. Administration Considerations contains several updates:

- Background includes new 2021 jurisdiction survey summary.
- Recommendations 3.1.7 and 3.1.8 from Edition 2 have been revised and merged into a single recommendation (3.1.7) in Edition 3.
- Recommendation 3.2.1 has been revised.
- MOE 2 has been revised.

Chapter 4. Vehicle Considerations contains several updates:

- The term "brand" has been replaced with the term "designation" throughout Chapter 4.
- 4.4 Designating and Titling New and Aftermarket Automated Driving System-Equipped Vehicles
- Recommendations 4.4.1, 4.4.2, and 4.4.3 have been revised.
- 4.4.4 from Edition 2 has been removed.
- 4.6 License Plates
- Recommendation 4.6.1 has been revised.
- 4.7 Financial Responsibility (also known as Mandatory Liability Insurance)
- Recommendations 4.7.1 and 4.7.3 have been revised.
- Recommendations 4.7.5 and 4.7.6 have been removed.
- 4.9 Federal Motor Vehicle Safety Standards and Canadian Motor Vehicle Safety Standards
- NHTSA Advanced Notice of Proposed Rulemaking about governing the safe behavior of ADS was added. It requires OEMs and operators of vehicles with Levels 2 to 5 to report crashes.
- 4.10 Periodic Motor Vehicle Inspections
- Recommendation 4.10.2 has been revised.

Chapter 5. Driver Licensing Considerations contains several updates:

- 5.3 Title changed to Remote Driver and Remote Driving
- Recommendations have been renumbered and several have been revised.
- 5.5 Driver Training for Drivers on Vehicle Technologies
- Recommendation 5.5.2 has been revised.
- 5.6 Training for Driver Educators, Driver Education, and Driver Training Program
- Recommendations have been renumbered and several recommendations have been revised.
- 5.6.2 and 5.6.5 has new recommendations.
- 5.7 Driver's License Skills Testing with Vehicle Technologies
- MOE 9 has been revised.

- 5.8 Training Motor Vehicle Agency Examiners on Vehicle Technologies
- Recommendation 5.8.3 has been revised.
- 5.9 Training Motor Vehicle Agency Staff on Vehicle Technologies
- Recommendation 5.9.2 has been revised.

Chapter 6. Law Enforcement Considerations contains several updates:

- 6.1 Vehicle Identification
- Recommendation 6.1.1 has been removed.
- MOE 10 has been removed (affecting MOE numbering throughout the remainder of the document. See Appendix B for a full list of MOE recommendations.)
- 6.2 Crash and Incident Reporting
- Recommendation 6.2.1 has been revised.
- MOE 10 has been revised.
- 6.4 Distracted Driving
- Recommendation 6.4.1 has been revised.
- Recommendations 6.4.2 is new.
- MOE 18 and 21 are new.
- 6.8 Law Enforcement and First Responder Safety and Training
- Recommendation 6.8.1 has been revised.
- 6.9 Adherence to Traffic Laws
- 6.9.3 and 6.9.4 are new recommendations.
- 6.10 Vehicle Response to Emergency Vehicles, Manual Traffic Controls, and Atypical Road Conditions
- MOE 27 has been revised.

Chapter 7. Other Considerations contains several updates:

- 7.5 Platooning
- Recommendations have been renumbered, and several have been revised.
- Recommendation 7.5.21 is new.
- 7.6 Automated Delivery Vehicles and Devices is a new subsection.

Appendices

A summary of the specific recommendations for jurisdictions contains several updates and can be found in Appendix A.

A summary of the specific recommendations for MOEs contains several updates and can be found in Appendix B.

Appendix C. The Automated Vehicles Subcommittee roster contains several updates.

Appendices D and E from Edition 2 have been removed.

Chapter 1 Introduction

Automated and non-automated vehicles are sharing the roadway, creating challenges for the safe integration of Advanced Driver Assistance Systems (ADAS) and Automated Driver System (ADS)-equipped vehicles. Motor vehicle and law enforcement agencies need to adapt as ADAS vehicles continue to evolve and as ADS-equipped vehicles become available. The terms *ADAS* and *ADS* are used throughout this document as applicable.

Manufacturers and other technology companies are testing ADS-equipped vehicles on public roadways, prompting the need for jurisdictions to explore ways to regulate this emerging technology to ensure safety of the motoring public. Some jurisdictions have begun to adopt regulations using different approaches, making it apparent there is a continued need for an updated framework to support a consistent regulatory approach.

In addition, introduction of ADS-equipped vehicles into the existing roadway transportation system requires a transformation some jurisdictions are not currently equipped to manage without assistance from industry, partners, and other community members.

The Automated Vehicles Subcommittee began its work in 2014 by making a significant contribution to the Model State Policy contained in Section II of the National Highway Traffic Safety Administration's (NHTSA's) *Federal Automated Vehicles Policy* published in September 2016 and NHTSA's *Automated Driving Systems: A Vision for Safety 2.0* published in September 2017 and is referenced in NHTSA's *Preparing for the Future of Transportation: Automated Vehicles 3.0* published in October 2018. The United States Department of Transportation's (U.S. DOT's) most recently published *Ensuring American Leadership in Automated Vehicle Technologies: Automated Vehicles 4.0* in January 2020. The subcommittee also examined the potential impacts of ADS-equipped vehicle testing and deployment on jurisdictions and developed this report.

Jurisdictional implementation of the recommendations will facilitate a consistent regulatory framework that balances current public safety with the advancement of vehicle innovations to reduce crashes, fatalities, injuries, and property damage.

Report Structure

The Automated Vehicles Subcommittee developed this report to provide voluntary recommended guidelines for motor vehicle administrations, law enforcement, manufacturers, and other entities for the safe testing and deployment of ADS-equipped vehicles and to provide information and recommendations related to ADAS vehicle technology. The recommended guidelines are divided into five chapters:

- Administrative Considerations
- Vehicle Considerations
- Driver Licensing Considerations
- Law Enforcement Considerations
- Other Considerations

Each chapter contains several sections, each discussing specific topics. The sections are organized in a similar format. This includes background information followed by guidelines and recommendations for testing vehicles. Guidelines for deployed vehicles are also discussed and will continue to evolve. Each

section concludes with a discussion of the benefits of implementing the recommendations and the potential challenges jurisdictions may encounter.

The appendices include:

- Appendix A, Summary of Recommended Jurisdictional Guidelines for the Safe Testing and Development of Automated Driving System-Equipped Vehicles
- Appendix B, Summary of Recommendations for Manufacturers and Other Entities for the Safe Testing and Development of Automated Driving System-Equipped Vehicles
- Appendix C, Automated Vehicles Subcommittee Roster

Guiding Principles

The principles guiding the development of this report were:

- facilitating a consistent and balanced oversight approach by motor vehicle administrators to avoid inconsistent regulatory practices that could create unnecessary hurdles for vehicle and technology manufacturers;
- supporting the research and development of technology that has the potential to improve traffic safety while providing mobility options for underserved populations;
- supporting the safe testing and deployment of ADS-equipped vehicles; and
- confirming the roles and responsibilities of jurisdictions and the federal government.

Collaboration Among Stakeholders and Partners

A successful path to the safe testing and deployment of ADS-equipped vehicles must include developing strong partnerships. These partnerships should be formed to address the far-reaching impacts of the technologies and should include representatives from a range of government organizations, government support associations, industry, research institutes, and advocacy groups.

Because automotive technology development and deployment has worldwide impact, collaboration within jurisdictions, nationally and internationally, is vital to the safe integration of ADS-equipped vehicles. Several national efforts, in which the American Association of Motor Vehicle Administrators (AAMVA), AAMVA members, and the Automated Vehicles Subcommittee participated, helped form the development of this report. In addition, AAMVA and the Canadian Council of Motor Transport Administrators (CCMTA) continue to collaborate to provide consistent recommendations to U.S. and Canadian jurisdictions.

Current Regulatory Efforts

Some jurisdictions have developed requirements for manufacturers and other entities (MOEs) to test ADS-equipped vehicles on public roadways; others have chosen not to adopt specific requirements until more information is available. Jurisdictional activities were reviewed to learn different oversight approaches. The Automated Vehicles Subcommittee used the collective experiences of the jurisdictions to assist in shaping these recommendations.

Recommendations Are Voluntary

AAMVA is neutral on the topic of jurisdictional regulation of ADS technology. The purpose of these jurisdiction recommendations is for the consideration of jurisdictions choosing to enact some form or level of regulation. If a jurisdiction chooses to adopt these recommendations, most can be appropriately applied to different types of vehicles, including, but not limited to, passenger vehicles, low-speed shuttles, fleet-owned vehicles, and commercial vehicles.

Out of Scope

The Automated Vehicles Subcommittee determined that several topics were out of scope. Although critical to the testing and deployment of ADS-equipped vehicles, they are not addressed in this report. These include but are not limited to:

- vehicle import/export considerations;
- enabling infrastructure;
- fiscal impacts to jurisdictions;
- economic considerations; and
- environmental impacts.

Chapter 2 Automated Vehicle Classification, Terms, Acronyms, and Technologies

This chapter provides an explanation of the terms commonly used to identify and differentiate ADAS- and ADS-equipped vehicles of varying capabilities at the time this report was published. Users of this report will benefit from familiarization with the terminology and acronyms.

A wide variety of vehicle technologies are available in the marketplace, and others are continually under development (e.g., forward collision warning, lane departure warning). This report does not attempt to define these specific vehicle technologies. Although there are technologies of a similar nature, some manufacturers use proprietary terms. Various resources, such as www.mycardoeswhat.org, provide information and videos of specific vehicle technologies.

Vehicle Classification Systems

AAMVA encourages the adoption of terminology developed by SAE International that is used throughout this report. Refer to the SAE taxonomy for additional information on each of the classifications.

SAE International Classifications

SAE International, which devises consensus standards for the engineering industry, established a six-tier classification system ranging from no vehicle automation to full vehicle automation.

Level 0 – No Driving Automation, the performance by the driver of the entire dynamic driving task (DDT), even when enhanced by active safety systems

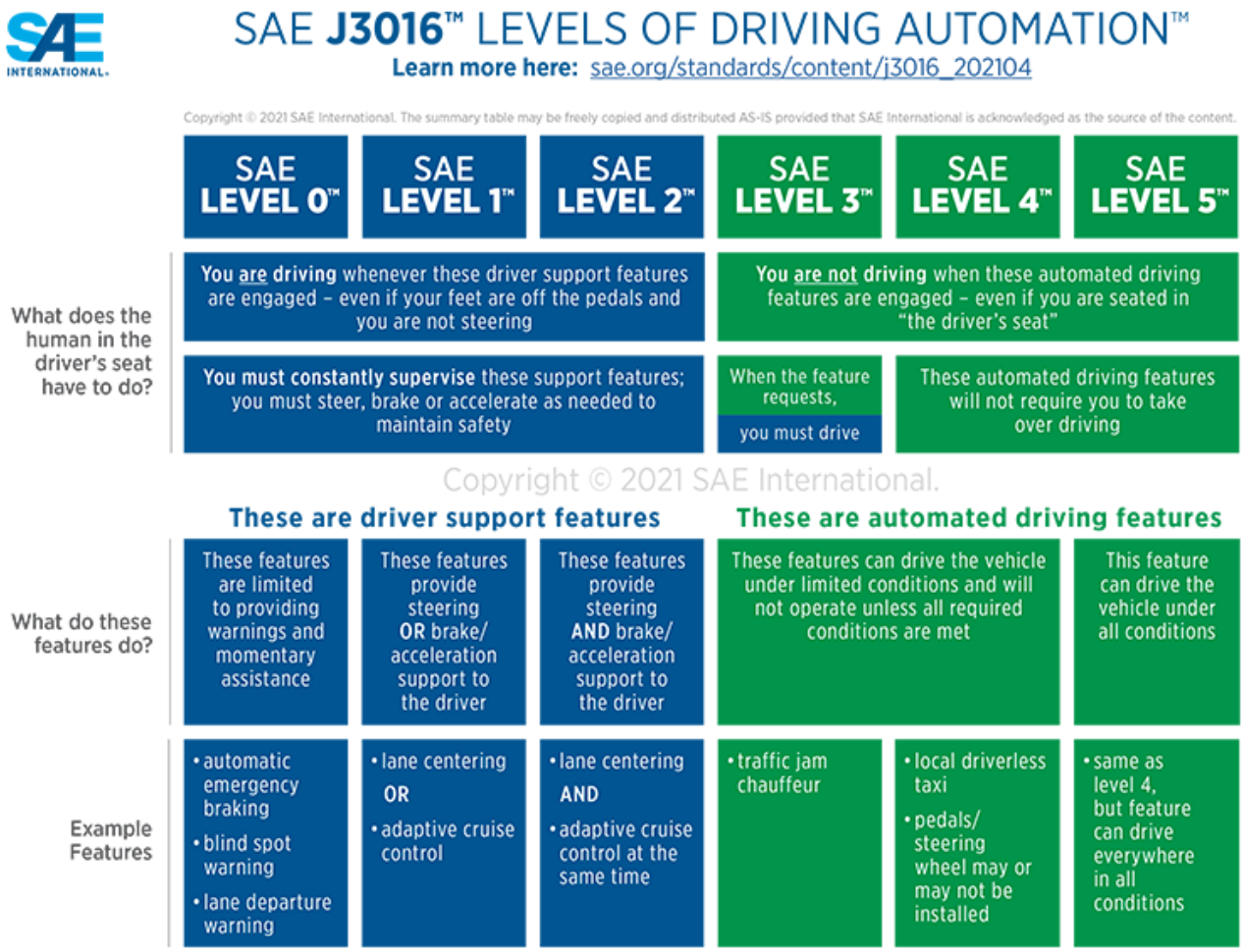
Level 1 – Driver Assistance, the sustained and operational design domain (ODD)–specific execution by a driving automation system of either the lateral or the longitudinal vehicle motion control subtask of the DDT (but not both simultaneously) with the expectation that the driver performs the remainder of the DDT

Level 2 – Partial Driving Automation, the sustained and ODD-specific execution by a driving automation system of both the lateral and longitudinal vehicle motion control subtasks of the DDT with the expectation that the driver completes the object and event detection and response (OEDR) subtask and supervises the driving automation system

Level 3 – Conditional Driving Automation, the sustained and ODD-specific performance by an ADS of the entire DDT with the expectation that the DDT fallback-ready user is receptive to ADS issued requests to intervene, as well as to DDT performance-relevant system failures in other vehicle systems, and will respond appropriately

Level 4 – High Driving Automation, the sustained and ODD-specific performance by an ADS of the entire DDT and DDT fallback without any expectation that a user will need to intervene

Level 5 – Full Driving Automation, the sustained and unconditional (i.e., not ODD-specific) performance by an ADS of the entire DDT and DDT fallback without any expectation that a user will need to intervene



SAE International Definitions

The following definitions are also provided by SAE International to establish a baseline for commonly used terms and are used throughout this report:

Automated Driving System (ADS) – the hardware and software that are collectively capable of performing the entire DDT on a sustained basis, regardless of whether it is limited to a specific ODD; this term is used specifically to describe a Level 3, 4, or 5 driving automation system.

NOTE: In contrast to ADS, the generic term "driving automation system" refers to any Level 1 to 5 system or feature that performs part or all of the DDT on a sustained basis. Given the similarity between the generic term "driving automation system" and the Level 3- to 5-specific term "Automated Driving System," the latter term should be capitalized when spelled out and reduced to its acronym, ADS, as much as possible, but the former term should not be.

ADS-dedicated vehicle (ADS-DV) – an ADS-equipped vehicle designed for driverless operation under routine/normal operating conditions during all trips within its given ODD (if any).

ADS-equipped vehicle – a vehicle equipped with an Automated Driving System (ADS).

ADS-equipped dual-mode vehicle – an ADS-equipped vehicle designed to enable either driverless operation under routine or normal operating conditions within it given ODD (if any), or operation by an in-vehicle driver, for complete trips

Driver – a user who performs in real-time part or all of the DDT and DDT fallback for a particular vehicle

Dynamic driving task (DDT) – all of the real-time operational and tactical functions required to operate a vehicle in on-road traffic, excluding the strategic functions such as trip scheduling and selection of destinations and waypoints and including without limitation, the following subtasks:

1. lateral vehicle motion control via steering (operational);
2. longitudinal vehicle motion control via acceleration and deceleration (operational);
3. monitoring the driving environment via object and event detection, recognition, classification, and response preparation (operational and tactical);
4. object and event response execution (operational and tactical);
5. maneuver planning (tactical); and
6. enhancing conspicuity via lighting, sounding the horn, signaling, gesturing, and so on (tactical).

Dynamic driving task (DDT) fallback – the response by the user to either perform the DDT or achieve a minimal risk condition (1) after occurrence of a DDT performance-relevant system failure(s) or (2) upon operational design domain (ODD) exit or the response by an ADS to achieve minimal risk condition, given the same circumstances

(Human) user – a general term referencing the human role in driving automation

Minimal risk condition – a stable, stopped condition to which a user or an ADS may bring a vehicle after performing the DDT fallback to reduce the risk of a crash when a given trip cannot or should not be continued

Object and event detection and response (OEDR) – the subtasks of the DDT that include monitoring the driving environment (detecting, recognizing, and classifying objects and events and preparing to respond as needed) and executing an appropriate response to such objects and events (i.e., as needed to complete the DDT and/or DDT fallback)

Operate (a motor vehicle) – collectively, the activities performed by a (human) driver (with or without support from one or more Level 1 or 2 driving automation features) or by an ADS (Level 3–5) to perform the entire DDT for a given vehicle

Operational design domain (ODD) – operating conditions under which a given driving automation system or feature thereof is specifically designed to function, including, but not limited to, environmental, geographical, and time of day restrictions, and/or the requisite presence or absence of certain traffic or roadway characteristics

Passenger – a user in a vehicle who has no role in the operation of that vehicle

Remote Assistance – event-driven provision by a remotely located human of information or advice to an *ADS*-equipped *vehicle* in *driverless operation* to facilitate *trip* continuation when the *ADS* encounters a situation it cannot manage

Remote driver – a driver who is not seated in a position to manually exercise in-vehicle braking, accelerating, steering, and transmission gear selection input devices (if any) but is able to operate the vehicle

Remote driving – real-time performance of part or all of the *DDT* and/or *DDT fallback* (including, real-time braking, steering, acceleration, and transmission shifting) by a *remote driver*

Request to Intervene – an alert provided by a Level 3 ADS to a fallback-ready user indicating the s/he should promptly perform the DDT fallback, which may entail resuming manual operation of the vehicle (i.e., becoming a driver again), or achieving a minimal risk condition if the vehicle is not operable.

Other Key Terms and Definitions

For purposes of this report, the following definitions apply:

Advanced Driver Assistance Systems (ADAS) – systems designed to help drivers with certain driving tasks (e.g., staying in the lane, parking, avoiding crashes, reducing blind spots, and maintaining a safe headway). ADAS are generally designed to improve safety or reduce the workload on the driver. With respect to automation, some ADAS features could be considered SAE Level 1 or Level 2, but many are Level 0 and may provide alerts to the driver with little or no automation.

Aftermarket – the market for spare parts, accessories, and components for motor vehicles not manufactured and installed by the OEM at the time of vehicle manufacture

Applicant – a person who applies for or requests a driver's license permit or driver's license

Automated mode – the mode that is set in the vehicle for the automated actions to take over and the driver or user does not control the functions of the vehicle

Automated vehicle (AV) – any vehicle equipped with autonomous technology that has been integrated into that vehicle

Automated vehicle testing (AVT) – testing of ADS-equipped vehicles on public roadways

Automation – the use of electronic or mechanical devices to replace a driver

Background check – investigation of a candidate's background based on criteria determined by their prospective or current employer, which may include employment, education, criminal records, credit history, motor vehicle, and license record checks

Crash (reportable crash) – a collision resulting in a person's injury or death or property damage that reaches the jurisdiction's threshold

Crash report – a report completed by a law enforcement officer who investigates a motor vehicle crash

Data collection mechanisms (DCM) – includes, but is not limited to, recording media such as on-board Electronic Data Recorders (EDR), on-board CPU(s), cloud-based CPU(s), and so on (Source: SAE 1660)

Deploy/deployment/deployed – the operation of an ADS-equipped vehicle on public roads by members of the public or for use by the public who are not employees, contractors, or designees of a manufacturer or other testing entity or for purposes of sale, lease, providing transportation services for a fee, or otherwise making commercially available outside of a testing program

Driver history – record containing all convictions and other licensing actions of each driver maintained by the licensing jurisdiction

Driver testing – the examination of an applicant to determine if s/he possesses the knowledge, skills, and ability to safely operate a vehicle on public roadways

Driver training – instruction provided to an individual on how to operate a vehicle safely

Endorsement – an authorization to an individual's driver's license permitting the individual to operate certain types of vehicles

Event data recorder (EDR) – a device installed in some automobiles to record information related to vehicle crashes or incidents

Human–machine interface (HMI) – software and hardware that allow human operators to monitor the state of a process under control, modify control settings to change the control objective, and manually override automatic control operations in the event of an emergency. The HMI also allows a control engineer or operator to configure set points or control algorithms and parameters in the controller. The HMI also displays process status information, historical

information, reports, and other information to operators, administrators, managers, business partners, and other authorized users. Operators and engineers use HMIs to monitor and configure set points, control algorithms, send commands, and adjust and establish parameters in the controller. Source(s): NIST SP 800-82 Rev. 2.

Incident – an occurrence involving one or more vehicles in which a hazard is involved but not classified as a crash because of the degree of injury and extent of damage

Jurisdiction – any state, district, territory, or province of the United States or Canada

Manufacturer – an individual or company that designs, produces, or constructs vehicles or equipment. Manufacturers include original equipment manufacturers (OEMs), multiple and final stage manufacturers, modifiers or upfitters (individuals or companies making changes to a completed vehicle before first retail sale or deployment), and modifiers (individuals or companies making changes to existing vehicles after first retail sale or deployment).

Manufacturer's safety plan – a clearly stated policy to help all employees understand the priority of developing safe and healthy working conditions and appropriate goals and objectives for the program

Modifier or upfitter – an individual or company that specializes in the design or installation of aftermarket products

Motor vehicle agency (MVA) – either the motor vehicle or driver license agency or both if they are within one agency

Nondriver – a user of an automated vehicle who normally would not be able to drive a vehicle (i.e., age limitations, disabilities)

New Vehicle Information Statement (NVIS) – a record of a new vehicle that provides basic information on the vehicle, the manufacturer/importer, the authorized dealer who sells it, and information about the initial purchaser

Occupant – a human in the vehicle, regardless of role or responsibility

Other entities and educational institutes – any individual or company, that is not a manufacturer, involved with helping to design, supply, test, operate, or deploy automated vehicles, technology, or equipment

Rules of the road – phrase used to describe jurisdictional traffic laws

Society of Automotive Engineers (SAE) International – an automotive and aerospace standard setting body that coordinates development of voluntary consensus standards (see www.sae.org/about)

Skills test – a test to determine if the driver has a minimum level of skills to drive in most traffic situations while adhering to a jurisdiction's traffic laws

Suspension – the temporary withholding of the license to drive, usually for a specified period of time

Testing – the operation of an ADS-equipped vehicle on public roads by employees, contractors, or designees of a manufacturer or other entities for the purpose of assessing, demonstrating, and validating the ADS capabilities

Tier 1 supplier – direct suppliers to the OEM

Violation – failure to follow jurisdictional laws or regulations.

Acronyms Used in This Document

Advanced Driver Assistance Systems (ADAS)

Advance Notice of Proposed Rulemaking (ANPRM)

American Association of Motor Vehicle Administrators (AAMVA)

American Association of State Highway and Transportation Officials (AASHTO)

Association of National Stakeholders in Traffic Safety Education (ANSTSE)

Auto Information Sharing and Analysis Center (Auto ISAC)

Automated Driving System (ADS)

automated license plate reader (LPR)

Automated Vehicles Subcommittee (AVSC)

Canadian Council of Motor Transport Administrators (CCMTA)

Canadian Motor Vehicle Safety Standards (CMVSS)

central processing unit (CPU)

Code of Federal Regulations (CFR)

data collection mechanisms (DCMs)

Department of Motor Vehicles (DMV)

Department of Transportation (DOT)

event data recorder (EDR)

Federal Motor Vehicle Safety Standards (FMVSS)

Federal Motor Carrier Safety Administration (FMCSA)

Global Positioning System (GPS)

Governors Highway Safety Association (GHSA)

human–machine interface (HMI)

International Association of Chiefs of Police (IACP)

International Driver Examiner Certification (IDEC)

Law Enforcement Interaction Plan (LEIP)

Law Enforcement Protocol (LEP)

Manufacturer's Certificate of Origin (MCO)

manufacturers and other entities (MOEs)

manufacturer's statement of origin (MSO)

Model Minimum Uniform Crash Criteria (MMUCC)

motor vehicle agency (MVA)

National Conference of State Legislatures (NCSL)

National Fire Protection Association (NFPA)

National Highway Traffic Safety Administration (NHTSA)

National Institute of Standards and Technology (NIST)

National Motor Vehicle Title Information System (NMVTIS)

Noncommercial Model Driver Testing System (NMDTS)

object and event detection and response (OEDR)

original equipment manufacturer (OEM)

Society of Automotive Engineers (SAE) International

Test Maintenance Subcommittee (TMS)

Transportation Research Board (TRB)

United States Department of Transportation (U.S. DOT)

vehicle identification number (VIN)

vehicle to vehicle (V2V)

Chapter 3 Administrative Considerations

This chapter addresses the overall considerations for the administration of the testing and deployment of ADS-equipped vehicles and vehicles with ADAS. There are 10 recommendations in Chapter 3, 8 recommendations directed to jurisdictions for implementation consideration and 2 directed to MOEs.

3.1 Administration

Background

To successfully address the safe integration of ADS-equipped vehicles within the transportation system, a collaborative approach should be taken among jurisdictions and stakeholders to gain an understanding of emerging vehicle technologies and the impact to roadway safety, jurisdictional programs, and infrastructure.

Survey

The AAMVA Automated Vehicles subcommittee conducted a survey of AAMVA member jurisdictions in July and August of 2021 to gauge the level of activity related to ADS-equipped vehicles specifically regarding jurisdiction-level permitting and registration of vehicles. The survey results are provided in these guidelines to provide a baseline for jurisdictions' titling and registration of ADS-equipped vehicles, with the plan to repeat the survey to support future editions.

The AAMVA Automated Vehicles subcommittee conducted a survey of AAMVA member jurisdictions in July and August of 2021 to gauge the level of activity related to ADS-equipped vehicles specifically regarding jurisdiction-level permitting and registration of vehicles. Eight respondents require a Law Enforcement Interaction Plan (LEIP) and 12 jurisdictions are currently issuing permits.

The 2021 survey had 34 responses with these key findings:

- Eight jurisdictions indicated they require a LEIP be in place prior to testing or deployment of ADS vehicles.
- Twelve jurisdictions were currently issuing specific permits, registrations, or similar documentation to ADS-equipped vehicles, and nine jurisdictions were collecting or retaining data on those permits and registrations.
- Cumulatively, the responding jurisdictions identified more than 300 vehicles that were tracked as having an ADS permit, registration, or similar designation. The numbers ranged from just a handful in some states to more than 150 in one state. The vehicles were being used for individual passenger use and commercial operation, including freight transportation, shuttle, bus, and package delivery.
- Eight jurisdictions reported the number of ADS-equipped vehicles had increased in the past two years, one reported a decline, and four others reported no change. Thirteen jurisdictions anticipated issuing permits or registrations to an increasing number of ADS vehicles in the coming two years.

Guidelines for Testing Automated Driving System-Equipped Vehicles

A lead agency should be identified within each jurisdiction to address ADS-equipped vehicle testing and deployment within its borders. The lead agency should be charged with establishing a jurisdictional ADS-equipped vehicle committee. The committee should include, but may not be limited to, representatives from:

- governor or chief executive office;
- legislature;
- motor vehicle administration;
- department of transportation;
- law enforcement agency;
- office of highway safety;
- office of information technology;
- insurance regulator;
- agency representing the aging and disabled community;
- agency that regulates taxis and rideshare companies
- toll authority;
- transit authority; and
- local government.

Other stakeholders such as transportation research centers located within the jurisdiction and groups representing vulnerable road users should be consulted as appropriate. Communication with the ADS-equipped vehicle manufacturing industry is encouraged.

The jurisdiction's ADS-equipped vehicle committee should develop strategies for addressing the testing and deployment of such vehicles in their jurisdiction. There are a range of strategies to consider from addressing testing without active regulation to testing with regulation by policy or statute.

Jurisdictions will need to examine their laws and regulations to address unnecessary barriers to safe testing, deployment, and operation of ADS-equipped vehicles in areas such as:

- licensing and registration;
- driver education and training;
- financial responsibility (insurance and liability);
- rules of the road;
- enforcement of traffic laws and regulations; and
- administration of motor vehicle inspections.

AAMVA recommends the following resource to jurisdictions examining their laws and regulations: Implications of Automation for Motor Vehicle Codes, developed by the Transportation Research Board under the National Cooperative Highway Research Program (NCHRP 20-102 (07).

The objective of this research was to provide state transportation and motor vehicle departments with guidance and resources to assist with the legal changes that will result from the roll out of connected and automated vehicles (AVs). This research:

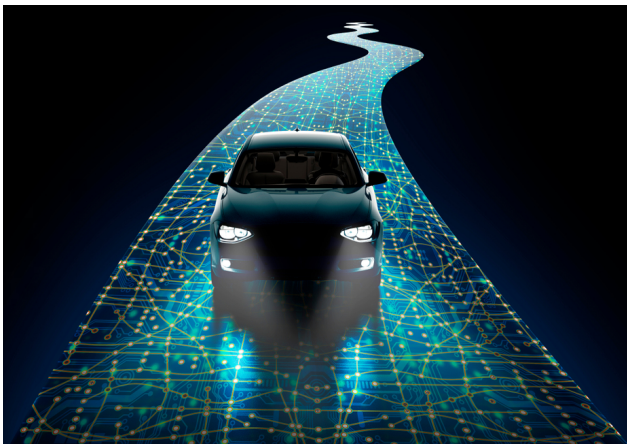
- Provides a review of applicable existing laws and regulations that may need reconsideration as connected and AVs (CVs, AVs, or CAVs) become more widely used with a focus on how these codes need to be revised (and how soon).
- Anticipates changes to motor vehicle laws, regulations, and statutes related to CVs and AVs that may affect current driving practices and continuous responsibility for managing traffic safety hazards.
- Identifies barriers to implementation of new rules of the road resulting from the roll out of CVs and AVs and developing strategies to overcome them.

- Addresses processes and stages for modifying relevant motor vehicle code, laws, regulations, and statutes.

Jurisdictions that regulate the testing of ADS-equipped vehicles are encouraged to take necessary steps to establish statutory authority and to use NHTSA's *Automated Driving Systems: A Vision for Safety 2.0* published in September 2017 and NHTSA's *Preparing for the Future of Transportation: Automated Vehicles 3.0* published in October 2018, *Ensuring American Leadership in Automated Vehicle Technologies: Automated Vehicles 4.0* published in January 2020, and later updates to frame the regulations.

The designated lead agency should keep its ADS-equipped vehicle committee informed of requests from MOEs to test in their jurisdiction and the status of the designated agency's response.

Several national associations are engaged in the discussion on ADS-equipped vehicles and are available for additional support to jurisdictional government officials. These include, but are not limited to, AAMVA, American Association of State Highway and Transportation Officials (AASHTO), Canadian Council of Motor Transport Administrators (CCMTA), Council of State Governments (CSG), National Conference of State Legislatures (NCSL), Governors Highway Safety Association (GHSA), National Governors Association (NGA), and Commercial Vehicle Safety Alliance (CVSA).



As technologies emerge, regulators and policy makers will need to continuously advance their knowledge, staying abreast of relevant reports and studies, attending ADS-equipped vehicle forums, and engaging with industry. This knowledge will help officials recognize when laws, rules, and policies are outdated or proposed prematurely.

The TRB has initiated an effort to harmonize state AV laws. NCHRP 20-06/Topic 26-03 [Pending] Multistate Coordination and Harmonization for AV Legislation, can be found at https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=5244

Recommendations for Jurisdictions

3.1.1. Identify a lead agency to manage the ADS-equipped vehicle committee and its efforts.

3.1.2. Establish an ADS-equipped vehicle committee.

3.1.3. Develop strategies for addressing testing and deployment of ADS-equipped vehicles in the jurisdiction.

3.1.4. Examine jurisdictional laws and regulations to consider barriers to safe testing, deployment, and operation of ADS-equipped vehicles.

3.1.5. Jurisdictions that regulate the testing of ADS-equipped vehicles are encouraged to take necessary steps to establish statutory authority and to use NHTSA's *Automated Driving Systems: A Vision for Safety 2.0* and *Preparing for the Future of Transportation: Automated Vehicles 3.0*, *Ensuring American Leadership in Automated Vehicle Technologies: Automated Vehicles 4.0* published in January 2020, and later updates to frame the regulations.

3.1.6. ADS-equipped vehicle committee members, regulators, and policy makers are encouraged to perform knowledge-gathering and information-sharing functions.

3.1.7. The motor vehicle agency (MVA) should designate an AV lead staff person if the agency is not the jurisdictional lead AV agency. As the jurisdiction becomes more engaged in the regulation of ADS-equipped vehicles, the lead person may eventually become dedicated to the project. Therefore, funding may be needed in the future for a dedicated position.

Recommendations for Manufacturers and Other Entities

MOE 1. MOEs should interact with and respond to jurisdictional ADS-equipped vehicle committee questions and requests.

Benefits to Implementation

By establishing a lead agency and an ADS-equipped vehicle committee, jurisdictions optimize collaboration among stakeholders as they become informed of the technologies and as they explore options for the safe testing and deployment of ADS-equipped vehicles. Awareness will assist officials to recognize when and how regulations may need to be developed and updated. A lead agency can provide the appropriate level of government oversight with flexibility to quickly modify regulations if needed. A flexible and consistent approach is beneficial to regulators and supports innovation within the industry.

Challenges to Implementation

Finding the right balance between ensuring roadway safety while supporting technological advancements through the development and testing phases of ADS-equipped vehicles is a challenge. Thorough review of jurisdictional laws and rules to ensure the safe testing of ADS-equipped vehicles in as many situations as possible, including testing without a driver, will require a resource commitment by jurisdictions.

3.2 Advanced Driver Assistance Systems

Background

ADAS are designed to help drivers with certain driving tasks (e.g., staying in the lane, parking, avoiding crashes, reducing blind spots, and maintaining a safe following distance). ADAS are generally designed to improve safety or reduce the workload on the driver. With respect to automation, some ADAS features could be considered SAE Level 1 or Level 2, but many are Level 0 and may provide alerts to the driver with little or no automation. ADAS may also be found in vehicles with higher levels of automation.

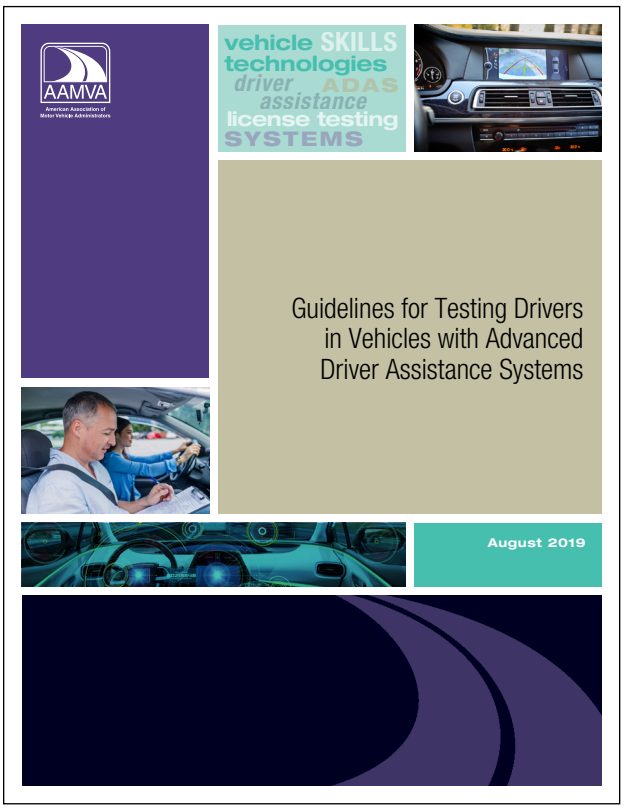
There is a lack of consistency among manufacturers, organizations, policy makers, and stakeholders in ADAS terminology, the indicators for the specific technology in vehicles, and how the technology works. This inconsistency can confuse drivers and other stakeholders when discussing, researching, and using ADAS technology.

There are currently efforts to minimize the lack of consistency in ADAS terminology. MyCarDoesWhat.org (https://mycardoeswhat.org) through the National Safety Council and the University of Iowa currently uses terminology for ADAS that is not specific to any one manufacturer.

Drivers need to understand how to use ADAS technology in their vehicles. If drivers are confused, they may turn it off, not use it as intended, use it beyond its limitations, or overly rely on it. To reduce confusion among the public, manufacturers, organizations, and policy makers should adopt consistent terminology for ADAS. The terminology needs to be simple to understand and based on the function of the technology. AAMVA is engaged in national efforts to support consistency in ADAS terminology.

The Automated Vehicles Subcommittee is partnering with the AAMVA Test Maintenance Subcommittee (TMS) and other organizations to update model

driver's manuals, knowledge tests, and skills tests. The Automated Vehicles Subcommittee is also assisting the AAMVA International Driver Examiner Certification (IDEC) Board in updating the driver's license examiner training materials to address emerging vehicle technology.



In the interim, the TMS and IDEC along with the AAMVA Automated Vehicles Subcommittee developed a guide *Guidelines for Testing Drivers in Vehicles with Advanced Driver Assistance Systems*. It is intended to assist members as they review and update their driver examination policies and procedures to address new vehicle technologies. It outlines technologies and implications for testing and provides recommendations for testing procedures and examiner training. Additional information about this guide and the impact of ADAS on driver licensing programs can be found in Chapter 5.

Recommendations for Jurisdictions

3.2.1. Use SAE International terminology to describe ADAS technology in vehicles as national standards are developed.

Recommendations for Manufacturers and Other Entities

MOE 2. MOEs should adopt SAE International terminology to describe ADAS technology in vehicles.

Benefits to Implementation

By using SAE International terminology drivers and other stakeholders can clearly understand the ADAS technology being referred to and therefore can ensure they are discussing, researching, and using the technology correctly.

Challenges to Implementation

Currently, there is a lack of consistency, and it will be difficult for manufacturers, organizations, policy makers, and other stakeholders to change the terminology currently being used.

Chapter 4 Vehicle Considerations

This chapter addresses vehicle-related topics such as permits to test, registration and titling, inspection, and safety standards for the testing and deployment of ADS-equipped vehicles. There are 31 recommendations in Chapter 4: 28 recommendations directed to jurisdictions for implementation consideration and 3 directed to MOEs.

4.1 Application and Permit for Manufacturers and Other Entities to Test Vehicles on Public Roadways

Background

Several jurisdictions have enacted statutes and rules that give qualifying MOEs authority to test ADS-equipped vehicles on public roadways. What follows is a recommended framework to achieve consistency among jurisdictions that opt to require a permit for testing ADS-equipped vehicles, including passenger vehicles, low-speed shuttles, fleet-owned vehicles, and commercial vehicles. The elements that compose the following framework reflect the need for jurisdictions to ensure safety is the foremost concern in permitting the testing of ADS-equipped vehicles.

Guidelines for Testing Vehicles

MOEs testing ADS-equipped vehicles should apply for and be issued vehicle-specific test permits before testing on public roadways.

The application process for test permits is intended to provide sufficient background information for jurisdiction and law enforcement personnel to interact with the manufacturer and its vehicle(s). In situations when a jurisdiction has opted to establish a program that allows testing, relevant jurisdiction and local officials, including law enforcement, should be made aware of who, how, where, and what testing is being conducted. With this information, officials will be better prepared to ensure safety is prioritized during testing and respond appropriately when there is a crash or incident. It is recommended the permit application process include the completion or attachment of all the following information:

- Name of MOE
- Corporate physical and mailing addresses of MOE
- In-jurisdiction physical and mailing addresses of MOE, if different than corporate address
- Program administrator or director
- Contact information for program administrator or director
- Vehicle-specific information for all vehicles to be permitted, including
  - Vehicle identification number (VIN)
  - Year (if assigned by the manufacturer)
  - Make (if assigned by the manufacturer)
  - Model (if assigned by the manufacturer)
  - License plate number and jurisdiction of issuance (if applicable)
  - Indication of intention for testing with or without a human controlling the vehicle from within the vehicle and SAE level if testing without the presence of a human driver
  - Vehicle type (passenger, commercial, low speed, and so on)

- List of all drivers of ADS-equipped vehicles, including:
  - Full name
  - Date of birth
  - Driver's license number and jurisdiction or country of issuance
- Summary of training provided to employees, contractors, or other persons designated by the MOE as drivers of test vehicles
- Disclosure of all jurisdictions where application or issuance of testing registration permits has occurred or been denied
- Confirmation that no active safety system (e.g., automatic emergency braking) has been modified (where applicable). If the active safety system has been modified, the capability must still remain.
- Disclosure of all jurisdictions where testing is or has occurred and an application or permit was not required
- Self-certification of prior testing of the technology to be used in the test vehicles under controlled conditions that simulate the real-world conditions (various weather, types of roads, and times of the day and night) the manufacturer intends to subject the vehicle to on public roadways
- Certification from the MOEs testing ADS-equipped vehicles within the jurisdiction that the vehicles comply with all applicable Federal Motor Vehicle Safety Standards (FMVSS) or Canadian Motor Vehicle Safety Standards (CMVSS) and no required safety devices have been made inoperable; in lieu of the certification, evidence the vehicle(s) received an exemption or waiver from the FMVSS or CMVSS (see Section 4.9)
- Copy of manufacturer's safety plan for testing vehicles, including a minimal risk condition component
- Routes to be used when testing ADS-equipped vehicles without a human controlling the vehicle from within the vehicle (if applicable)
- Description of remotely controlled operation of vehicles (as described in Chapter 5.3) in the course of testing, including items such as redundancy, latency, location of remote operator(s), and licensure of remote operators
- Evidence of the manufacturer's ability to respond to damages for personal injury, death, or property damage caused by a vehicle during testing; evidence may be in the form as approved by the jurisdiction (e.g., an instrument of insurance, a surety bond, proof of self-insurance)
- Plan for sharing crash data relevant to the vehicle and driver and leveraging provisions of NHTSA's current *Standing General Order Incident Reporting for Automated Driving Systems and Level 2 Advanced Driver Assistance Systems*

Such permits should be valid in the jurisdiction of issuance only. Each permit, subject to periodic renewal, should contain the following information:

- owner name;
- mailing and physical addresses;
- emergency contact information;
- jurisdiction specific limitations (e.g., geographic, environmental);
- VIN;
- year of vehicle (if assigned by the manufacturer);
- make of vehicle (if assigned by the manufacturer);
- model of vehicle (if assigned by the manufacturer);

- vehicle type (passenger, commercial, low-speed, and so on); and
- indication of permit holder's intention for testing with or without a human controlling the vehicle and the SAE level. If testing with a human driver, indicate whether the driver is in the vehicle or controlling the vehicle remotely.

In jurisdictions where MOE-owned vehicles are required to be individually registered, the permit information should be available for verification at time of vehicle registration issuance (new and renewal) either by presentation from the holder or through electronic means. If at any time such a permit is no longer valid, the associated vehicle registration should become void.

Test registration permits should be carried in the test vehicle while present on public roadways until or unless an electronic process has been created by jurisdictions that will allow permit information to be made readily available to law enforcement. Jurisdictions should move toward providing electronic access to permit information.

Reciprocity issue – while test permits should be specific to the jurisdiction where they are issued, there may be opportunities for a jurisdiction to cooperate with an adjoining jurisdiction to develop a consistent or concurrent test permit process for vehicles that might routinely cross jurisdiction borders during testing, such as in multi-state metro areas.

Recommendations for Jurisdictions

4.1.1. Require all MOEs testing ADS-equipped vehicles to apply for and be issued vehicle specific permits before testing on public roadways.

4.1.2. Establish a test registration permit application process for ADS-equipped vehicles that does not create unnecessary barriers for MOEs and requires the completion or attachment of the information listed in Section 4.1.

4.1.3. Implement a process for denying an application, as well as an appeal process for applicants or permittees whose applications have been denied.

4.1.4. Require test registration permit information be available for verification at the time of vehicle registration issuance (new and renewal) either by presentation from the holder or through electronic means in jurisdictions where MOE-owned vehicles are required to be individually registered.

4.1.5. Require test registration permits to be carried in the test vehicle while present on public roadways until or unless an electronic process has been created by jurisdictions that will allow permit information to be made readily available to law enforcement.

Guidelines for Deployed Vehicles

Deployed vehicles are not subject to permit issuance.

Benefits of Implementation

ADS-equipped vehicles tested on public roadways will meet minimum testing requirements before authorized operation. In addition, authority granted for on-road testing will be identifiable to law enforcement and MVAs.

Finally, jurisdiction and local officials will have increased awareness of ADS-equipped vehicles through the sharing of permit and testing information. This includes where, when, and by whom testing was conducted as well as the number and types of vehicles tested and if involved in any incidents or crashes. These data elements are valuable when providing information to other government officials and

agencies, the public, industry, the media, and other interested stakeholders.

Challenges to Implementation

Some manufacturers may indicate permit issuance is burdensome and not necessary if vehicles being operated are properly registered or plated.

4.2 Actions on Permit Process

Background

Jurisdictions have significant flexibility in establishing a permitting process as described in Section 4.1. However, although provisions of the permitting process may vary significantly among jurisdictions, public trust and integrity require a means to enforce any conditions imposed on the testing entity.

Guidelines for Testing Vehicles

The jurisdiction should have the authority to fine, suspend, or revoke any permit to test on public roads if permit holders violate permit or safety conditions, as well as the ability to deny renewal of an application. The jurisdictions should also consider the imposition of further penalties if the testing entity continues to operate or test in violation of that suspension or revocation. Jurisdictions should establish a process for reporting traffic law violations to the permit issuing agency.

When creating grounds for suspension, revocation, and fines, jurisdictions should consider:

- incorrect information supplied on the application or documentation pertaining to the application;
- failure to maintain financial responsibility;
- failure to follow the jurisdictions laws regarding testing;
- the ADS and the manufacturer are subject to an investigation by any law enforcement, licensing, or permitting agency; the U.S. DOT; or any other federal government agency;
- failure to follow the rules of the road;
- failure to timely file required reports with the jurisdiction; and
- failure to properly monitor its drivers, either as to their driver record or actions on the road.

Jurisdictions should also set forth an appeal process from any action taken against a MOE.

Recommendations for Jurisdictions

Develop provisions for suspension, revocation, or fining of any permit holder to test on public roads if permit holders violate permit conditions and for reporting such actions to the jurisdiction's lead law enforcement agency.

4.2.1. Consider the imposition of penalties if the testing entity continues to operate or test in violation of a suspension or revocation order.

4.2.2. Establish a process for reporting traffic law violations to the permit issuing agency.

4.2.3. Have an appeal process for administrative actions taken against a MOE.

Guidelines for Deployed Vehicles

Regulations developed to ensure safety during testing would not be applicable to deployed vehicles. Deployed vehicles have been adequately tested, evaluated, and certified for safety and compliance with FMVSS or CMVSS.

Benefits of Implementation

By enforcing permit compliance, public safety and the integrity of the permitting process are improved. The purpose of the permitting process is to ensure safety during development. But issuing a permit alone does not ensure safety if a permit holder is not held accountable to the conditions of the permit (i.e., background checks, operating in school zones). There

must be ramifications for violating the conditions of the permit to ensure integrity in the testing process.

Challenges to Implementation

Manufacturers may view any permitting process as an impediment to their ability to test and develop ADS-equipped vehicle technology. Jurisdictions may lack the resources to monitor and enforce provisions of its permitting process and may find responding to manufacturers' appeals time consuming.

4.3 Automated Driving System-Equipped Vehicle Information on the Manufacturer's Certificate of Origin and Manufacturer's Statement of Origin

Background

Manufacturer's Certificate of Origin (MCO) and Manufacturer's Statement of Origin (MSO) documents are used by the majority of jurisdictions during the titling and registration process of a new motor vehicle. In Canada, jurisdictions use an equivalent document referred to as the New Vehicle Information Statement (NVIS). The MCO, MSO, or NVIS format is not governed by federal statute or rule; however, most jurisdictions have statutes or rules governing their appearance, content, and acceptance. AAMVA provides jurisdictions and manufacturers with general guidance through AAMVA policy positions to promote uniformity among jurisdictions.

Typically, the MCO, MSO, or NVIS contains, at a minimum, the issue date of certificate, control or certificate number, VIN, model, make, series or model, and body style. Furthermore, MCOs, MSOs, and NVISs list engine horsepower, engine displacement or number of cylinders, gross vehicle weight rating (GVWR), and shipping weight, as well as the manufacturer's name and address and the dealership name and address where the vehicle was initially delivered. The back of the document contains sales reassignment areas for the purchaser (whether a retail customer or a subsequent dealer). MCOs, MSOs, and NVISs are generated on security paper similar to jurisdictional title stock.

Guidelines for Testing Vehicles

Manufacturer test vehicles are often not titled. As such, the lack of MCO, MSO, and NVIS documents with ADS-related information will not impact test vehicles in most jurisdictions. However, some jurisdictions have chosen to title test vehicles. In these instances, the jurisdictions have relied on self-reporting during the permitting process in lieu of MCO, MSO, and NVIS documents during the titling process. For instance, California requires the titling of a test vehicle when used in the automated vehicle testing (AVT) program, which ensures the proper tracking and eventual disposal of the vehicle when no longer used for testing.

Recommendations for Jurisdictions

4.3.1. Jurisdictions should not initiate a process for titling test vehicles if the jurisdiction does not already require this protocol.

Guidelines for Deployed Vehicles

AAMVA supports NHTSA's *Preparing for the Future of Transportation: Automated Vehicles 3.0* recommendation that various levels of government and private industry continue to collaborate and cooperate in meeting identification goals for ADS-equipped vehicles entering the marketplace. Developing a process for identifying ADS-equipped vehicle functionality through the VIN directly from the manufacturer is crucial to meeting this goal; however, it will require NHTSA to make rule changes to VIN requirements. In conjunction with a VIN identifier or because of the lack of a VIN identifier, it is recommended vehicle manufacturers indicate "Automated Driving System" on the MCO, MSO, or NVIS. This information should be listed in a new field

on the MCO, MSO, or NVIS to avoid confusion with existing content.

Recommendations for Manufacturers and Other Entities

MOE 3. Vehicle manufacturers should indicate it is an ADS-equipped vehicle on the MCO, MSO, or NVIS. This functionality should be listed in a new field on the MCO, MSO, or NVIS to avoid confusion with existing information.

Benefits of Implementation

Using information from a MCO, MSO, or NVIS provides each MVA with certainty that the manufacturer has certified the vehicle includes ADS functionality. Additionally, this information would be available to every jurisdiction in the same format.

Challenges to Implementation

Changing VIN requirements will involve NHTSA adopting a rule change, and some jurisdictions will require software changes to accommodate changes in VIN.

4.4 Designating and Titling New and Aftermarket Automated Driving System-Equipped Vehicles

Background

There has been limited action taken to designate ADS-equipped vehicles as such on titles. In anticipation of manufacturers and jurisdictions making this change, AAMVA will consider an enhancement to the AAMVA-operated national motor vehicle titling information system (NMVTIS) to enable including a vehicle's ADS-capabilities in the NMVTIS record.

Guidelines for Testing Vehicles

Generally, jurisdictions do not require titling of a motor vehicle until it has been sold to a consumer. There is no reason to change this practice for ADS-equipped vehicles.

However, to better track ADS-equipped vehicles used for testing, jurisdictions should record and maintain the vehicle information in their vehicle records. Jurisdictions can achieve this through the normal titling process, through a titling exception process unique to ADS-equipped vehicles, or by recording relevant information in the registration record without titling.

Storing information, such as the VIN and ADS capability (based on SAE Level of automation), whether through titling or some other method devised by the jurisdiction

- provides pertinent information to stakeholders in case of a crash or other interaction with law enforcement or first-responders;
- provides pertinent information to law enforcement and other first responders;
- ensures ownership transfer of the vehicle will be within its laws or policies depending on how a jurisdiction wants to treat a post-test vehicle;
- provides information to the NMVTIS so the status of the vehicle is readily available to other jurisdictions; and
- provides information to policy makers regarding the number of ADS-equipped vehicles operating within a jurisdiction

If a jurisdiction chooses to title an ADS-equipped vehicle during testing, the title should carry an appropriate "ADS" designation, and the SAE Level of automation should be included within the titling and/or registration system.

Recommendations for Jurisdictions

4.4.1. Record and maintain the test vehicle information in the vehicle record through the normal titling process, through a titling

exception process unique to ADS-equipped vehicles or recording vital information in the database without titling. If a jurisdiction titles an ADS-equipped vehicle used for testing, the title should carry an appropriate "ADS" designation and the SAE Level of automation should be included within the titling and/or registration system.

Guidelines for Deployed Vehicles

All deployed ADS-equipped vehicles should be titled pursuant to the jurisdiction's laws or policies, and the SAE Level of automation should be included within the titling and/or registration system. Uniform language, referenced in Section 4.5, is recommended for proper disclosure from jurisdiction to jurisdiction. This guideline is especially significant if exemptions are created for activities currently prohibited (e.g., driving without a license if suspended or revoked privilege; issues related to medical fitness, texting, cell phone use, or display screen content streaming).

For vehicles not equipped with automated technologies by the OEM, designating vehicles with aftermarket-altered automated technologies is recommended. Vehicles that have had a Tier 1 supplier or an aftermarket company alter the vehicle with automated technologies enabling ADS-equipped vehicle functionality should be designated for law enforcement and MVAs, and the SAE Level of automation should be included within the titling and/or registration system.

Recommendations for Jurisdictions

4.4.2. Title all ADS-equipped vehicles, pursuant to the jurisdiction's laws or policies; each title should be "ADS" designated, and the SAE level of automation should be included within the titling and or registration system.

4.4.3 Titles for vehicles with added aftermarket components enabling ADS-equipped vehicle functionality should also be "ADS" designated and the SAE Level of automation should be included within the titling and/or registration system. Since there is currently no readily available central source of ADS-equipped vehicle information, jurisdictions should consider requiring self-reporting of this information during the titling and registration process.

Recommendations for Manufacturers and Other Entities

MOE 4. The OEM or the installer of the aftermarket automated technology, either parts or software systems, should notify the MVA when a motor vehicle has been altered by adding or removing an AV technology.

Benefits of Implementation

Traditionally, jurisdictions have used title designation as a mechanism to identity unique events or qualities that impact the value or safety aspects of a vehicle. Using a proven and existing process to identify ADS-equipped vehicles will ease implementation and adoptability for jurisdictions.

Disclosure via title designation allows law enforcement, MVA personnel, and other stakeholders the ability to better identify ADS-equipped vehicles. Additionally, title designation will provide a mechanism for sharing the information between jurisdictions until a national solution, such as a VIN indicator, becomes available.

Challenges to Implementation

Each jurisdiction has its own unique method of titling and registering vehicles. There is no one guideline that will fit all jurisdictional processes. Additionally, making modifications to titling and registration systems to accommodate designating ADS information

may require significant work on the part of the jurisdiction to modify information technology systems, forms, procedures, and rules. Jurisdictions should consider manual alternatives as an interim measure.

Titling and registration are closely linked. When jurisdictions are considering how to manage titling, they should also review their registration process. See Section 4.5. As technology progresses and the availability of aftermarket automation products increases, the level of autonomy of a registered vehicle may change over time. Vehicle software updates or upgrades may complicate the titling process, such as increasing or decreasing the level of automation. Neither the MCO/MSO/NVIS nor the VIN currently provides an ADS-equipped vehicle identifier. The AAMVA AVSC is aware of resources such as NHTSA's Product Information Catalog & Vehicle Listing (vPIC)-powered VIN Decoder, which may provide information for the vehicle's automation capabilities. However, the VIN Decoder may not be useful for a vehicle with retrofitted ADAS/ADS by a third-party vehicle automation supplier or vendor. Furthermore, vehicle manufacturers are not required to submit information related to vehicle automation capabilities under the 49 CFR Part 565 requirements.

Special Considerations

With the increased technological functionality of these vehicles, jurisdictions may need to consider new types of requirements for ADS-equipped vehicles such as the repair of vehicles returning to road use after severe crashes. ADS-equipped vehicles involved in severe crashes may require evaluation and certification by the manufacturers' authorized repair technicians before being authorized to return to service or for the appropriate title designation.

4.5 Vehicle Registration

Background

Vehicle registration credentials and records are basic tools that enable identification of a vehicle and its owner. As testing and deployment of ADS-equipped vehicles expand, the need for owner and vehicle information is necessary to distinguish these vehicles in mixed-fleet operations. Several jurisdictions already require the use of special registrations for ADS-equipped vehicles tested on public roadways.

Guidelines for Testing Vehicles

A jurisdiction that titles and registers ADS-equipped vehicles used for testing should register these vehicles in a manner consistent with its titling and registration process for ADS-equipped vehicles, which could be its normal process or exception process unique to ADS-equipped vehicles. If a jurisdiction chooses not to title ADS-equipped vehicles during testing, the jurisdiction should record vital information in the registration record.

The registration record should indicate "Automated Driving System." These notes should appear on the vehicle registration credential and electronic record. Jurisdictions should also consider using a separate field for such notes.

The registration, title, and plate issued by the titling jurisdiction for purposes of ADS-equipped vehicle testing should be recognized by other jurisdictions to offer manufacturers process efficiencies and enhance interjurisdictional testing.

Recommendations for Jurisdictions

4.5.1. Record and maintain test vehicle information in the vehicle record through the normal registration process, through a registration exception process unique to ADS-equipped vehicles or by recording vital information in the database without titling.

4.5.2. Establish uniform language that will benefit law enforcement, the MVA, and other stakeholders for testing ADS-equipped vehicles. Use "Automated Driving System" on the vehicle registration record.

4.5.3. Recognize the registration, title, and plate issued by another titling jurisdiction for purposes of testing.

Guidelines for Deployed Vehicles

Uniform language should be established to aid law enforcement, the MVA, and other stakeholders in identifying these vehicles. Such language should use the common terminology "Automated Driving System."

Additionally, jurisdictions should consider using a separate field for this notation (review *AAMVA's Best Practice for Registration Credentialing* for suggestions on open fields). See Section 4.4 for more information.

Recommendations for Jurisdictions

4.5.1. Establish a field on the registration credential or record for deployed vehicles that indicates "Automated Driving System" for motor vehicles with ADS. See Section 4.4 for more information.

4.5.2. Establish uniform language to aid law enforcement, the MVA, and other stakeholders. Use "Automated Driving System" on the vehicle record.

Benefits of Implementation

Disclosure of a vehicle as an ADS-equipped vehicle on the registration credential allows law enforcement to identify vehicles quickly and accurately during a traffic stop or at a vehicle crash scene. Additionally, the ADS-equipped vehicle notation can be maintained until a national solution, such as a VIN indicator, is established. See references for Section 4.3.

The ADS-equipped vehicle indicator on registration records also improves ADS-equipped vehicle summary data reporting. This could include total number of ADS-equipped vehicles registered in each jurisdiction and number of such vehicles involved in crashes and violations. These data can be useful when analyzing the impacts of ADS-equipped vehicle highway safety statistics, adoption rates, and revenue projections.

Challenges to Implementation

Registration and titling are closely linked. When jurisdictions are considering how to manage registrations, they should also review their titling process. See Section 4.4. As technology progresses and the availability of aftermarket automation products increases, the level of automation of a registered vehicle may change over time. Vehicle software updates or upgrades may complicate the registration process, such as increasing or decreasing the level of automation. The MCO, MSO, NVIS, and VIN currently do not provide an ADS-equipped vehicle identifier.

4.6 License Plates

Background

License plates serve a common purpose—to identify motor vehicles. Any jurisdiction that adopts a license plate design specifically for ADS-equipped vehicles should design the plates for license plate readers (LPRs) and optimal legibility to the human eye. The ability for MVA employees, police officers, tolling authorities, and citizens to identify license plate numbers quickly and easily is fundamental to accurate vehicle registration data creation, maintenance, retrieval, and eyewitness reporting.

AAMVA published *License Plate Reader Program Best Practices* in November 2021. LicensePlateReaderProgramBestPracticesGuide-October2021.pdf (aamva.org)

Guidelines for Testing and Deployed Vehicles

Special license plates for ADS-equipped vehicles should not be required. If a jurisdiction does require them, the plates should adopt the administrative, design, and manufacturing specifications contained in the *AAMVA License Plate Standard, Edition 2*. License-Plate-Standard,-Edition-2-Revised.pdf (aamva.org)

Recommendations for Jurisdictions

4.6.1. If a jurisdiction chooses to require a special license plate for ADS-equipped vehicles, the plates should adopt the administrative, design, and manufacturing specifications contained in the *AAMVA License Plate Standard, Edition 2*.

Benefits of Implementation

There is limited benefit for implementing a special license plate for ADS-equipped vehicles as long as the jurisdiction follows the recommendation on registration credential notation from Section 4.5.

Challenges to Implementation

Challenges in implementing a new license plate design include the identification of the jurisdiction of issuance; discernibility of the plate design from others it issues; and cost if there is special significance to the license plate design, as in the design for an ADS-equipped vehicle license plate.

4.7 Financial Responsibility (Also Known as Mandatory Liability Insurance)

Background

An important element of the administration and regulation of ADS-equipped vehicles is ensuring adequate insurance is in place to protect not only the occupants of an ADS-equipped vehicle but also other road users. For example, many jurisdictions require minimum financial responsibility, also known as mandatory liability insurance requirements, for each vehicle operating on public roads. Also, Federal Motor Carrier Safety Administration (FMCSA) regulations require specified liability insurance levels for commercial vehicles over 10,000 pounds, those transporting hazardous materials, and passenger carriers (buses).

Motor vehicle regulators should monitor the legal trends ensuring limits stay relevant and appropriate. It is advisable that there be sufficient coverage available for third-party liability in jurisdictional scenarios when there is no explicit distinction in property damage versus personal injury.

Jurisdictions with higher liability insurance requirements for vehicles used for public transportation, including ridesharing and peer-to-peer motor vehicle rentals, should give special consideration to liability insurance requirements for test vehicles that are designed and manufactured to provide similar transportation services.

Guidelines for Testing Vehicles

Different liability insurance requirements among jurisdictions can create incentives for ADS-equipped vehicle testing where the liability insurance requirement is the lowest. The increase in commercial motor vehicle ADS-equipped vehicle testing interest has some jurisdictions considering if the potential for high risk or greater damage in a crash necessitates higher limits for liability insurance.

However, all ADS-equipped vehicles permitted for on-road testing should be required to have at least minimum liability insurance in the form and manner required by the jurisdiction and FMCSA regulations.

Additionally, jurisdictions may want to consider requirements for commercial vehicles not covered by the federal regulations 49 CFR §387.9 that are distinctive from requirements for personal and private vehicles.

Recommendations for Jurisdictions

4.7.1. Require all ADS-equipped vehicles permitted for on-road testing to have a minimum liability insurance (many jurisdictions have implemented a $5 million requirement) in the form and manner required by the jurisdiction and/or FMCSA regulations.

4.7.2. Consider minimum liability insurance requirements for commercial vehicles not covered by the federal regulations that are distinctive from the requirements for personal and private vehicles.

4.7.3. Jurisdictions with higher liability insurance requirements for vehicles used for public transportation, including ridesharing and peer-to-peer motor vehicle rentals, should give special consideration to liability insurance requirements for test vehicles that are designed and manufactured to provide similar transportation services. Additional consideration should be given to adjusting insurance liability limits based on vehicle design and application.

Guidelines for Deployed Vehicles

At a minimum, liability insurance requirements should follow current jurisdictional and federal requirements. It is premature to provide additional specific guidance on deployed ADS-equipped vehicles because so much is still unknown. There are many factors to consider as the development of these vehicles progresses, including but not limited to the following:

- While a vehicle is in the testing phase, liability insurance responsibility is clearer than in the deployment stage.
- For deployed vehicles, consider all issues related to determining the responsible party. Should liability be transferred wholly or in part to the driver, the manufacturer, the systems developers, or a third-party installer?[1] In the event of a commercial setting, such as ridesharing or a peer-to-peer rentals, the issue becomes even more complicated.
- Consideration should also be given to liability insurance requirements for commercial vehicles not covered by the federal regulations that are distinctive from rates for personal or private vehicles.
- It is unknown if the risks associated with ADS-equipped vehicles is lower or greater than the risks with traditional vehicles.

Recommendations for Jurisdictions

4.7.4. Jurisdictions should consider the challenges described above when establishing minimum insurance liability on deployed ADS-equipped vehicles.

4.7.5. Consider liability insurance requirements for commercial vehicles not covered by the federal regulations that are distinctive from rates for personal or private vehicles.

Benefits of Implementation

The public will be given some assurance that companies interacting on the public roadways are testing and operating in a responsible manner.

Challenges to Implementation

Determining the appropriate minimum coverage for deployed ADS-equipped vehicles is difficult because there are many unknowns on how to assess the associated risks.

4.8 Jurisdictional Approval of the Automated Driving System as the Driver

Note: This section includes recommendations related to the jurisdictional approval of ADS-equipped vehicles for deployment and is closely related to Section 4.10, which examines the issue of periodic vehicle safety inspection programs as they relate to ADS-equipped vehicles.

Background

A persistent issue is whether jurisdictions should be responsible for approving ADS technology prior to deployment. In the absence of a national regulatory structure, jurisdictions have the dilemma

1 This decision should not abrogate any product liability responsibly on the part of the manufacturer.

of approving the testing of ADS-equipped vehicles on public roadways without assurance that they meet a minimum federal standard of safety. Here are a few examples of approaches jurisdictions have taken:

- California law requires an application to be submitted and approved for the safe operation on California roadways. As a result, California Department of Motor Vehicles (DMV) initially explored developing a third-party verification system for these new technologies during their first rule-making process. California shifted direction to a self-certification process.
- The Colorado State Patrol (CSP) has conducted basic safety assessments on ADS-equipped vehicles that have been tested on Colorado's public roadways. These safety assessments did not probe proprietary software but verified that the vehicles were configured with equipment such as lighting, steering, braking, suspension, and collision avoidance systems that enabled the vehicles to navigate various scenarios on public roadways. During the assessments, the CSP additionally verified that when the vehicles were in motion under their own power, they maintained basic lane position and speed, and they reacted to objects in their path of travel.
- Rhode Island requires a general safety inspection along with a safety self-certification from the entity conducting a pilot but does not approve the ADS.

Other ideas have focused on requiring ADS skills testing and therefore possible future licensure of the system before deployment approval of ADS-equipped vehicles for public use. This topic has been raised in the U.S. DOT's guidance on Automated Vehicles (https://www.transportation.gov/AV), in particular in the NHTSA's *Automated Driving Systems: A Vision for Safety 2.0,* Validation Methods section, as well as the section Best Practices for Legislatures *and Preparing for the Future of Transportation: Automated Vehicles 3.0*, State, Local, and Tribal Governments and Automation section.

The Uniform Law Commission (ULC) has a different consideration in its model state legislation. A key component of the recommended model legislation is the creation of "an Automated Driving Provider" designation. An Automated Driving Provider would "vouch" (or more appropriately, self-certify) for the ADS functionality and performance (not unlike what is envisioned by NHTSA). An entity would identify itself as responsible for the "performance" of the ADS and would validate its development and functionality before it would offer to register as the Automated Driving Provider for the vehicle or system. The ULC's report published in 2-19 *Automated Operations of Vehicles Act* can be found at https://www.uniformlaws.org/viewdocument/committee-archive-112?CommunityKey=4e70cf8e-a3f4-4c55-9d27-fb3e2ab241d6.

Although ADS licensure or skills testing before approval has been considered in discussions of public safety, the recommendation has practical limitations, such as what to test for, how to test, and who conducts the testing. Creating a series of recommended skills an ADS should perform would not guarantee ADS is ready for open deployment. Like human skills testing, such testing does not assure continuous safe operation in a normal and changing environment.

The counter argument is that an ADS vehicle should be subject to the same expectation jurisdictions place on new drivers, who are required to undergo

a structured test in which every new driver faces the same number of right and left turns, speed changes, and so forth. However, jurisdictions have varying standards and courses for driver's skills testing. Some are closed courses, others have public roads with closed portions (parallel parking), and others are on public roads for all components.

Guidelines for Deployment

The subcommittee recommends jurisdictions neither put themselves in the position of approving ADS nor imposing a "skills test" on the ADS or its manufacturer at this time. Doing so could create inconsistencies between jurisdictions unless a national test standard were developed and place a burden on jurisdictions to employ experts in the field of ADS. An ADS-equipped vehicle for sale or use on public roads should follow the existing self-certification process used for other vehicle equipment pending further oversight from the federal government.

The absence of jurisdictional testing of ADS does not preclude development of a federal or third-party certification process. The benefits of creating a third-party certification process would be assurance to the public that an entity has reviewed and assessed the abilities of the product before it is offered for public use.

Benefits of Implementation

There is limited benefit to establishing a state-specific ADS technology approval process or ADS vehicle "skills test" currently. Not doing so limits inconsistencies between jurisdictions.

Challenges to Implementation

The longstanding delineation of authority for vehicle design and safety rests with the federal government. Skills testing, licensure, and rules of the road compliance rest with the jurisdictions. Jurisdiction skills testing and licensure of an ADS are difficult to implement without federal standards. A jurisdictional certification process at this time could create a false sense of security and create liability for the jurisdiction.

4.9 Federal Motor Vehicle Safety Standards and Canadian Motor Vehicle Safety Standards

Background

Title 49 CFR 301 Motor Vehicle Safety (2021) legislatively mandates NHTSA to issue FMVSS and Regulations to which manufacturers of motor vehicle and equipment items must conform and certify compliance. FMVSS 209 was the first standard to become effective on March 1, 1967. New standards and amendments to existing standards are published in the *Federal Register*. These federal safety standards establish minimum safety performance requirements for motor vehicles or items of motor vehicle equipment. These requirements are specified in such a manner "that the public is protected against unreasonable risk of crashes occurring as a result of the design, construction or performance of motor vehicles and is also protected against unreasonable risk of death or injury in the event crashes do occur."

The NHTSA establishes FMVSS, and manufacturers must certify that their motor vehicles comply with all applicable standards.[2] Absent an exemption or exception, vehicles equipped with ADS must comply with all applicable FMVSS.[3]

Generally, there are two types of temporary exemptions available from NHTSA: an import exemption for research, testing, and demonstration (testing exemption)[4] and a deployment exemption.[5] Testing exemptions are currently only available for imported vehicles, and noncompliant vehicles cannot be imported into the United States unless the importer receives this exemption. The process for requesting a testing exemption is established in 49 CFR part

2 49 U.S.C. § 30115(a).
3 49 U.S.C. § 30112.
4 49 U.S.C. § 30114.
5 49 U.S.C. § 30113.

591. Deployment exemptions are available only to manufacturers. The process for requesting a deployment exemption is established in 49 CFR part 555.

Additionally, in 2015, the Fixing America's Surface Transportation Act added an exception[6] that allows a manufacturer that produced compliant vehicles prior to enactment of the Act to operate noncompliant vehicles on public roads "solely for purposes of testing or evaluation."[7] Because of this exception, these legacy manufacturers are permitted to test noncompliant vehicles on public roadways without applying for an exemption.

As related to used vehicles, the Safety Act also prohibits manufacturers, dealers, rental car companies, and repair facilities from making inoperative a component or system previously installed in compliance with FMVSS.[8] This provision is meant to prevent automotive professionals from disabling safety equipment to ensure the integrity of critical safety systems.

49 U.S.C. § 30101, Purpose and Policy, states: "The purpose of this chapter is to reduce traffic accidents and deaths and injuries resulting from traffic accidents. Therefore, it is necessary *(*1) To prescribe motor vehicle safety standards for motor vehicles and motor vehicle equipment in interstate commerce; and (2) To carry out needed safety research and development."

In 2020, NHTSA released an advance notice of proposed rulemaking (ANPRM) seeking public comment on the potential development of a framework of principles to govern the safe behavior of ADS in the future. NHTSA and others have identified elements of a framework necessary for objectively defining and assessing ADS competence. The ANPRM seeks public comment on these elements and how they could most appropriately form a framework that provides for motor vehicle safety while also providing flexibility to develop more effective safety innovations. Further NHTSA actions include the issuance of a Standing General Order requiring manufacturers and operators of vehicles equipped with SAE Level 2 ADAS or SAE Level 3 to 5 ADS to report crashes. This action will enable NHTSA to collect information necessary for the agency to play its role in keeping Americans safe on the roadways, even as the technology deployed on the nation's roads continues to evolve.

In 2021, NHTSA expanded the Automated Vehicle Transparency and Engagement for Safe Testing (AV TEST) Initiative from a pilot (started in 2019) to a full program. The online tracking tool provides data on the on-road testing and safety performance of ADS in cities across the country and with the expansion is available to all stakeholders and the public.

The CMVSS serve the same form and function in Canada as the NHTSA FMVSS do in the United States. The ensuing narrative and following recommendations apply to both.

Guidelines for Testing Vehicles

It is critical that manufacturers or other entities testing ADS-equipped vehicles ensure that vehicles either comply with all applicable FMVSS or CMVSS or that the manufacturer or importing entity has an exemption for any noncompliant vehicles.

Recommendations for Jurisdictions

4.9.1. Consider requiring MOEs testing ADS-equipped vehicles within the jurisdiction to certify the vehicles comply with all applicable FMVSS or CMVSS and no required safety devices have been made inoperable. In lieu of the certification, require manufacturers to provide evidence the vehicle(s) have received an exemption from the FMVSS or CMVSS.

Benefits of Implementation

ADS-equipped vehicles tested on public roadways and sold to drivers will meet minimum federal safety

6 49 U.S.C. § 30112(b) (10).

7 The manufacturer must also meet certain other requirements, including having submitted manufacturer identification information to the agency and agreeing not to sell the test vehicles. 49 U.S.C. § 30112(b)(10).

8 49 U.S.C. § 30122.

standards or will have an exemption from the FMVSS or CMVSS, depending on where the vehicle is being tested.

Challenges to Implementation

Some manufacturers, importing entities, or other entities may indicate that FMVSS do not apply to their vehicle technology. Manufacturers or importing entities should provide evidence of an exemption from FMVSS if their vehicles do not comply with FMVSS or CMVSS.

Special Considerations

Jurisdictions need to partner with federal agencies to assist and support the common goal of encouraging technological innovation while increasing safety and mobility.

4.10 Periodic Motor Vehicle Inspections

Background

Some jurisdictions in the United States and Canada require registered vehicles to undergo periodic motor vehicle safety inspection (not the same as emissions testing). Typically, under these programs, vehicle owners are responsible for periodically validating the safety of their vehicle's structure, equipment, and components (including elements such as brakes, lighting, airbags, steering mechanisms, tires, and so on) through a certified inspection station, technician, or mechanic. Jurisdictions that have established these programs are responsible for setting and maintaining minimum operational safety requirements, which in some cases are federally established, applicable motor vehicle safety standards. Vehicles that fail to meet minimum requirements cannot be permitted for use on the road until equipment and components are brought into compliance.

The design and application of safety inspection programs vary among jurisdictions, ranging from requiring all vehicles to pass an annual safety and emissions inspection to requiring an inspection upon change of ownership, upon titling in a change state of record, or when an inspection is ordered by law enforcement at roadside. Although these programs differ, inspection initiatives share the common objective of promoting vehicle safety. Traditionally, these safety inspection programs aim to ensure vehicles maintain mechanical fitness and safety-related functionalities by inspecting components with common designs (e.g., brakes, bulbs).

The emergence and proliferation of automated and connected technologies may result in a diminished human role in the driving task but do not diminish the expectation that the vehicles are inherently safe. Vehicles will increasingly fulfill safety-critical functions that today are the primary responsibility of human drivers. This greater reliance on vehicle technology raises important questions about the role of jurisdictions, MOEs, and owners in ensuring that automated technology is properly and regularly maintained. This also raises the question of how jurisdictions will ensure safe operation when aftermarket software may change the operating features of a vehicles.

Guidelines for Testing Vehicles

It would be difficult for jurisdictions to establish new inspection requirements for ADS-equipped test vehicles given the experimental nature of new and emerging forms of automated technology.

Furthermore, the federal governments have not yet created FMVSS and CMVSS standards for ADAS and ADS technology. The responsibility for ensuring ADS-equipped test vehicles are safe rests with MOEs and testers.

Recommendations for Jurisdictions

4.10.1. Jurisdictions should not be expected to create new safety inspection programs for ADS-equipped vehicles during the testing stages. A jurisdiction that currently has such a program should apply its same standards.

Recommendations for Manufacturers and Other Entities

MOE 5. MOEs should ensure all technology being tested on public roads is safe.

Guidelines for Deployed Vehicles

Integrating new and emerging technologies into inspection programs is a common occurrence in jurisdictions that use such programs. Existing organizational practices such as using working groups, task forces, and subject matter experts can be leveraged to assist in the integration of ADS technology into inspection programs.

However, given the pace of change in ADS technology, it is likely premature for jurisdictions to develop new inspection and maintenance standards for ADS-equipped vehicles, particularly without federal vehicle safety standards for ADS technologies or MOE voluntary consensus on diagnosis strategies.

Federal and jurisdictional governments should continue to work with manufacturers to understand mechanisms for verifying the safety and active functionality of ADS technology components (e.g., through computer diagnostics) and how vehicle safety might be discernable in the future by trained technicians.

Jurisdictions should regularly review their inspection programs in the context of new and emerging technologies to ensure their inspection programs are up to date.

Recommendations for Jurisdictions

4.10.2. Until a national standard (FMVSS, CMVSS, or established MOE consensus standard) is developed, jurisdictions should not incorporate ADAS- or ADS-specific components (e.g., software, sensors) as part of their motor vehicle inspection programs. However, any vehicle abnormality noticed should be documented and provided to the vehicle owner.

4.10.3. Jurisdictions should continue to work closely with MOEs to understand mechanisms for verifying the safety and functionality of current ADAS and ADS technology components, and how safety might be discerned in the future.

Benefits of Implementation

Continuous discussion and consideration of how ADS technology fits into safety inspection programs supports safe operation in the future. However, many questions remain given the rapid development of ADS technology and lack of federal standards. The Automated Vehicles Subcommittee will continue to explore this topic.

Chapter 5 Driver Licensing Considerations

This chapter addresses driver-related topics relative to vehicles with ADAS- and ADS-equipped vehicles. Within this chapter, *driver* and *passenger* are defined. Other topics discussed include driver's license requirements for testing vehicles, remote driver, endorsements and restrictions for deployed vehicles, and driver training for drivers on vehicle technologies as well as educating MVA staff, driver's license examiners, and driver educators. Commercial Driver Licensing (CDL) is also addressed. There are 66 recommendations in Chapter 5: 62 recommendations are directed to jurisdictions for implementation consideration and 4 directed to MOEs.

5.1 Driver and Passenger Roles Defined

Background

As described in Chapter 2, this report uses SAE International's definitions. Universal terms and definitions are critical for jurisdictions, manufacturers, and other entities when discussing AV technologies and ADS-equipped vehicles. Definitions and terms used in this chapter are from J3016 (2021) unless otherwise noted.

Driver – a licensed user who performs in real time part or all the dynamic driving task (DDT) and DDT fallback for a particular vehicle.

Passenger – a user in a vehicle who has no role in performing the DDT for that vehicle.

It should be noted this report uses the term "driver." Although use of the term "operate" or "operating" implies the existence of an "operator," this term is not defined or used in this document, consistent with SAE International definitions and use of terms.

Recommendations for Jurisdictions

5.1.1. Use the SAE International definitions provided in Chapter 2.

5.1.2. As discussed in Section 3.1, jurisdictions should review the resource *Implications of Automation for Motor Vehicle Codes,* which may be a useful guide for updating laws and regulations.

Recommendations for Manufacturers and Other Entities

MOE 6. MOEs should use the SAE International definitions provided in Chapter 2.

Benefits of Implementation

Universal definitions of these terms will facilitate communication, understanding, and standardization of the roles and responsibilities for ADS-equipped vehicles.

Challenges to Implementation

Educating all entities on the need for acceptance and implementation of these universal terms and definitions will be an implementation challenge.

Jurisdictions will need to review their laws and regulations ensuring motor vehicle laws permit the operation of ADS-equipped vehicles Level 4 and 5 without a driver. Legislative action amending statutory and regulatory definitions of "driver" and related terms, as well as reviewing and adapting existing rules regarding vehicle operation may pose challenges until more policymakers are versed in the subject matter.

5.2 Driver's License Requirements for Testing by Manufacturers and Other Entities

Background

Currently, numerous MOEs are testing ADS-equipped vehicles in multiple jurisdictions. It is anticipated testing will be expanded to include most jurisdictions. This section provides guidelines for testing ADS-equipped vehicles by MOEs.

Guidelines for Testing by Manufacturers and Other Entities

ADS-equipped vehicles should be operated solely by employees, contractors, or other persons designated by the MOEs, such as universities involved in testing. Test drivers in ADS-equipped vehicles should receive training and instruction related to, but not limited to, the capabilities and limitations of the vehicle and should be subject to a background check as described in Section 6.3. Training should be documented and submitted to the jurisdiction's AV lead agency along with other required information. Jurisdictions may need to develop or review and adapt their existing rules for submission of such information and background checks.

Because the design of some *Level 4 and 5 ADS-equipped vehicles* may not include a driver's seat or equipment that enables actual physical control of the vehicle's operations, jurisdictions will need to support the safe testing without a human driver inside the vehicle. In this case, the jurisdiction should require a user designated by the manufacturer or any such entity involved in the driverless testing of the ADS-equipped vehicle, be capable of assuming control of the vehicle's operations, or require that the ADS has the ability to achieve a minimal risk condition. Mandating these features (e.g., driver's seat) may conflict with a federally granted exemption and entail changes to the MOE's design of test vehicles, which is configured differently than those ultimately sold to or used by drivers.

Allowing for the safe testing of ADS-equipped vehicles without a driver's seat or traditional driver equipment is important to the continued research, design, and ultimately deployment of ADS-equipped vehicles. Testing without federally mandated equipment may require the manufacturer to obtain an FMVSS exemption from NHTSA.

Jurisdictions will need to take appropriate steps to ensure their motor vehicle laws allow for the testing of ADS-equipped vehicles and for the testing of *Level 4 and 5 ADS-equipped vehicles* by an occupant who is not a licensed driver when the vehicle does not require manual fall back to achieve a minimal risk condition. This may require amending statutory and regulatory definitions of "driver" and other related terms.

The guidelines in this section are not relevant to Level 0 to 2 vehicles unless otherwise noted.

Recommendations for Jurisdictions

5.2.1. Review and develop or adapt existing rules, if applicable, regarding vehicle operation to ensure ADS-equipped vehicle testing is permitted.

5.2.2. Require test ADS-equipped vehicles be operated solely by employees, contractors, or other persons designated by the manufacturer of the ADS-equipped vehicle or any such entity involved in the testing of the ADS-equipped vehicle.

5.2.3. Require test drivers to receive training and instruction related to, but not limited to, the capabilities and limitations of the vehicle and be subject to a background check as described in Section 6.3.

5.2.4. Require training provided to the employees, contractors, or other persons designated by the manufacturer or entity to be documented and a summary of the training be submitted to the jurisdiction's AV lead agency along with other required information.

5.2.5. Support safe testing without a human driver inside of the vehicle by requiring a user designated by the manufacturer of the ADS technology or any such entity involved in the driverless testing of the ADS-equipped vehicle to be capable of assuming control of the vehicle's operations or require that the ADS can achieve a minimal risk condition.

5.2.6. Take steps to ensure motor vehicle laws allow for the manufacturer to safely test Level 4 and 5 vehicles without a licensed driver, provided a user designated by the manufacturer or any such entity involved in the driverless testing of the ADS-equipped vehicle, can assume control of the vehicle's operations or require that the ADS can achieve a minimal risk condition.

5.2.7. Consider requiring manufacturers or other entities testing ADS-equipped vehicles within the jurisdiction to certify the vehicles comply with all applicable FMVSS or CMVSS and no required safety devices have been made inoperable. In lieu of the certification, evidence may be needed indicating the vehicle has received an exemption from the FMVSS or CMVSS. See Section 4.9.

Recommendations for Manufacturers and Other Entities

MOE 7. MOEs should complete a background check and provide or ensure appropriate training for ADS-equipped vehicle test drivers. See Section 6.3 on background checks.

Benefits of Implementation

The review of jurisdictional laws and rules regarding vehicle operation to ensure ADS-equipped vehicle testing is permitted will benefit the safe testing and deployment of ADS-equipped vehicles. Test driver training is a key element for the safe testing of ADS-equipped vehicles. Testing of ADS-equipped vehicles by MOEs, in as many situations as possible, will support the safe deployment of ADS-equipped vehicles to consumers.

Challenges to Implementation

Challenges to implementation include the review of jurisdictional laws and rules regarding vehicle operation for the testing of ADS-equipped vehicles and educating manufacturers on the process for submitting required documentation.

5.3 Remote Driver and Remote Driving

Background

Current technologies now enable a driver to completely control a vehicle from a remote location using a virtual driver's seat. There is the potential for remote drivers to operate all types of vehicles from personal to commercial vehicles, including shuttles and delivery vehicles. They may control more than one vehicle at a time because most likely, the vehicles will be part of a fleet of vehicles. The remote driver may be in a company office, may work from home, may be in another vehicle, or may be in a vehicle that does not have traditional manual controls such as a steering wheel or foot pedals.

The remote driver's role is emerging. The subcommittee developed this information to assist jurisdictions but anticipates updates in the future as this technology progresses.

Remote drivers are defined by SAE International as "A driver who is not seated in a position to manually exercise in-vehicle braking, accelerating, steering, and transmission gear selection input devices (if any) but is able to operate the vehicle."

Although not part of the definition, SAE International also provides the following clarification:

> NOTE 1: A remote driver may include a user who is within the vehicle, within line-of-sight of the vehicle, or beyond line-of-sight of the vehicle.

NOTE 2: A remote driver is not the same as a driverless operation dispatcher, although a driverless operation dispatcher may become a remote driver if [they have] the means to operate the vehicle remotely.

NOTE 3: A remote driver does not include a person who merely creates driving-relevant conditions that are sensed by, or communicated to, the ADS (e.g., a police officer who announces over a loudspeaker that a particular stop sign should be ignored; another driver who flashes [the] head lamps to encourage overtaking, or a pedestrian using a dedicated short-range communication (DSRC) system to announce [their] presence).

EXAMPLE 1: A level 2 automated parking feature allows the remote driver to exit the vehicle near an intended parking space and to cause the vehicle to move into the parking space automatically by pressing and holding a special button on the key fob, while [they are] monitoring the driving environment to ensure that no one and nothing enters the vehicle pathway during the parking maneuver. If, during the maneuver, a dog enters the pathway of the vehicle, the remote driver releases the button on the key fob to cause the vehicle to stop automatically. (Note that the remote driver in this level 2 example completes the OEDR subtask of the DDT during the parking maneuver.)

EXAMPLE 2: Identical situation to Example 1, except that the remote driver is sitting in the back seat, rather than standing outside the vehicle.

EXAMPLE 3: A level 4 closed campus delivery vehicle that has experienced a DDT performance relevant system failure, which forced it to resort to a minimal risk condition by parking on the side of a campus roadway, is returned to its designated marshalling yard by a remote driver who is able to operate the vehicle using wireless means.

As explained by SAE International, a dispatcher or passenger who enters a point of origin or destination into a system but does not perform the DDT is not a remote driver.

In its April 2021 revisions of the J3016, SAE International added two new related definitions.

"Remote assistance" is defined as "Event-driven provision, by a remotely located human of information or advice to an *ADS*-equipped *vehicle* in *driverless operation* in order to facilitate *trip* continuation when the *ADS* encounters a situation it cannot manage."

SAE International provides the following notes and examples:

NOTE 1: *Remote assistance* does not include real-time *DDT* or *fallback* performance by a *remote driver*. Rather, the *ADS* performs the complete *DDT* and/or *fallback*, even when assisted by a remotely located human.

NOTE 2: *Remote assistance* may include providing an *ADS* with revised goals and/or tasks.

NOTE 3: The *remote assistance* function does not include providing strategic instruction regarding selection of destinations or *trip* initiation timing (i.e., *dispatch* functions), even if the same person performs both *remote assistance* and *dispatching* functions.

EXAMPLE 1: A Level 4 *ADS-DV* encounters an unannounced area of road construction within its *ODD*. The *ADS-DV* communicates to a remotely located human that it is unable to proceed around the construction. The remotely located human provides a new pathway for the *vehicle* to follow around the construction zone that allows the *ADS-DV* to automatically proceed and complete its *trip*.

EXAMPLE 2: A Level 4 *ADS-DV* detects an object in its lane that appears to be too large to drive over and stops. A *remote assistant* uses the *vehicle*'s cameras to identify that the object is an empty bag that can be safely driven through/over and provides the instruction to the *ADS-DV* to proceed.

A second new term, "remote driving," is defined as "Real-time performance of part or all of the *DDT* and/or *DDT fallback* (including real-time braking, steering, acceleration, and transmission shifting) by a *remote driver*." Again, notes are provided for clarification:

> NOTE 1: A receptive *remote fallback-ready user* becomes a *remote driver* when s/he performs the *fallback*.
>
> NOTE 2: The *remote driver* performs or completes the *OEDR* and has the authority to overrule the *ADS* for purposes of lateral and longitudinal *vehicle* motion control.
>
> NOTE 3: Remote driving is not *driving automation*.
>
> NOTE 4: Remote driving of a *vehicle* by a human is sometimes referred to as "teleoperation." However, "teleoperation" is not defined consistently in the literature, and thus, to avoid confusion, is not used herein.

Guidelines for Testing Vehicles

Jurisdictions should recognize remote driving is being developed, tested, and piloted today. A consistent definition will be beneficial as these vehicles move across borders.

It is also important to recognize that the FMCSA, which has regulatory authority over CDLs and interstate commercial vehicles, is in the process of developing regulations that will need to be considered as they are introduced.

The location of the remote driver, in relation to the vehicle they are operating, needs continued conversation with all stakeholders. It is possible that a remote driver could be very close to the vehicle or could be miles away, in another jurisdiction, or even in another country.

Remote drivers must be familiar with the traffic laws in the jurisdictions in which they are driving, just as traditional drivers in vehicles are today. However, the issue becomes more complicated when there is a crash or incident that requires law enforcement interaction with the driver.

It will be difficult for officers to identify the remote driver and determine the remote driver's actual physical location. If the officer is in one jurisdiction but the remote driver is in another, it may become problematic. This can be significant if there is a need to determine if the remote driver was distracted or impaired or violated other laws. It will also be important to determine the limit on the number of vehicles a remote driver can safely drive and the number of vehicles a remote driver can safely supervise at one time.

The remote driver must be able to determine the vehicle's physical condition and that it can be operated safely. This will require systems, sensors, and mechanisms to be in place to monitor the condition of vehicle equipment.

Recommendations for Jurisdictions

5.3.1. Define "remote driver" in statutes by adopting the SAE International definition and review the SAE International document J3016 dated April 2021 *Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles* for additional information and further explanation of the definition.

5.3.2. Define "remote assistance" in statutes by adopting the SAE International definition and review the SAE International document J3016 dated April 2021 *Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles* for additional information and further explanation of the definition.

5.3.3. Define "remote driving" in statutes by adopting the SAE International definition and review the SAE International document J3016

dated April 2021 *Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles* for additional information and further explanation of the definition.

5.3.4. Require the testing entity to agree in writing that a remote driver would be subject to an operator fitness evaluation by law enforcement in the event of an incident or crash.

5.3.5. Clarify in law that all laws applicable to drivers also apply to remote drivers.

5.3.6. Review current license restrictions and endorsements to determine which apply to a remote driver and when a remote driver must comply with the restriction or endorsement. For example, restrictions could apply include corrective lenses, hearing devices, and accommodations for missing limbs.

5.3.7. Ensure driver's license program staff and law enforcement understand remote driving and are well versed in responding to inquiries.

5.3.8. Require MOEs testing vehicles using a remote driver to notify the jurisdiction's lead AV agency, comply with all other testing requirements and to provide the names and driver's license information for all remote drivers.

5.3.9. Require documentation from the MOEs that remote drivers have been trained to safely operate the vehicle remotely, including but not limited to, appropriate law enforcement and first responder interaction plans.

Recommended Requirements for Remote Test Drivers

5.3.10. Comply with all federal and jurisdictional laws unless otherwise exempt.

5.3.11. Hold the class of license for the vehicle they are remotely driving with appropriate endorsements and restrictions.

5.3.12. Be physically located in the same jurisdiction as the vehicle they are remotely driving.

5.3.13. Inform their employer and/or test entity immediately of any moving violations or testing permit condition violations that occur whether they are remotely driving a vehicle or driving any other vehicle.

5.3.14. Be fit to remotely drive and not be impaired or distracted.

5.3.15. Remotely drive only one vehicle at a time.

5.3.16. Ensure that the location, communication method, and control interface can allow uninterrupted control of remotely controlled vehicles.

5.3.17. Make available to law enforcement, upon request, their name, physical location, license number, and jurisdiction of issue, as well as the name and contact information of their employer.

5.3.18. Report a crash immediately to the appropriate law enforcement in the jurisdiction in which the vehicle is located.

Recommended Requirements for Test Vehicle Owners

5.3.19. Post the responsible party's name and contact information within a remotely driven vehicle.

5.3.20. Testing entities should verify remote test driver's driving records at least annually or participate in an Employer Notification System offered by the jurisdiction.

Recommendations for Law Enforcement

5.3.21. Support the enactment of laws that require the officer to charge the remote driver with the violation and, if convicted, to hold the remote driver responsible. For other nondriving violations, such as lights not working, the remote driver should be held responsible unless they provide the registered owner's name and contact information, and the registered owner is charged with the violation.

Guidelines for Deployed Vehicles

There is not enough information on deployed vehicles with a remote driver to provide guidance currently. The working group will continue to explore remote driving, remote driving a dual-mode vehicle, and the possibility of a human remotely supervising a vehicle.

Benefits of Implementation

Standardized understanding, definitions, and license requirements of remote drivers ensure consistency throughout jurisdictions and reinforces that remote drivers hold a valid driver's license and are properly trained. It will also assist law enforcement in determining violations and investigating crashes.

Challenges to Implementation

Several different remote driver scenarios are being developed and tested. Educating the public, MVA staff, and law enforcement will be a challenge. Implementing the recommendations will require resources to conduct educational outreach and staff training. Laws and regulations will need to be updated to include remote driver's licensing requirements. The enforcement of remote driver qualifications and driver fitness along with the complication of the vehicle and driver being in separate locations will need to be considered.

5.4 Endorsements and Restrictions for Deployed Vehicles

Background

Because the driver of Level 0 to 3 vehicles with ADAS is expected to be in control of the vehicle, most current driver's license qualifications will apply to their operation. Therefore, existing driver's license qualifications will remain applicable.

Vehicles with Level 4 and 5 ADS functionality have the expectation of enhancing the mobility of those unable to drive or to be licensed because of physical disability, age, or some other condition. Enabling passengers without a licensed driver in these vehicles while the ADS is performing the DDT within its ODD would allow everyone the benefit from the technology. Level 4 and 5 ADS-equipped vehicles may not have a driver or passengers (e.g., empty vehicle or cargo).

Guidelines for Endorsements and Restrictions

The full implications of endorsements or restrictions for ADS-equipped vehicles are not yet fully understood, particularly for Level 4 and 5 ADS-equipped vehicles. Until these technologies have completely developed, driver's license endorsements and restrictions are not recommended.

Additionally, there is a risk of creating conflicting jurisdictional endorsements and restrictions if jurisdictions consider this licensure regime. This will complicate the exchange of driver's licenses from jurisdiction to jurisdiction in translating codes. It will be important to fully examine the development of standardized codes for endorsements and restrictions if they are warranted.

Jurisdictions should not impose any other requirements, such as licensure, sobriety, or clean driving history, for nondrivers to be passengers in Level 4 and 5 ADS-equipped vehicles if the vehicle cannot be operated in manual mode. Assuming Level

4 and 5 ADS-equipped vehicles will require the passenger to only provide destination or navigation inputs; no special training or qualification should be required. The operation of Level 4 and 5 ADS-equipped vehicles is comparable to taking a taxi, riding a bus, or riding the subway, none of which requires special training or licensure.

There is the potential for unsupervised children to be placed in ADS-equipped vehicles. Jurisdictions will want to review their laws and regulations related to unsupervised children in motor vehicles to ensure safety.

Recommendations for Jurisdictions

5.4.1. Do not establish endorsements or restrictions on driver's licenses, specifically for ADS-equipped vehicles at this time.

5.4.2. Take steps to ensure jurisdictional motor vehicle laws allow for the operation of Level 4 and 5 ADS-equipped vehicles without a driver only if the vehicle cannot be operated in manual mode.

5.4.3. Do not limit the operation of Level 4 and 5 ADS-equipped vehicles to individuals who are licensed as drivers.

5.4.4. Do not impose any other requirements, such as licensure, sobriety, or clean driving history, for nondrivers to use Level 4 and 5 ADS-equipped vehicles.

5.4.5. Review jurisdictional laws and regulations related to unsupervised children in motor vehicles to ensure safety.

Benefits of Implementation

By not creating ADS-equipped vehicle endorsements and restrictions, jurisdictions will eliminate conflict of jurisdictional codes and the complications in translating codes when exchanging driver's licenses from jurisdiction to jurisdiction.

Challenges to Implementation

If a jurisdiction implements ADS-equipped vehicle endorsements and restrictions, it will create challenges for other jurisdictions for the exchange of driving privileges.

5.5 Driver Training for Drivers on Vehicle Technologies

As technology is rapidly changing and advancing, it will remain difficult to keep training current and accurate. The goal for training is to cover all the relevant safety features. Initially, standard safety features should be included in training to remain broad enough to keep the training current and accurate. Categorizing these standard safety features to help drivers understand the purposes and limitations would provide a good baseline as the features evolve.

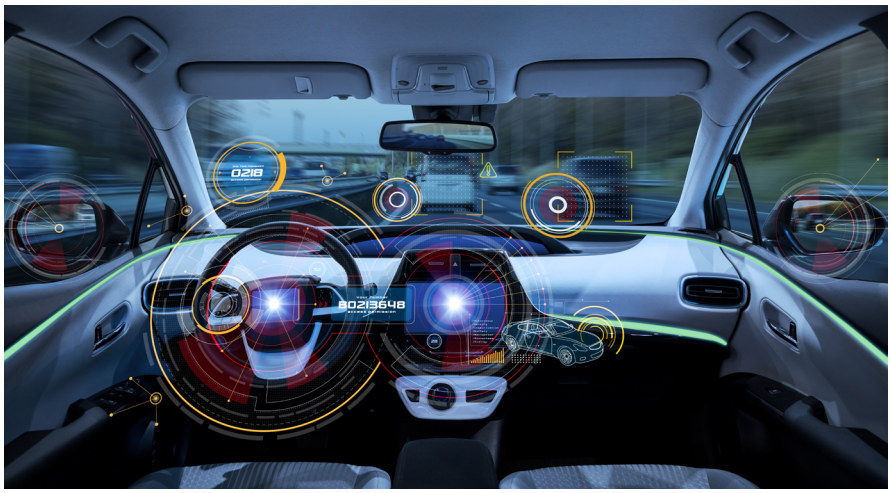
Background

Although most of this report addresses ADS-equipped vehicles, technology described as ADAS also has implications for the driver's license training and testing process. Therefore, Sections 5.5 to 5.9 include discussions on ADS-equipped vehicles as well as ADAS-equipped vehicles.

The operation of ADAS- and ADS-equipped vehicles by drivers will have significant implications for driver training. As ADAS- and ADS-equipped vehicles are deployed and become available to the public, drivers will need to understand the technology and receive proper training on the operation and limitations of their ADAS- and ADS-equipped vehicles when available.

Drivers need to understand the use and limitations of ADAS technology in their vehicles. If drivers are not educated on the purpose of the technology, they may turn it off, not use it as intended, use it beyond its limitations, or overly rely on it. Manufacturers, organizations, and policy makers should adopt consistent terminology for ADAS to reduce confusion among the public. The

terminology needs to be consistent and simple to understand and be based on the function of the technology. As described in Section 3.2, efforts are underway by national organizations to support consistency in ADAS terminology.



Driver training for ADAS- and ADS-equipped vehicles may be achieved by one or more of the following:

- drivers to seek the appropriate training from a recognized professional (see 5.6 for examples);
- manufacturers, dealers, and other appropriate entities provide adequate training to drivers; and
- jurisdictions may regulate education and training for drivers.

The appropriate entities need to develop quality training programs that will effectively train drivers to operate ADAS- and ADS-equipped vehicles safely. The training should educate drivers on the benefits, limitations, and capabilities; how to engage and disengage the system functions; risks of misuse; risks of accidentally or deliberately disengaging a system; how to remain engaged in the driving task; and how to deal with emergency situations. The training should encompass relevant safety features to help drivers understand the products and their purposes and limitations.

Guidelines for Deployed Vehicles

Communication and education among new, used, and aftermarket manufacturers and dealers with drivers on ADAS- and ADS-equipped vehicle functions are critical elements for the safe operation of these vehicles. Manufacturers will need to ensure vehicle information and content contained in the vehicle "owner's manual" or aftermarket information is fully available and assists the driver with reviewing it. However, familiarity of the information and content is not sufficient and should not replace applicable training on ADAS- and ADS-equipped vehicle functions.

Jurisdictions will need to encourage manufacturers and dealers to provide proper training for drivers. Jurisdictions may also need to encourage manufacturers and dealers to offer incentives for drivers to seek training from a fully qualified driver educator.

Agreement on a minimum set of training requirements, outside of the normal owner's manual or aftermarket information, will have a direct impact on the safe operation and success of ADAS- and ADS-equipped vehicles. Manufacturers may provide educational resources through a variety of platforms. Many dealerships already provide personal training classes on features of the vehicle for their customers. Standardized training should be available to everyone who purchases or has the technology installed on their vehicle. In addition to these jurisdictional guidelines, stakeholder consultation is highly recommended.

Recommendations for Jurisdictions

5.5.1. Promote driver training on the use of ADAS- and ADS-equipped vehicle functions.

5.5.2. Encourage communication between dealers and drivers including, but not limited to,

acknowledgement of the sections in the vehicle "owner's manual" related to the ADAS- and ADS-equipped vehicle functions.

5.5.3. Encourage manufacturers, dealers, and insurance companies to provide incentives for drivers to receive proper training on the use of ADAS- and ADS-equipped vehicle functions from a fully qualified driver educator.

5.5.4. Encourage aftermarket system manufacturers and dealers to provide educational materials and resources to drivers.

Recommendations for Manufacturers and Other Entities

MOE 8. Manufacturers and dealers should take steps to make training available to drivers to ensure they understand the functionality of the vehicle and are prepared to properly operate them.

Benefits of Implementation

Drivers who are properly educated on ADAS- and ADS-equipped vehicle operation will support the safe deployment of these vehicles.

Challenges to Implementation

Challenges to implementation include drivers having an interest in and taking the time to seek training on their ADAS- and ADS-equipped vehicle functions and obtaining buy-in from manufacturers, dealers, and insurance companies to provide training or to offer incentives to drivers to seek training.

5.6 Training for Driver Educators, Driver Education, and Driver Training Programs

Background

The training of driver educators and the creation of driver education curricula must adapt as ADAS and ADS technologies evolve. New standards and materials must be developed to include information on the proper use of and interaction with these technologies. Likewise, behind the wheel or in-operation training should include instruction on the proper use of these features.

National organizations that play a key role in the development of driver education and driver training curricula including driver educator training curricula include:

- American Automobile Association (AAA)
- American Driver and Traffic Safety Association (ADTSEA)
- Driving School Association of the Americas (DSAA)
- American Association of Retired Persons (AARP)
- Association of National Stakeholders in Traffic Safety Education (ANSTSE)

ANSTSE develops free standards and resources to assist jurisdictions in their driver education efforts. Each of these organizations and the Automated Vehicles Subcommittee are available to assist driver educators and driver education programs as they broaden their knowledge of ADAS- and ADS-equipped vehicles.

For commercial vehicle operations, where ADAS and ADS technologies are also evolving rapidly, national organizations that play a key role in training include:

- Commercial Vehicle Training Alliance (CVTA)
- National Association of Publicly Funded Truck Driver Training Schools (NAPFTDS)
- Professional Truck Driver Institute (PTDI)

Driver educators can play a key role in educating new and existing drivers on ADAS- and ADS-equipped vehicles. Standardized materials for the training of driver educators on the use of ADAS- and ADS-

equipped vehicles to ensure they are familiar with the function and operation will need to be created and maintained.

For novice drivers, driver education materials will need to be updated and maintained to include information on the proper use and limitations of these technologies and provide hands-on training in this technology during behind-the-wheel instruction. Educators should also consider utilizing various delivery platforms to effectively train novice drivers.

Training standards are developed and maintained by ANSTSE and are available through the Novice Teen Driver Education and Training Administrative Standards (NTDETAS) posted on the ANSTSE website.

Recommendations for Jurisdictions

5.6.1. Require driver education curricula to contain information on ADAS- and ADS-equipped vehicles.

5.6.2. Provide behind-the-wheel instruction on the use of ADAS if equipped.

5.6.3. Require all definitions and language on ADAS- and ADS-equipped vehicles provided in driver education to use the SAE International or AAMVA's guidelines for consistency.

5.6.4. Establish standardized materials for the training of driver educators on the use of ADAS- and ADS-equipped vehicles.

5.6.5. Continually review materials and revise curricula to reflect current ADAS features.

Benefits of Implementation

Standardized training for driver educators will ensure they have the most current information about ADAS- and ADS-equipped vehicles. Standardization of content in driver education curricula will ensure consistent information on vehicle technologies is provided by driver educators to all drivers.

Educating the driving public on the benefits, limitations, and functionality of ADAS- and ADS-equipped vehicles will enhance highway safety and assist with public acceptance.

Challenges to Implementation

The lack of standardized training content and delivery, and consistent human machine interfaces adversely impacts how driver education is delivered.

5.7 Driver's License Skills Testing with Vehicle Technologies

Background

It is important to determine what technologies are permitted during the driver's license examination procedures. These technologies can be grouped into the following categories:

- Convenience technologies – for purposes of this report, are technologies that provide conveniences for the driver (e.g., parking assist feature or auto-cruise control) and do not require the applicant to demonstrate a required skill set and should not be permissible for testing.
- Active safety technologies – active safety systems, as defined in SAE J3063, are vehicle systems that sense and monitor conditions inside and outside the vehicle for the purpose of identifying perceived present and potential dangers to the vehicle, occupants, and/or other road users, and automatically intervene to help avoid or mitigate potential collisions via various methods, including alerts to the driver, vehicle system adjustments, and/or active control of the vehicle subsystems (brakes, throttle, suspension, and so on).

Guidelines for Deployed Vehicles

The purpose of the driver license skills test is to determine an applicant's skill in operating a motor vehicle. Comfort and convenience technologies should not be used during the skills examination. See *Guidelines for Testing Drivers in Vehicles with Advanced Driver Assistance Systems* (August 2019).

Even though a vehicle is equipped with technology features, the applicant must demonstrate the ability to perform the entire dynamic driving task and not solely rely on the technology.

As technologies evolve, there may be a need to examine drivers on their ability to operate specific vehicle technologies. Guidance in this area will be considered in future iterations of this report.

The use of active safety systems should be permitted for skills examinations. These technologies should not be disengaged during skills examinations. In fact, some active safety systems cannot be deactivated. Active safety systems include, but are not limited to:

- back-up camera;
- blind spot warnings;
- lane keeping assist
- lane departure warnings; and
- automated emergency braking

NHTSA and Transport Canada now require all new vehicles to have rearview video systems, also known as backup cameras.

The skills examination and parking maneuvers should be revised to incorporate use of these technologies. In the case of backup cameras or other cameras, the criteria for checking mirrors and blind spots (head-check) while backing up should be updated to evaluate the applicant's behaviors to use cameras in conjunction with mirrors and head-checks, as an example.

The skills examination scoring standards should be updated to reflect the proper procedures for examiners to follow when active safety system(s) activate during the testing process.

SAE International defines a dual-mode vehicle as "An ADS-equipped vehicle designed to enable either driverless operation under routine/normal operating conditions within its given ODD (if any), or operation by an in-vehicle driver, for complete trips. A driver must be licensed to operate a dual-mode vehicle when it is not in driverless operation. When conducting a skills examination in an ADS-equipped dual-mode vehicle, it must be operated in the manual mode."

MVA driver's manuals may not currently contain information on ADAS or ADS technologies. These manuals will need to be updated and maintained to include pertinent and up-to-date information on ADAS- and ADS-equipped vehicles.

AAMVA assists jurisdictions with driver examination practices and driver's license examiner training. The AAMVA TMS is responsible for maintaining and updating AAMVA's model driver testing systems, including the AAMVA Noncommercial Model Driver Testing System (NMDTS). The AAMVA International Driver Examiner Certification (IDEC) program is responsible for maintaining and updating examiner training materials. The materials provide uniformity amongst examiners by requiring standardized training, which in turn improves the efficiency and effectiveness of driver examining personnel.

Recommendations for Jurisdictions

5.7.1. Include ADAS and ADS information on vehicle technologies in the jurisdiction's driver's manual when provided by the AAMVA TMS.

5.7.2. Include questions addressing ADAS and ADS in the jurisdictional knowledge test when provided by the AAMVA TMS.

5.7.3. Jurisdictions should not allow the applicant to use convenience technologies, such as the parking assist feature, for skills examination or parking maneuvers during the skills examination.

5.7.4. Allow the applicant to use active safety system technologies during skills examinations. These technologies, such as backup or other cameras, should not be disengaged during examinations.

5.7.5. Jurisdictions should not require applicants to deactivate active safety system technologies during the skills examination process.

Benefits of Implementation

Standardized testing procedures and driver's manual information will ensure consistent driver examination practices for ADAS and ADS technologies. AAMVA's NMDTS and the AAMVA TMS may facilitate this standardization.

Challenges to Implementation

Agreement among jurisdictions on standardized procedures for examination of drivers in vehicles with technologies will be essential to achieve consistency. Additionally, agreement on standardized information to be included in jurisdictional driver's manuals on the operation of vehicle technologies will be a challenge.

It is important to ensure licensing restrictions are not placed on a passenger if dual-mode vehicles preventing manual operation for occupants unable to operate a vehicle safely become available.

There may be some resistance to requiring a driver's license for ADS-equipped dual-mode vehicles. MVAs will need to work with manufacturers and designers to better understand the appropriate safeguards for the public and the occupants. Further analysis is needed on ADS-equipped dual-mode vehicles and its impact on driver licensing.

The subcommittee will continue to explore the dual-mode vehicles as the technology progresses.

Recommendation for Manufacturers and Other Entities

MOE 9. MOEs that develop an ADS-equipped dual-mode vehicle should consider taking steps to prevent the manual mode from being engaged in error.

5.8 Training Motor Vehicle Agency Examiners on Vehicle Technologies

Background

AAMVA's TMS and the IDEC Board recognize that vehicle technologies are emerging faster than driver's license test design and examiner training can keep pace. The AAMVA TMS and IDEC Board will assist jurisdictions with development of standardized testing and training needed for safely administering both knowledge and skills exams.

The Automated Vehicles Subcommittee has partnered with the AAMVA TMS and other organizations to update model driver's manuals, knowledge tests, and skills tests to address the use of vehicle technology to support the driver testing process. The Automated Vehicles Subcommittee is also assisting the AAMVA IDEC Board to update driver's license examiner training materials to address emerging vehicle technology. In the interim, the TMS and IDEC along with the AAMVA Automated Vehicles Subcommittee developed a guide *Guidelines for Testing Drivers in Vehicles with Advanced Driver-Assistance Systems*. It is intended to assist members as they review and update

their driver examination policies and procedures to address new vehicle technologies within driver testing.

The guidelines apply to noncommercial and commercial vehicles unless prohibited by state and federal law. It outlines technologies and implications for testing and provides recommendations for testing procedures and examiner training.

Guidelines for Deployed Vehicles

As ADAS and ADS technologies continue to advance, the training of driver's license examiners will need to keep pace with these advancements. AAMVA's *Guidelines for Testing Drivers in Vehicles with Advanced Driver-Assistance Systems* will assist jurisdictions to revise or enhance their driver testing and examiner training programs. AAMVA's IDEC model training materials, which will be updated in the future to include ADAS- and ADS-equipped vehicle technologies, will also be a valuable resource.

See Appendix D for an overview of the plan Nevada DMV used to provide Driver Examiner Training on ADAS.

Recommendations for Jurisdictions

5.8.1. Provide training to driver's license examiners on vehicle technologies, including the operation of ADAS- and ADS-equipped vehicles. AAMVA's *Guidelines for Testing Drivers in Vehicles with Advanced Driver-Assistance Systems* resource guide, published in 2019, should be used in examiner training.

5.8.2. Use AAMVA's IDEC model training materials, when updated, to assist with ADAS and ADS examiner training requirements.

5.8.3. Require driver's license examiners to use the definition and language on ADAS- and ADS-equipped vehicles from AAMVA's guidelines (adopted from SAE International).

Benefits of Implementation

Standardization of ADAS and ADS content in examiner training will ensure consistent information on vehicle technologies is provided to examiners.

Challenges to Implementation

Inconsistencies among jurisdictions on standardized content of vehicle technologies for driver's license examiner training standards impact how driver testing is administered.

Driver examiners may not be well informed of vehicle technologies; therefore, there is the potential for inconsistencies in driver testing practices.

5.9 Training Motor Vehicle Agency Staff on Vehicle Technologies

Background

ADAS- and ADS-equipped vehicle technologies have the potential to impact most MVA driver programs. Therefore, it is important to provide information and training to MVA staff as technology evolves. Managers should begin to understand the technology to help them anticipate and prepare for impacts on their program areas.

Guidelines for Testing Vehicles

Although most MVA staff will not be impacted by MOE testing of ADS-equipped vehicles, senior-level managers will benefit from understanding their jurisdiction's approach to the regulation of MOE testing. By understanding the progression of testing, the managers will be better prepared to adjust the programs under their responsibility.

Recommendations for Jurisdictions

5.9.1. MVA senior managers and applicable staff should be aware of MOE ADS-equipped vehicle testing and their jurisdiction's regulatory approach.

Guidelines for Deployed Vehicles

As AV technologies continue to advance, the training of MVA staff will need to keep pace. Section 5.8 specifically addresses the training of MVA examiners on vehicle technologies.

Recommendations for Jurisdictions

5.9.1. Provide general training to MVA staff on vehicle technologies, including what the technology does and how it works. AAMVA's Guidelines for Testing Drivers in Vehicles with Advanced Driver-Assistance Systems resource guide, published in 2019, should be used when training driver licensing staff (see Section 5.9.)

5.9.2. Require all definitions and language on ADAS- and ADS-equipped vehicles provided to MVA staff use the SAE International and AAMVA's guidelines for consistency.

5.9.3. Begin to expose staff to vehicle technology by incorporating some general education in staff meetings. This could include showing videos, graphics, and pictures of vehicles equipped with ADAS and ADS.

Benefits of Implementation

Training for MVA staff will ensure they are familiar with ADAS- and ADS-equipped vehicles. Standardized staff training will ensure consistent information on vehicle technologies is provided. By introducing ADAS technology, staff can be better informed and more aware of the safe operation and limitations of the technology as they operate vehicles provided by the jurisdiction and purchase vehicles for their personal use. The public expects MVA staff to be versed in highway safety. This includes understanding new advancements in vehicle safety, including ADAS- and ADS-equipped vehicles.

Challenges to Implementation

It is always a challenge to find the time and resources to provide training to staff when much of their time is spent providing services to the public. A lack of understanding of vehicle technology available today in the driver licensing programs can lead to inconsistencies among staff and across jurisdictions.

5.10 Commercial Driver Licensing

Background

The FMCSA regulates the safety of commercial motor carriers operating in interstate commerce, the qualifications and safety of commercial motor vehicle (CMV) drivers, and the safe operation of commercial trucks and motor coaches. FMCSA is broadly considering whether to amend its existing regulations to accommodate the integration of ADS into commercial vehicle operations. Many of FMCSA's current regulations can be readily applied in the context of ADAS- and ADS-equipped CMVs.

FMCSA informed the Automated Vehicles Subcommittee it is considering amendments to its rules to account for significant differences between human operators and ADS. It also indicated the agency's preliminary approach is to integrate ADS-equipped CMVs and their operation into existing

regulations. FMCSA acknowledged that federal and jurisdiction enforcement officials may need further training to identify problems with ADS-equipped CMVs, but it is not the FMCSA's goal to have these officials be responsible for conducting diagnostic tests of a CMV's ADS. FMCSA discourages inspectors from delaying the movement of ADS-equipped CMVs unless there are clear indications of safety-critical CMV violations and ADS faults or malfunctions.

Guidelines for Testing Vehicles

All existing jurisdiction and federal laws, rules, and regulations should remain in effect unless specific exemptions or authorizations are granted to the testing entity.

Recommendations for Jurisdictions

The next four recommendations pertain to commercial vehicles regulated by the jurisdictions. Vehicles regulated by the federal government will be addressed in the future as federal regulations are established.

5.10.1. Require commercial vehicle test drivers to have a CDL and appropriate endorsements and restrictions for the vehicles they are testing.

5.10.2. Require the CDL test driver to be located inside the vehicle unless specifically approved to test the vehicle with the CDL test driver outside the vehicle or remotely located.

5.10.3. Require MOEs that are testing ADS technologies on commercial vehicles to follow all regulations for companies that hire CDL drivers are required to follow.

5.10.4. Require compliance with all regulations related to the vehicle and the load being transported.

Guidelines for Deployed Vehicles

CDL laws, rules, and regulations will need to be updated to address ADS-equipped vehicles. However, at this time, it is important for jurisdictions to work with FMCSA to ensure that jurisdiction and federal regulations are aligned.

Recommendations for Jurisdictions

5.10.5. Engage in the review and development of federal regulations by FMCSA.

5.10.6. Review and adopt amendments to jurisdictional laws as federal regulations are updated.

Benefits of Implementation

Jurisdictions will have input into updated federal regulations through the usual notice-and-comment rulemaking process and can assist in continuing to align jurisdictional and federal regulations.

It is anticipated that automated technologies in commercial vehicles, as in automobiles, will reduce the errors and poor decisions made by humans and improve safety.

Challenges to Implementation

Updating federal regulations is a lengthy process, and FMCSA may not be able to react to the testing and deployment of the technology at the same pace as the technology emerges. However, FMCSA has the authority to grant waivers and exemptions and to conduct pilot programs per 49 CFR part 381. FMCSA discussed this in its previous *Federal Register* notices seeking public comment. These waivers and pilot programs allow FMCSA to react at a much faster pace than rulemaking.

Another challenge is ensuring uniformity across jurisdictions during their implementation process. Uniformity across jurisdictions may facilitate further expansion of this technology.

Chapter 6 Law Enforcement Considerations

Introduction

This chapter outlines the leading concerns to law enforcement for ADAS- and ADS-equipped vehicles operated on public roadways. There are 42 recommendations in Chapter 6: 19 recommendations directed to jurisdictions for implementation consideration and 23 directed to MOEs.

6.1 Vehicle Identification

Background

Identification of a motor vehicle as an ADS-equipped vehicle is necessary for law enforcement officers and other first responders (police, fire, emergency medical services, and tow and recovery services) to fulfill their duties. These duties include ensuring the occupant(s) is properly credentialed (if required), ensuring safety at the scene if the occupant(s) is incapacitated in a crash, and aiding in the recovery of stolen vehicles.

From a law enforcement perspective, traditional means for identifying a vehicle via a license plate check may not be the optimal method to identify a vehicle equipped with ADS. License plates are susceptible to theft, only allow identification from the rear in one-plate jurisdictions, and may be obscured in crashes involving front or rear damage. In addition, jurisdictions currently issue a vast array of unique plate designs; one more plate design will not aid in the identification of an ADS vehicle if a similar model vehicle exists in the marketplace.

In contrast, vehicle labeling or permanent marking to identify the vehicle equipped with ADS allows for redundant marking in multiple locations (exterior and interior), improving conspicuity from multiple vantage points. SAE International, the International Organization for Standardization (ISO), and NHTSA have all developed ADS labeling guidelines or have issued proposed rules for labeling of alternative fuel vehicles. These guidelines, or in the case of NHTSA's proposed rule, have varied purposes. Each provides some guidance for accepted labeling.

Vehicle identification strategies should be considered to improve safety and facilitate motor vehicle administration practices and law enforcement efforts. The VIN conveys significant information regarding the characteristics of the motor vehicle to which it is issued. A new VIN system should be considered. VIN information must include information relative to ADS onboard the vehicle. This information should be tied to registration and user credentialing (see references in Section 4.4 and 4.5).

The following information was provided by the Commercial Vehicle Safety Alliance (CVSA):

> Specific to commercial motor vehicles (CMV), CVSA is pursuing the establishment of a universal electronic vehicle identifier, which could be integrated with a new VIN system. In 2018, CVSA submitted a petition to NHTSA to require that CMV's be manufactured to wirelessly broadcast a universal electronic vehicle identifier. The petition outlines the need for universal electronic vehicle identification to enhance inspection screening and prepare for deployment of ADS technology. These two concepts would combine to facilitate identification and safety assessment of ADS-equipped CMV.

Guidelines for Testing Vehicles

ADS-equipped vehicles will be co-mingled with vehicles operated by human drivers for decades and will be susceptible to being involved in crashes. In addition, there may be laws specific to the operation of ADS-equipped vehicles that require law enforcement officers to identify the vehicle as ADS equipped. For the safety of law enforcement and other first responders, an ADS-equipped vehicle should be readily and clearly identifiable from other vehicles on the roadway. The optimal means for accomplishing identification is through vehicle labeling.

Because jurisdictions have authority over vehicle registration, a unique ADS identifier on the vehicle registration and title can provide a means of identifying ADS-equipped vehicles for law enforcement purposes during testing (see Sections 4.4 and 4.5).

Benefits of Implementation

The vehicle registration and titling recommendations, if adopted, will allow law enforcement and other first and secondary responders to readily identify a vehicle as one with ADAS and/or ADS capability in a standardized manner.

Challenges to Implementation

Development of a standardized VIN nomenclature incorporating SAE level and modifying all applicable DMV systems to incorporate a new VIN nomenclature. In addition, aftermarket applications may change the SAE level post-production.

6.2 Crash and Incident Reporting

Background

Crash reporting should occur when there are crashes or incidents involving ADS-equipped vehicles and other vehicles, persons, animals, or objects whether or not the ADS is the proximate cause. Other reportable incidents may include a person falling from a vehicle or a rollover in which no other object is struck.

Safety and crash avoidance are priorities of automobile manufacturers. Regardless of the level of safety engineering, crashes are inevitable during testing and deployment on public roads. Crash and incident reporting are important for purposes of identifying and documenting safety concerns and establishing liability. Crash report information is not only of importance to manufacturers and the engineering community but also to a variety of public constituencies, including regulators and policy makers. Analysis of crash data may lead to safety best practices that can prevent future crashes or incidents. Full disclosure of information concerning how a crash occurred will be essential to crash investigation, future development, regulation, and public acceptance of ADS.

An additional resource for law enforcement specific to crash reporting and reconstruction is *Law Enforcement, First Responder and Crash Investigation Preparation for Automated Vehicle Technology*, Appendix B.5, Virginia Tech Transportation Institute.

Guidelines for Testing Vehicles

When testing occurs on public roadways, ADS MOEs should collect data elements and submit to jurisdictions incident or crash related information to expand ADS data and research. Information should include relevant data from a crash when ADS-equipped vehicles are operating in automated or manual mode or if ADS technology was disengaged (by the user or by the system). The information should include status of the ADS leading up to, during, and until the end of the crash event. The information should also include incidents in which the users of ADS-equipped vehicles are unexpectedly prompted to transition into manual mode because of a failure of the automated system. MOEs should be required to submit a summary of their analysis of the incident.

Requiring MOEs to report unexpected incidents and crashes to the jurisdiction provides transparency between agencies and MOEs throughout the testing phase. Sharing these data and the manufacturer's

analysis of the incident would be beneficial to jurisdictional policymakers.

When an ADS-equipped vehicle is involved in a crash, the information obtained from the ADS recorded data could prove important to determining whether an ADS malfunction or programming caused the crash or contributed to the crash or if the crash could otherwise have been avoided. Additionally, the data collected from the vehicle(s) involved could potentially provide insight into how the ADS reacts to given scenarios. The data recorded should include, but not be limited to, the mode of operation (ADS vs. manual control), vehicle control (what the ADS did), vehicle location, speed, steering input, throttle or brake application, impact speed, vehicle lighting, and a 360-degree video sample of the vehicle surroundings if so designed or equipped. Law enforcement should be provided with access to this information as well as a minimum of 30 seconds pre-crash through the end of the crash event for completing a proper investigation. Data should be provided in a standardized manner that is consistent with other EDR information formats to allow clarity and understanding of the relevant crash factors.

Recommendations for Jurisdictions

6.2.1. Require ADS test entity to submit to the jurisdiction, at a minimum, the NHTSA crash reporting requirements for ADAS- and ADS-equipped vehicles (NHTSA Standing General Order 2021-01 [Amended August 2021]).

Guidelines for Deployed Vehicles

The U.S. DOT Model Minimum Uniform Crash Criteria (MMUCC), 5th Edition (August 2017), includes guidance for capturing AV data on crash reports to assist in crash causation determination and support further AV development and safety. U.S. jurisdictions will need to adopt the MMUCC recommendation as soon as practicable.

Large amounts of data are captured by the vehicle Data Collection Mechanisms (DCM). Such information would aid a crash investigation by revealing pre-and post-crash causative factors and actions. This information may include both the driver and automated system actions when the users of ADS-equipped vehicles are prompted to transition into manual mode because of a failure or dysfunction of the automated system.

Manufacturers should ensure ADS records vehicle behavior sensor data and the human–vehicle interface (HMI) and should also include time stamping and Global Positioning System (GPS) location in the DCM data. In addition, to ensure effective crash investigation and safety analysis, manufacturers should make DCM information retrievable in a standard, nonproprietary format for ready access by those duly authorized in accordance with laws protecting data privacy.

Recommendations for Jurisdictions

6.2.2. U.S. jurisdictions should adopt the MMUCC 5th Edition (August 2017) or subsequent edition recommendation as soon as practicable.

Recommendations for Manufacturers and Other Entities

MOE 10. MOEs should design ADS to record vehicle location, behavior sensor data, and the HMI. Manufacturers should record 360-degree video data of the vehicle's operating environment. Law enforcement should be provided with access to this information as well as a minimum of 30 seconds pre-crash through the end of the crash event (cessation of involved vehicle movement) for completing a proper investigation.

MOE 11. In addition to complying with the requirements of 49 CFR Part 563, manufacturers should make DCM information retrievable in a standard, nonproprietary format for ready access by those duly authorized.

MOE 12. MOEs should include time stamping and GPS location in DCM data.

Benefits of Implementation

Collection of crash and incident data is beneficial to manufacturers and developers during the testing and developmental stages. In addition to manufacturers and developers, regulatory agencies, policy makers, and law enforcement agencies benefit from data recorded prior to, during, and until the end of the crash to aid in determining causation factors, identifying crash prevention strategies, and identifying safety promising and proven best practices.

Challenges to Implementation

Because much of the ADS industry is proprietary, manufacturers may object to part or all of this recommended guideline. Regulations or statutes vary among jurisdictions, which may impede implementation.

6.3 Criminal Activity

Background

There are both substantial opportunities and risks presented by automated driving that will increase the tactical performance of physical tasks over manually driving a vehicle. ADS-equipped vehicles have the potential to improve driving safety and make mobility more efficient. However, they will also create greater possibilities for dual-use applications and ways for a vehicle to be used to further criminal enterprises, or worse, be used as a tool for the delivery of explosives or other means of causing harm. This is not only a clear and present danger but also further complicates any subsequent criminal investigation.

New technologies that will be available in vehicles present opportunities to prevent certain vehicle-related crimes from being committed and assisting law enforcement in interdicting crimes. Technologies also present an opportunity to aid in the investigation of crimes that have been committed.

Although ADS-equipped vehicles may substantially reduce the risk of in-vehicle distractions leading to crashes, criminals will also be able to conduct tasks that require use of both hands or to take one's eyes off the road. Aiming and firing a weapon at a pursuing patrol vehicle is an example of a multitasking threat.

Guidelines for Testing Vehicles

Prior to authorization to operate an ADS-equipped test vehicle, the employees, contractors, and other persons designated by the manufacturer or other entities should be required to pass a background check, including, but not limited to, a driver history review and a criminal history check. In the interest of safety, it may be prudent to disqualify persons with poor driving records or criminal records from operating ADS-equipped vehicles as agents or contractors of MOEs in a test environment.

Recommendations for Jurisdictions

6.3.1. Jurisdictions that have ADS-equipped vehicle permitting requirements as described in Section 4.1 should require the designated test users (employees, contractors, and other persons) to pass a background check, including, but not limited to, a driver history review and a criminal history check, prior to authorization to operate an ADS-equipped test vehicle.

6.3.2. Jurisdictions that have ADS-equipped vehicle permitting requirements as described in Section 4.1 should establish provisions which

disqualify a test user who has a criminal record or a driving history that includes driving under the influence, reckless driving, or other significant conviction history from operating an ADS-equipped test vehicle in a test environment.

Recommendations for Manufacturers and Other Entities

MOE 13. The MOE, operating in jurisdictions not requiring ADS-equipped vehicle permits, should require the designated test user to pass a background check, including, but not limited to, a driver history review and a criminal history check, prior to authorization to operate an ADS-equipped test vehicle.

MOE 14. The MOE, operating in jurisdictions not requiring ADS-equipped vehicle permits, should disqualify a test user who has a criminal record or poor driving history from operating an ADS-equipped test vehicle in a test environment.

Guidelines for Deployed Vehicles

ADS-equipped test vehicles may also be a target for criminal activity, such as carjacking, because they may not be capable of intuitive reaction or evasive maneuvers a human user could employ.

To assist law enforcement in investigating criminal activity when an ADS-equipped test vehicle was implicitly involved as a tool for committing a crime, manufacturers should ensure ADS leave an electronic fingerprint that can allow tracing of input data to whomever initiated them.

Recommendations for Manufacturers and Other Entities

MOE 15. MOEs should ensure ADS-equipped vehicles leave an electronic fingerprint that can allow tracing of input data to whomever initiated the activity.

Benefits of Implementation

Requiring manufacturers to program software that creates an electronic fingerprint of HMI will mitigate the risk of an AV being used as a tool to assist in the commission of or escape from a crime.

Challenges to Implementation

Inherent issues of privacy are recognized, and legislative action or administrative rule making will be required to implement the recommended guideline.

6.4 Distracted Driving

Background

The potential for reducing or eliminating distracted driving is a common topic when discussing ADS-equipped vehicles. The term "distraction" as used by NHTSA is a specific type of inattention that occurs when drivers divert their attention away from the driving task to focus on another activity. These distracting tasks can affect drivers in different ways and can be categorized into the following types:

Visual distraction: tasks that require the driver to look away from the roadway to visually obtain information

Manual distraction: tasks that require the driver to take hand(s) off the steering wheel to manipulate a device or other distracting activity

Cognitive distraction: tasks that are defined as the mental workload associated with a task that involves thinking about something other than the driving task

Many activities involve a combination of these types of distractions, including texting, which can involve all three. The impact of distractions on driving is determined not just by the type of distraction but also

by the frequency and duration of the task. Because drivers often have a choice regarding when and how often to multitask when driving, their exposure to risk is typically within their control; however, some research has shown that drivers underestimate the overall risk of various tasks.9

In February 2021, the AAMVA Automated Vehicles Subcommittee published a white paper titled *Strengthening Distracted Driving Education, Legislation, and Enforcement* that provides more detailed information on this issue.

Guidelines for Testing Vehicles

When testing any ADS-equipped vehicle, the user is an active participant in the testing process; therefore, all distracting activities should be prohibited.

Recommendations for Manufacturers and Other Entities

MOE 16. MOEs should minimize distractions in ADS-equipped vehicles.

MOE 17. MOEs should prohibit users from all added distracting activities when testing ADS-equipped vehicles.

MOE 18. MOEs should incorporate technology to alert the "driver" when the ADS cannot maintain or complete the driving task and the "driver" needs to assume control of vehicle operation.

Guidelines for Deployed Vehicles

Jurisdictions should consider at what level of autonomy their distracted driving laws continue to apply. When a vehicle is in automated mode, the user may still need to maintain a level of awareness if they need to re-engage with the driving function if prompted by the vehicle. Because the operation of some ADS-equipped vehicles may require no participation by the driver, distracting activities may not be relevant, and distracted driving laws may not apply. Manufacturers should design ADS-equipped vehicles with a means of identifying when a vehicle is in automated mode to facilitate effective enforcement of distracted driving laws (e.g., so an officer knows if using a hand-held device is legal at the time of observation).

Recommendations for Jurisdictions

6.4.1. Consider strengthening a jurisdiction's distracted driving laws by utilizing the model legislation provided in the *Distracted Driving White Paper* as a template.

6.4.2. Utilize the best available distracted driving educational materials in proactive public education efforts. One such source is the IACP Distracted Driving Toolkit.

Recommendations for Manufacturers and Other Entities

MOE 19. MOEs should design ADS-equipped vehicles with a means of identifying when a vehicle is in automated mode to facilitate effective enforcement of distracted driving laws (e.g., so an officer knows if using a hand-held device is legal at the time of observation).

MOE 20. MOEs should minimize distractions in ADAS-equipped vehicles with part-time self-driving features.

MOE 21. Manufacturers should incorporate technology that monitors the driver's awareness (e.g., monitoring the eyes or hand placement) with the vehicle prompting disengagement of activated self-driving mode if the driver is not paying sufficient attention to the DDT.

9 Overview of the National Highway Traffic Safety Administration's Driver Distraction Program, DOT HS 811 299, April 2010.

Benefits of Implementation

It is anticipated there would be a reduction in crashes caused by driver distraction.

Challenges to Implementation

Many jurisdictions have laws prohibiting distracted driving. A challenge will be for industry to develop consistent methodologies for systems that allow law enforcement to determine the level of the ADAS and what mode the vehicle is in when they observe a user potentially violating distracted driving laws.

6.5 Establishing Operational Responsibility and Law Enforcement Implications

Background

Jurisdictions have legal authority to regulate vehicle operation by humans but may not have established authority over nonhuman operation. This uncertainty presents significant challenges to enforcement of traffic laws and to establishing legal responsibility when Level 3 to 5 vehicles are involved in motor vehicle crashes on public roads. Jurisdictions will need to address the following issues:

- Is the driver of a vehicle with automated features engaged still responsible for the operation of that vehicle even if they are not performing the DDT?
- In such instances, how will law enforcement officers know when the human is actively driving or if the ADS is in control?

Although this may appear to be less of an issue as vehicle technologies approach Level 5, from an enforcement perspective, the issue is still confounding because many jurisdictions lack any procedural enforcement mechanism against any entity other than the human driver operating the vehicle at the time of the offense or crash. Traffic tickets or violation notices usually cannot be issued to registered owners or corporate entities, and with the exception of parked vehicles, crash reports require a human driver for each involved vehicle. This may not apply to automated enforcement. Jurisdictions may need to define what enforcement actions can be taken and who or what is responsible when there is no human onboard.

Guidelines for Testing Vehicles

Jurisdictions will need to clearly establish legal responsibility for every vehicle operating on public roads. If a licensed driver is required to be onboard the vehicle during testing, that driver is responsible for the safe operation of the vehicle at all times and should be accountable for any violations of law and be considered the "driver" of the vehicle regardless of their degree of actual control of the DDT.

When Level 4 and 5 ADS-equipped vehicles, with or without a human onboard, are tested on public roads, the permitting process, described in Section 4.1, should clearly identify the person or entity legally responsible for the safe operation of the vehicle at all times. Before any testing permits are issued, the legal mechanism and authority to hold the responsible entity accountable for violations of laws and crashes that may occur during testing should be clearly established.

Recommendations for Jurisdictions

6.5.1. Define what enforcement actions can be taken and who or what is responsible when there is no human onboard an automated test vehicle.

Guidelines for Deployed Vehicles

Legal responsibility for every vehicle operated on public roads should be clearly established. Currently, the licensed drivers of Level 0 to 2 vehicles are responsible for their safe operation at all times and are held legally responsible for any violation of law that may occur during operation. The same should be the case with

Level 3 ADS-equipped vehicles. Although the licensed driver of a Level 3 ADS-equipped vehicle may cede control of the DDT to the vehicle under certain circumstances or driving conditions, such a vehicle by definition still requires the driver to monitor the DDT and to take control as necessary. A licensed driver, therefore, is still responsible for the safe operation and liable for violations of law during operation.

ADS-equipped vehicles classified as Level 4 or 5, which may be operated without a licensed driver onboard and in which the DDT may be performed independent of human control, warrant consideration of new rules to establish similar responsibility and liability for violations of traffic laws. Registered owners of such vehicles should be responsible for properly maintaining all vehicle equipment and systems, including, but not limited to, the prompt completion of any required updates impacting their operation. It is anticipated therefore that registered owners of such vehicles, as the agents of the operation of such vehicles on public roads, should be responsible for their adherence to applicable laws and subject to legal process as determined by the jurisdiction. Product liability issues arising from such cases may be matters of civil process ex post facto but should not impact the enforcement of laws contemporaneously with operation.

The Automated Vehicles Subcommittee will continue to explore this topic.

Recommendations for Jurisdictions

6.5.2. Clearly establish legal responsibility for every vehicle operating on public roads.

Benefits of Implementation

These guidelines ensure there is a clearly identified party who is legally responsible for the operation of all vehicles at all times and provides law enforcement with a mechanism to enforce traffic safety laws. This will provide clarity to manufacturers, technology developers, law enforcement officers, courts, and vehicle owners of legal responsibility for vehicles of varying automated capabilities.

Challenges to Implementation

The insurance industry may oppose holding registered owners responsible for the operation of the vehicle as opposed to the manufacturer or technology upfitter. Industry may oppose these guidelines as unnecessary regulation that may hinder development and public acceptance of technology adoption.

6.6 Law Enforcement and First Responder Interaction Plans

Background

Law enforcement and first responders engaging with ADS-equipped vehicles will face unique challenges. It is imperative that law enforcement officers and other first responders understand how to safely interact with these vehicles during a traffic enforcement contact or emergency incident. In an emergency, it is imperative first responders have the ability to render the vehicle safe to protect themselves and the public alike. Law enforcement must also be able to immediately contact those responsible for the vehicle's operation to gather pertinent information about the vehicle. The LEIP is developed by the MOE and should be developed in collaboration with law enforcement.

Guidelines for Testing Vehicles

LEIPs should be developed for each unique ADS-equipped vehicle model or aftermarket ADS and provided to all agencies within the vicinity of the ODD of the test vehicle; training outlined in Section 6.8 of this guide should include all information provided in the LEIP. The LEIP should identify the applicable vehicle and system and include the following minimum set of elements:

- Introduction
- Description of ODD

- Fleet Operations
- Identifying ADS-DVs
- Contact information (available 24/7/365)
- Disabling ADS-DV
- Accessing required information
- De-powering ADS-DV
- Moving ADS-DV from roadway
- Determining the presence of passengers
- Extracting passengers
- Firefighting on or around ADS-DV
- Safe towing ADS-DV
- ADS-DV Data Integrity

In addition, jurisdictions should also consider:

- how to verify that the remote driver (if applicable) is a licensed driver (see Section 5.3); and
- any additional information the manufacturer deems necessary regarding hazardous conditions or public safety risks associated with the operation of the AV.

The LEIP should be reviewed on a regular basis by the manufacturer and updated as necessary but at least annually.

Recommendations for Jurisdictions

6.6.1. Maintain communication with manufacturers to ensure the latest version of the applicable LEIPs are available to law enforcement and other first responders.

Guidelines for Deployed Vehicles

All first responders will require immediate access to the LEIP upon encountering an ADS-equipped vehicle in the field. This may include first responders in remote areas without internet access. As manufacturers publish each LEIP, there should be an established procedure for disseminating new and updated LEIPs.

Recommendations for Jurisdictions

6.6.2. Designate the lead law enforcement agency in the jurisdiction as a liaison to vehicle MOEs for the distribution of the LEIP to all law enforcement agencies and other first responders within that jurisdiction.

Recommendations for Manufacturers and Other Entities

MOE 22. MOEs, in partnership with law enforcement and other first responders, should develop a LEIP in a standardized format for each ADS-equipped model deployed.

MOE 23. The LEIP should be reviewed regularly and updated as necessary but at least annually.

Benefits of Implementation

A LEIP for all ADS-equipped vehicles will protect law enforcement and other first responders, enhance public safety, and prevent unnecessary traffic delays.

Challenges to Implementation

Currently, there is no standardized format for LEIPs or a process for maintaining the most current LEIPs. Without a standardized format, law enforcement and other first responders may have difficulty finding the necessary information quickly.

6.7 Law Enforcement Protocols for Level 4 and 5 Vehicles

Background

Level 4 and 5 ADS-equipped vehicles represent unique challenges to law enforcement and other first

responders traditionally focused on human behavior because of their inherent driverless nature and the potential for operation without a human occupant. Protocols should be devised and established to guide law enforcement officers and other first responders in their interactions with Level 4 and 5 ADS-equipped vehicles to better ensure safety and uniform application of the laws.

The LEP is different from the LEIP (Section 6.6) in that the LEP is a document authored by the lead law enforcement agency in a jurisdiction, if one has been designated, for the broader law enforcement community within that jurisdiction.

These protocols should outline appropriate procedures to be followed during emergencies and traffic enforcement situations, including, but not limited, to investigating crashes, traffic or criminal violations, and incidents involving a vehicle with no operator present. It should be noted that although some entities may develop a Law Enforcement Protocol (LEP) that may be agency, or law enforcement specific, entities may want to include development of protocols that are inclusive of considerations faced by the entire first responder community. The LEP is different from the LEIP (Section 6.6) in that the LEP is a document authored by the lead law enforcement agency in a jurisdiction, if one has been designated, for the broader law enforcement community within that jurisdiction.

Guidelines for Testing and Deployment

LEPs should be developed in cooperation with vehicle manufacturers and test entities as guidance or policy for law enforcement officers in the performance of their duties when interacting with Level 4 and 5 ADS-equipped vehicles. The LEP should identify and include the following details:

- the applicable policies of the law enforcement agency(s);
- terms used within the document that may be unfamiliar to officers in the field; and
- a list of all the LEIPs within that jurisdiction.

The LEP should be reviewed continually to ensure consistency with new laws and regulations, recommendations of the manufacturer, and enforcement guidelines and updated as necessary, but not less than annually.

Recommendations for Jurisdictions

6.7.1. LEPs should be developed by the lead law enforcement agency in cooperation with the vehicle manufacturer and test entity and may be vehicle specific. In addition, the protocols should outline any specific federal, jurisdictional, or local laws, regulations, or policies governing Level 4 and 5 ADS-equipped vehicles operating within the law enforcement agency's jurisdiction.

6.7.2. Designate a liaison within the lead law enforcement agency to be responsible for developing and maintaining the LEP and ensuring its distribution to the law enforcement and first responder community. The liaison should review the LEP continually and ensure consistency with:

- jurisdictional laws and regulations,
- recommendations from the manufacturer, and
- enforcement guidelines.

6.7.3. Ensure the LEP and LEIP are available to law enforcement officers and first responders with or without an internet connection.

Benefits of Implementation

LEPs provide consistent direction to law enforcement officers and other first responders allowing them to enhance public and first responder safety, prevent

unnecessary traffic delays, and take appropriate enforcement action in accordance with federal, jurisdictional, and local laws and regulations.

Challenges to Implementation

A challenge is providing training for all law enforcement officers and first responders to ensure they are knowledgeable prior to coming into contact with a Level 4 or 5 vehicle. See Section 6.8 for more details.

Jurisdictions without specific political direction or legal requirement may be challenged to establish a LEP.

6.8 Law Enforcement and First Responder Safety and Training

Background

It is essential that law enforcement and other first responders receive specific training regarding the potential hazards they may face and how ADAS- and ADS-equipped vehicles may impact their duties. These duties may vary by profession and therefore require profession-specific training. Law enforcement officers, for example, may require training specific to how jurisdictional laws apply to ADAS- and ADS-equipped vehicles that other professions do not. Law enforcement officers may encounter ADAS- and ADS-equipped vehicles during traffic stops or other law enforcement related contacts; however, occupant extraction safety training may be more universally applicable.

Although ADAS- and ADS-equipped vehicles may provide significant safety benefits by reducing human errors, they will inevitably be involved in traffic crashes, especially during the years of initial introduction and integration with the existing motoring population. Because of the potential for unique operational characteristics of ADS, responders to these crashes may be placed at risk if they are not trained for the hazards they may encounter. These hazards include, but may not be limited to:

- silent operation;
- self-initiated or remote ignition, thermal runaway, and/or stranded energy;
- alternate fuel propulsion systems;
- high voltage; and
- unexpected movement, to include movement directed by a remote operator

A resource for law enforcement specific to training is *Law Enforcement, First Responder and Crash Investigation Preparation for Automated Vehicle Technology* (ghsa.org)

The report offers a wide range of training considerations but recommends six core training topics:

1. Understanding the differences between and capabilities of ADAS- and ADS-equipped vehicles
2. Identifying ADS technologies on the road today
3. Understanding governmental responsibilities regarding vehicle oversight
4. Anticipating ADAS- and ADS-equipped vehicle deployment
5. Interacting with ADS-equipped vehicles
6. Understanding and accessing data

Many of these areas are further developed in the following subsections of this chapter.

ADAS-Specific Caution for Law Enforcement

ADAS technologies (Levels 1 and 2) are evolving with the release of each passing model year. It is critically important to officer safety that agency fleet managers are well informed of technology capabilities of new model year vehicles that are issued for law enforcement use by their officers. Some "safety" features can have unintended consequences that may be harmful to officer

safety in emergency situations. For example, some vehicles will no longer allow the vehicle to operate in reverse if the driver's door is open. Another example is some vehicles equipped with back-up sensors may not allow the vehicle to move if it senses an obstruction even if that obstruction is not an immovable object. Both these examples illustrate a potential danger to an officer who is in the midst of a tactical situation.

Recommendation for Jurisdictions

6.8.1. Law enforcement agency fleet managers should be aware of technology advancements and new safety features not present on previous pursuit fleet vehicle model years and communicate this information to the director of training for that agency. The training director will determine if that information should be integrated into emergency vehicle operations course training for officers issued these new vehicles.

Guidelines for Testing Vehicles

The ability of first responders to identify an ADS-equipped vehicle is essential to the safe and effective performance of their specific duties. For the safety of all first responders, manufacturers should permanently label ADS-equipped vehicles that will be tested on public roadways, at a minimum, on the rear and sides of the vehicle (see Section 6.1). For the safety of vehicle occupants and first responders, manufacturers should ensure ADS-equipped vehicles have safety systems or procedures that allow first responders to immobilize or otherwise disable the vehicle post-crash to prevent movement or subsequent ignition of the vehicle. Information regarding these systems and procedures should be made available to law enforcement and other first responders in the jurisdiction where the vehicle will be operated (see Section 6.7).

In addition, law enforcement should receive training specific to jurisdictional laws and their application. When training and educational tools become available, they should be disseminated through jurisdiction-level established training bodies. The use of approved training materials allows for uniformity across jurisdictions and their law enforcement agencies. Training should be updated as laws and rules change and when manufacturers make design changes. Primary stakeholders to develop and disseminate training may include associations such as AAMVA, NFPA, CVSA, and International Association of Chiefs of Police (IACP).

Guidelines for Deployed Vehicles

For the safety of law enforcement and other first responders, manufacturers should permanently label ADS, at a minimum, on the rear and sides of the vehicle. Manufacturers should also ensure that ADS-equipped vehicles have safety systems or procedures that allow first responders to immobilize or otherwise disable a vehicle post-crash or during certain law enforcement contacts to prevent movement or subsequent ignition of the vehicle.

National or international standardized law enforcement and other first responder training on safely interacting with vehicles and users should be developed. Jurisdictions should work with manufacturer driver training programs to make training available to law enforcement and other first responders at no cost to agencies.

Recommendations for Jurisdictions

6.8.2. Work with manufacturer driver training programs to make ADS training available to law enforcement and other first responders at no cost to agencies.

Recommendations for Manufacturers and Other Entities

MOE 24. MOEs should ensure ADS-equipped vehicles have safety systems or procedures that allow law enforcement and other first responders to immobilize or otherwise

disable the vehicle post-crash or during certain law enforcement contacts to prevent movement or subsequent ignition of the vehicle.

MOE 25. MOEs, in partnership with highway safety stakeholders, should develop national or international standardized first responder training on safely interacting with vehicles and users in both the testing and deployment of ADS-equipped vehicles.

Benefits of Implementation

Training will help prevent injuries or deaths of emergency personnel who respond to crash scenes and the public involved in or near crash scenes and during other law enforcement contacts with ADS-equipped vehicles.

Challenges to Implementation

The lack of standardized training is exacerbated by the absence of a training delivery system that services all law enforcement and other first responders. The NFPA's Alternative Fuel Vehicles Safety Training is indicative of this challenge. Although the NFPA training has been available for most fire services in the United States for many years, the information has not well permeated the diverse first responder community, resulting in significant vulnerabilities. Even when training is available, another challenge will be keeping training current as the technology continues to evolve.

6.9 Adherence to Traffic Laws

Background

Traffic laws are the purview of jurisdictions, although local jurisdictions may enact additional traffic and parking laws. Most traffic laws are similar from jurisdiction to jurisdiction, and some are jurisdictional specific. For example, although all jurisdictions have laws regarding speed limits, minimum and maximum speed limits may vary significantly between jurisdictions (e.g., roads in some jurisdictions have no specified minimum speed limit). Similarly, traffic laws relative to vehicle movements commonly referred to as "rules of the road," such as lane changes, left- and right-hand turns, yielding right of way, stopping, passing, and movements in regard to traffic control devices and pedestrian crossings, also vary between jurisdictions.

Where speed limits are concerned, it is common knowledge that compliance with these limits is often low, and drivers often adjust their vehicle speed to that of the prevailing flow of traffic. Users frequently set the vehicle cruise control to speeds that exceed the speed limit. In light of this common practice, there is concern that future drivers of ADS-equipped vehicles may desire similar discretionary control of the maximum operating speed, leading manufacturers to develop ADS-equipped vehicles capable of violating speed limits and other traffic laws. This would be legally imprudent and could be unsafe. However, manufacturers should give consideration to exigent circumstances when it may be necessary to perform maneuvers that may otherwise violate traffic laws, such as following the directions of police officers or flaggers to cross double yellow lines or drive on a sidewalk to avoid hazards such as at a crash scene, a flooded road, or road debris.

Please note impaired driving and distracted driving are addressed in other areas of this report.

Guidelines for Testing and Deployed Vehicles

Jurisdictions should ensure that all vehicles under their authority are required to adhere to all traffic laws and rules of the road, except in legally acceptable exigent circumstances. Jurisdictions will need to examine their traffic laws to identify laws that may not be relevant or appropriate for ADS-equipped vehicles and amend them as necessary. For example, the New York traffic law requiring, in part, that a user maintain at least one hand in control of the steering mechanism at all times

may not be appropriate where ADS are concerned. However, because of the uncertainty of their deployment, it is likely premature to modify current traffic laws and regulations to accommodate SAE Level 5 ADS-equipped vehicles at this time.

Jurisdictions are encouraged to review SAE International J3016 Standard – *Taxonomy and Definitions for Terms Related to Driving/Autonomous Systems for On-Road Motor Vehicles*. To provide a seamless transition between jurisdictions, it is important that not only the traffic laws have continuity but also legal definitions. The J3016 Standard provides definitions that can be adopted and incorporated into law.

In October 2018, the TRB published the document NCHRP20-102(07) *Implications of Automation for Motor Vehicle Codes* to assist jurisdictions with updating their motor vehicle codes as ADS technology continues to evolve.

Additionally, vehicles designed to operate in either automated mode or manual mode should not have the ability to override the ADS settings allowing for violation of traffic laws, without transitioning out of automated mode into manual mode.

Recommendations for Jurisdictions

6.9.1. Refer to Transportation Research Board NCHRP20-102(07) *Implications of Automation for Motor Vehicle Codes* to identify traffic and other laws that may need to be repealed or revised to accommodate ADS technology.

6.9.2. Jurisdictions should not modify current traffic laws specifically to accommodate SAE Level 5 ADS-equipped vehicles until their development advances to the extent that such amendments and statutes are warranted.

6.9.3. Jurisdictions should conduct a comprehensive review of legal definitions related to their traffic laws and adopt definitions from SAE J3016 Standard as applicable. This effort should be ongoing with the continued advancement of vehicle technology.

6.9.4. Support legislation that allows an officer to charge a remote driver with a violation. And, for nondriving violations, such as defective equipment, the registered owner should be charged with the violation.

Recommendations for Manufacturers and Other Entities

MOE 26. Manufacturers or other entities should ensure users of vehicles designed to operate in either automated mode or manual mode do not have the ability to override the ADS settings, without transitioning out of automated mode into manual mode, unless faced with a legally acceptable exigent circumstance.

Benefits of Implementation

Ensuring that ADS-equipped vehicles are programmed to comply with all jurisdictional and local traffic laws will contribute to the safe operation of ADS by avoiding the human decision-making process, which currently contributes to most crashes.

Challenges to Implementation

Some drivers may demand more control over the functions of their ADS-equipped vehicles and manufacturer's desire to accommodate drivers. Additionally, it will be a challenge to ensure the ADS is updated with new and amended traffic laws each legislative session from jurisdiction to jurisdiction.

6.10 Vehicle Response to Emergency Vehicles, Manual Traffic Controls, and Atypical Road Conditions

Background

Traffic safety is often dependent on the ability of a driver to recognize and respond appropriately to a wide variety of hazards and traffic controls in an ever-changing roadway environment. Hazards include, but are not limited to:

- moving or stopped emergency vehicles;
- emergency workers and other pedestrians manually directing traffic;
- changing traffic patterns or conditions in roadway construction and maintenance zones;
- crash or incident scenes;
- animals, road debris or other obstructions; and
- severe weather or limited visibility conditions.

Object and event detection and response (OEDR) refers to the detection by the driver or ADS of any circumstance that is relevant to the immediate driving task, as well as the implementation of the appropriate driver or system response to such circumstance.

Guidelines for Testing and Deployment

Manufacturers should ensure that vehicles operated on public roads, both during testing and deployment, are able to recognize and properly respond to all hazards, environmental conditions, and temporary traffic controls in the roadway environment. Temporary traffic controls include cones; flare patterns, including LED traffic flares; and barricades, as well as human hand directions and flagging. In addition, vehicles should properly identify, differentiate, and respond appropriately to both moving and stopped emergency vehicles and hazard vehicles, such as road maintenance vehicles bearing flashing lights, and comply with move-over/slow-down laws, as applicable.

Recommendations for Manufacturers and Other Entities

MOE 27. MOEs should ensure that vehicles operated on public roads, both during testing and deployment, are able to recognize and properly respond to all temporary traffic controls and hazards in the roadway environment. Toward that end, manufacturers should use publicly available traffic data such as crash notifications, traffic congestion, and construction zone information.

Benefits of Implementation

Vehicles that adequately respond to changing road conditions will increase safety of first responders, roadway workers, and the public.

Challenges to Implementation

It may not be practicable to replicate every possible road restriction or hazard that may be encountered during ADS-equipped vehicle testing in the real world, and under extraordinary circumstances, it may be necessary for vehicles to operate outside established rules of the road to safely navigate some hazards safely (e.g., driving on shoulders, disobeying lane markings or signs). In addition, manual traffic control gestures are not universally consistent and may be performed by professionals or nonprofessionals alike. Move-over and other traffic laws are not currently uniform among jurisdictions, and adherence to these laws may require geographic awareness.

6.11 System Misuse and Abuse

Background

Misuse of an AV system may be defined as operating automated features improperly or inappropriately, such as failure to take affirmative control of a vehicle when directed to do so by the automated system. Issues of misuse may be linked to training

and credentialing and may have a major role in determining crash causation, which may distinguish fault and criminal or civil liability. Law enforcement has the responsibility of determining crash causation whenever possible, but partial or complete automation may make these determinations more difficult to discern from traditional human user errors.

Abuse of an AV system may be defined as the intentional or malicious use of ADS capabilities for some unlawful purpose. Issues of abuse (or intentional misuse as defined above) will likely involve criminal behavior and may have vast implications on public safety. Examples of abuse range from criminal transportation, such as drug running, to cybersecurity breaches or terrorism. Strategies to address both misuse and abuse must consider the myriad ways to perpetrate each.

One issue is whether new laws or regulations are necessary to deter these behaviors or to assist law enforcement in performance of their duties in prevention and after an incident. The elements of law violations inherent to misuse or abuse already exist, whether or not vehicle technology was employed in the violation of law. For example, a speeding violation is still a speeding violation whether or not cruise control was active at the time of the offense, and vehicles are widely used in the commission of crimes or to transport goods or proceeds of crimes today. In some foreseeable instances, such as vehicular assault or homicide, culpability may be an issue.

Crash and criminal investigation would be greatly aided by electronic records of the HMI. FMVSS codified in 49 CFR/Part 563 currently specifies that certain information be recorded by vehicle event data recorders (EDRs), but the data stored may be inadequate for the forensic need in determining misuse or abuse. In addition to the EDR, the vehicle's central processing unit (CPU) stores data not resident in the EDR and may also need to be accessed, under certain circumstances, by law enforcement. Lack of standard data formatting in a nonproprietary format hinders its usefulness for law enforcement or public safety purposes.

Guidelines for Testing Vehicles

It could be assumed that it is less likely misuse or abuse of ADS would occur in a test environment where users are intimately familiar with the vehicle capabilities and use is highly controlled, recorded, and researched. Nonetheless, because extensive testing occurs on public roads, the public interest demands that researchers and developers record the behavior of the vehicle and the driver–vehicle interface at all times during operation.

Recommendations for Manufacturers and Other Entities

MOE 28. MOEs, such as researchers and developers, should always record the behaviors of the vehicle and the HMI during operation because extensive testing occurs on public roads.

Guidelines for Deployed Vehicles

Manufacturers should design ADS-equipped vehicles to record both vehicle behavior and the driver–vehicle interface to identify the actions of the vehicle and the actions (or lack thereof) by the driver at all times. This recording mechanism should include GPS and time information to allow investigators to ascertain what occurred, where and when. Precedent is currently established for standardization of data recording in 49 CFR 563 (FMVSS) relative to EDR information, but this information is not time or geo-stamped and is only triggered by the airbag module when the airbag is deployed.

The EDR and CPU information should be stored and retrievable in some recognized, standard, nonproprietary format with a commercially available tool making the data readily accessible by those duly authorized.

Recommendations for Manufactures and Other Entities

MOE 29. MOEs should design ADS-equipped vehicles to record both vehicle behaviors and the driver–vehicle interface to identify the actions of the vehicle and the actions (or lack thereof) by the human at all times.

MOE 30. MOEs should ensure the EDR and CPU information that accomplishes *Recommendation MOE 29* is stored and retrievable in some recognized, standard, nonproprietary, format with a commercially available tool, making the data readily accessible by those duly authorized.

Benefits of Implementation

These recommendations will assist law enforcement in determining crash causation and criminal investigation, including, but not limited to, whether system misuse or abuse were involved by providing behavioral information and vehicle performance information in the most serious cases. Users of ADS may be deterred from engaging in misuse or abuse knowing their behaviors are recorded by the vehicle and that information is accessible by law enforcement or others duly authorized.

Challenges to Implementation

Such requirements may be perceived as an overreach of governmental authority. EDRs have operated and stored data in proprietary formats for proprietary purposes. Manufacturers may oppose requirements that dictate what information is captured and accessible to the authorized investigator.

Chapter 7 Other Considerations

This chapter outlines other considerations to address for ADS-equipped vehicles operated on public roadways, including cybersecurity, data collection, low-speed automated shuttles, CVs, and platooning. There are 42 recommendations in Chapter 7: 39 recommendations directed to jurisdictions for implementation consideration and 3 directed to MOEs.

7.1 Cybersecurity for Vehicles with Automated Driving Systems

Background

Cybersecurity must be a priority in the design and ongoing system development of all motor vehicles to ensure safe operation, traffic and public safety, and national security and should remain a priority for the entire life cycle of ADS-equipped vehicles. This priority must extend to all entrants in the supply chain. Ideally, cybersecurity measures should be designed to protect the safety of the ADS and provide for data privacy (see Section 7.2). This presents significant challenges for MOEs adding ADS to existing vehicle platforms.

The following are recommendations or resources from leading entities:

- NHTSA recommends industry undertake a layered approach to harden ADS-equipped vehicles' electronic architecture against possible attacks, both wireless and wired, to reduce the chances of a successful attack and mitigate any effects of unauthorized access. This layered approach isolates operation critical systems and databases to compartmentalize ramifications of successful security breaches.

- The National Institute of Standards and Technology (NIST) has created a cybersecurity framework that provides a systematic and comprehensive layered cybersecurity approach. Although developed initially for critical infrastructure, it can be used by any sector to improve cybersecurity risk management. The NIST framework specifies five principal pillars: Identify, Protect, Detect, Respond, and Recover.

  Similarly, industry should review and consider information technology security standards and best practices such as the Center for Internet Security's *Critical Security Controls (CIS CSC) for Effective Cyber Defense*.

- The Auto Information Sharing and Analysis Center (Auto ISAC) serves as a central node for its members for sharing, tracking, and analyzing related intelligence and creates a forum for collaboration for participating entities to share solutions. As such, all cyber threats, vulnerabilities, and incidents should be reported to the Auto ISAC as soon as practical.

- Mobility as a Service (MaaS) operations, platooning operations, vehicle-to-infrastructure

(V2I) interfaces, and other ADS integrators present additional driver-related cyber and data security considerations that must be considered and addressed.

Recommendations for Manufacturers and Other Entities

MOE 31. MOEs should use best practices, design principles, and guidance based on or published by NIST, NHTSA, Auto ISAC, and recognized standards-setting bodies such as SAE International standard J3061 *Cybersecurity Guidebook for Cyber-Physical Vehicle Systems*.

MOE 32. All cyber threats, vulnerabilities, or incidents should be reported to the nearest fusion center and to the lead law enforcement agency in the affected jurisdiction if one has been so designated.

Benefits of Implementation

Ensuring cybersecurity industry best practices are incorporated in ADS design and throughout the entire supply chain and life cycle of the ADS-equipped vehicle and during operation throughout the life cycle will aid in preventing incidents and mitigating potential exploitation and subsequent risks to traffic and public safety as well as national security.

Challenges to Implementation

As cybersecurity threats, attacks, and data security breaches continue to evolve at a rapid pace, meeting that pace of change with effective threat prevention, detection, and mitigation strategies is likely to become increasingly difficult. Ensuring necessary security related system updates are performed in a timely manner is another challenge that must be addressed, as well as identifying the party or entity legally responsible for performing such updates.

References

Center for Internet Security. *Critical Security Controls for Effective Cyber Defense*. https://www.cisecurity.org/controls

National Highway Traffic Safety Administration. (2016, October). *Cybersecurity Best Practices for Modern Vehicles*. (Report No. DOT HS 812 333). Washington, DC.

National Institute of Standards and Technology. *Framework for Improving Critical Infrastructure Cybersecurity*. https://www.nist.gov/publications/framework-improving-critical-infrastructure-cybersecurity-version-11

SAE International. Standard J3061 *Cybersecurity Guidebook for Cyber-Physical Vehicle Systems*. https://www.sae.org/standards/content/j3061_201601/

7.2 Data Collection

Background

Vehicles equipped with ADAS and ADS rely on the collection and use of data. ADAS collect data about the driver, their driving habits, and the vehicle. This information is necessary to optimize and personalize the performance of these systems. Additionally, data about the performance of ADS is vital to the evolving technology and improving the systems performing DDTs. Event Data Recorders (EDRs), for instance, were integrated into cars in the 1990s and currently are installed in 90% of vehicles. They can provide valuable information about the vehicle operation and conditions regarding a traffic incident. On-board diagnostic information was required to be included on all vehicles manufactured after 1996. These systems primarily assisted vehicle technicians with service, maintenance, and diagnostics. This information is now being accessed for additional reasons. An example is the collection of information about geolocation data and driver behavior such as speed or aggressive braking habits. This information may even be used to qualify

for insurance discounts. The plethora of data collected, the sensitive nature of it, and the potential for both the advancement of safety and potential harm from misuse must be considered.

Large amounts of data are captured by the vehicle Data Collection Mechanisms (DCM). Such information may aid a crash investigation by revealing pre-and post-crash causative factors and actions. This information may include both the driver and automated system actions when the users of ADS-equipped vehicles are prompted to transition into manual mode because of a failure or malfunction of the automated system.

Manufacturers should ensure ADS record vehicle behavior sensor data and the HMI and should also include time stamping and GPS location in the DCM data.

NHTSA is working closely with the Federal Trade Commission (FTC), which is the primary federal agency that protects drivers' privacy and personal information. These technologies generate and share a significant amount of vehicle data that are likely to be considered by private citizens as sensitive and personal. NHTSA reiterated that "privacy considerations are critical to driver acceptance of ADS and should be taken into account throughout the design, testing and deployment process."[10] The agency also indicated that it would continue to work closely with the FTC when motor vehicle safety matters have potential driver privacy implications.

The FTC has the authority to bring actions against companies or individuals that engage in unfair or deceptive acts or practices that include vehicle data privacy and security. The FTC has authority to use law enforcement, policy initiatives, and driver and business education to accomplish its mission. In the motor vehicle context, for example, the FTC could use its enforcement authority in appropriate circumstances to bring an action against a manufacturer that uses a driver's data in a way that violates the manufacturer's stated privacy policies.

Guidelines for Testing Vehicles

Automated features in vehicles today may include technologies such as navigation, blind spot detection, automatic emergency braking, parking assist, and lane departure warnings. Other features include "infotainment," in-car apps, telephone and text connectivity, and in-vehicle internet connectivity.

Many of these features depend on collecting certain data about the driver, the vehicle, and driving habits to perform effectively. Some of these data may be collected automatically, and some drivers may choose to provide these data to enable certain functions. For example, for a driver to benefit from navigation and traffic services, the location of the vehicle is generally needed. Similarly, to enable easy hands-free dialing, the driver may choose to sync their phone address book to the vehicle.

Drivers may not realize the connection between the use of the technology and the collection, storage, retrieval, and dissemination of data and the potential impact it has on their privacy.

It is important for drivers to be aware they should review and understand the privacy policies of the manufacturer, as well as any third party with access to the vehicle data. These policies will serve as the

10 NHTSA Data Privacy. https://www.nhtsa.gov/technology-innovation/vehicle-data-privacy

main legal mechanism regulating use of data. Drivers may have the right to "opt out" or request additional information not be gathered or not be shared. However, opting out may also limit the functionality of some of the features available.

It is also important for drivers to keep in mind that these commitments regarding data collection and use by automobile manufacturers may not extend to other third parties that may also access data in vehicles such as cell phones, apps, or other vehicle devices. Drivers should consult the owner's manual and work with the vehicle dealer to reset and remove information from the vehicle system.

Recommendations for Jurisdictions

7.2.1. Conduct a thorough review of jurisdictional laws pertaining to the collection and dissemination of data. Particular attention should be given to personally identifiable information and under what circumstances it may appropriately be recorded, maintained, and released. In addition, the issue of transparency should be evaluated: what data are permitted to be collected, how the individual is informed about the collection and use of the data, and whether an affirmative consent be considered.

7.2.2. Provide information about vehicle data collection resources on the jurisdiction's website to encourage drivers to check with their vehicle manufacturer for information about the collection of data by the systems in their vehicle.

Guidelines for Deployed Vehicles

As manufacturers and technology providers move toward deployment of these vehicles either in a ride-share model or for public sale, they should provide drivers with a baseline understanding of the data being used and their potential privacy implications. The manufacturer or technology providers should work jointly to provide users with information on how these data are being protected. This could be done with data sharing agreements, outlined when an individual chooses to participate or enroll in a ride-share program, or as part of an owner's manual provided at a retail sale.

Recommendations for Manufacturers and Other Entities

MOE 33. MOEs should comply with industry privacy principles relating to data collection and sharing. Guidelines may include those developed by trade associations that represent vehicle manufacturers and the Automotive Privacy Principles published by the National Automobile Dealers Association, which affirms commitments in three key areas: Transparency, Affirmative Consent for Sensitive Data, and Limited Sharing with Government and Law Enforcement.

Benefits of Implementation

It is important to increase awareness of data that is being collected in vehicles, by whom, and how it is being used and shared. Drivers are better protected when vehicle manufacturers follow consistent methods of securing and sharing data.

Challenges to Implementation

Data collection in a vehicle is necessary to ensure the technology in a vehicle can function as it was designed. Therefore, more and more data are being collected and used at the time of collection, but these data are also stored and can be very valuable to many entities. Drivers may not realize the privacy impact of the collection, storage, retrieval, and dissemination of information.

References

The following are recommendations or resources from leading entities:

Future Privacy Forum. Data and the Connected Car. https://fpf.org/wp-content/uploads/2017/06/2017_0627-FPF-Connected-Car-Infographic-Version-1.0.pdf

National Automobile Dealers Association. Personal Data in Your Car. https://fpf.org/wp-content/uploads/2017/01/consumerguide.pdf

National Highway Safety Administration. Vehicle Data Privacy. https://www.nhtsa.gov/technology-innovation/vehicle-data-privacy

7.3 Low-Speed Automated Shuttles

Background

Low-speed automated shuttles are some of the most commonly discussed AVs. Many entities, including local governments, universities, and private communities, have expressed interest in using low-speed automated shuttles to meet specific transportation needs. Low-speed automated shuttles, as envisioned in deployment, will provide low-cost, flexible, and relatively safe transportation in areas such as closed campuses, gated communities, and first-last mile transportation. However, the sheer number of vehicles in development and pilots underway has made condensing the discussion of low-speed automated shuttles challenging.

According to the U.S. DOT's *Low-Speed Automated Shuttles: State of Practice Final Report*, low-speed automated shuttles can vary widely in design but generally carry between 4 and 15 passengers, have a top speed of around 25 mph, and are automated at SAE Level 4. However, manufacturers are still trying to identify the best design for a deployable low-speed automated shuttle. As a result, many pilots and tests currently involve low-speed automated shuttles that carry more, fewer, or no passengers or operate at speeds above 25 mph. Some government entities are leading tests and pilots. About the only aspect of low-speed automated shuttles consistent at this time is a desire for the low-speed automated shuttle to operate at a Level 4 or above.

Currently, low-speed automated shuttles are considered noncompliant motor vehicles because they do not fall under an existing FMVSS or CMVSS definitions. Specifically, these shuttles do not generally qualify as low-speed vehicles (LSVs) under the FMVSS or CMVSS because they do not meet existing design standards that apply to LSVs (e.g., top speed, vehicle weight, exterior mirrors). An exemption through NHTSA or Transport Canada is necessary to bring vehicles into U.S. and Canadian markets. Jurisdictions may also not have an existing registration process in place to accommodate this vehicle type.

It is important to recognize, as well, that certain low-speed automated shuttles may not be FMVSS compliant. The safety and crashworthiness of these vehicles when used in mixed traffic on public roads is unproven, and any jurisdiction considering accommodating on-road applications of these vehicles should do so only after careful consideration.

Guidelines for Testing Vehicles

Low-speed automated shuttles are a subset of AVs designed to meet specific transportation needs. As

such, jurisdictions should require low-speed automated shuttles to meet the same registration, titling, and permitting requirements for testing as other AVs.

Recommendations for Jurisdictions

7.3.1. Treat low-speed automated shuttles similar to other AVs for the purposes of permitting and on-road testing (see Section 4.1.)

7.3.2. Give special consideration to the application of additional measures to ensure safety is preserved in test applications (e.g., slow-moving vehicle signage, requirement for shuttles to travel in designated lanes or along the far right-hand side of the roadway, restriction of the shuttle to low-speed municipal roads).

7.3.3. Understand the capabilities, limitations, and performance standards of shuttles before shuttles are tested on public roads, including, but not limited to, safety mechanisms and features, prior testing, vehicle crashworthiness and crash testing, ODD and OEDR, emergency fallback, and the ability of vehicles to operate in mixed traffic.

7.3.4. Require testing entities to confirm that shuttles are constructed to meet all applicable vehicle equipment laws and standards set by federal, state, and provincial governments; shuttles must continue to meet these laws and standards while operating on roadways.

7.3.5. Work closely with the testing entity or manufacturer throughout testing to address technical issues, receive relevant hardware and software upgrades, and receive technical support.

Require testing entities to:

7.3.6. Confirm the vehicle can operate safely on public roads.

7.3.7. Only operate the shuttle in accordance with the manufacturer's instructions.

7.3.8. Only operate the shuttle on routes that conform to the manufacturer's instructions and account adequately for weather, traffic, and road conditions; physical infrastructure; and other factors that might compromise safety.

7.3.9. Ensure information on law enforcement interaction is adequately distributed and understood by all relevant parties. (This may include the creation and distribution of an LEIP.)

7.3.10. Confirm that safety drivers are adequately trained in all aspects of shuttle operation and are fully capable of safely operating the shuttles as intended by the manufacturer.

7.3.11. Confirm that safety drivers have been trained to abide by all applicable jurisdictional laws while operating or overseeing the operation of shuttles, including those related to driver licensing and rules of the road.

7.3.12. Outfit the shuttle with appropriate equipment to protect occupants' safety, which may include, but not be limited to, occupant restraints, hand holds, and appropriate lighting.

Guidelines for Deployed Vehicles

Low-speed automated shuttles are currently considered noncompliant vehicles because they do not conform to an existing vehicle class or definition under the FMVSS or CMVSS. For these vehicles to be deployed on a broad scale in North America, federal governments would need to develop safety standards specific to low-speed automated shuttles or to provide exemptions from current safety standards.

Recommendations for Jurisdictions

7.3.13. Be cautious to accommodate on-road deployment of low-speed automated shuttles absent federal safety standards and a corresponding definition for this vehicle type.

Benefits of Implementation

Low-speed automated shuttles offer jurisdictions the opportunity to realize the benefits of AVs in a manner that is safe and friendly to the public. Low-speed automated shuttles operate at very low speeds and within specific ODDs, which limits operation to safer environments. Additionally, the 2019 AAA study[11] found that although the public was still very uncomfortable with the idea of AVs, the public was more accepting of low-speed automated shuttles. By using low-speed automated shuttles, jurisdictions can help their citizens overcome some of the uncertainty and fear surrounding automated technologies.

Challenges to Implementation

Low-speed automated shuttles are difficult to define because of their rapidly changing designs. As a result, jurisdictions may find it difficult to adequately identify these vehicles in their statutes and regulations such that jurisdictions allow for testing and deployment in a technology-neutral manner.

Until federal regulations define and develop a classification for these unique vehicles, jurisdictions may encounter obstacles to registering and titling these vehicles.

References

Annex A of Transport Canada's Guidelines for testing ADS in Canada

Annex A (best practices for automated shuttle testing in Canada) was created among CCMTA members https://tc.canada.ca/en/road-transportation/innovative-technologies/connected-automated-vehicles/guidelines-testing-automated-driving-systems-canada#_Toc78892239

U.S. DOT's Low-Speed Automated Shuttles: State of the Practice Final Report (September 1, 2018) https://rosap.ntl.bts.gov/view/dot/37060

7.4 Connected Vehicles

Background

CVszcommunicate with other vehicles, infrastructure, and potentially, vulnerable road users such as bicycles and pedestrians. Potential applications of connected technology are widespread and promise broad benefits related to safety, traffic flow optimization, congestion reduction, and emissions reductions. For example, a connected vehicle could communicate with a traffic signal to determine when the signal would turn green or an app on a pedestrian's phone to determine when the person is in the crosswalk. Connected technologies may warn drivers that they are approaching a work zone, warn bus drivers of passing vehicles at a bus stop, and inform road users of inclement weather or roadway conditions ahead.

Connected and automated technologies can exist independent of each other. A vehicle can be connected, automated, or connected and automated. Although it is not necessary for a vehicle to be both automated and connected, many experts believe vehicles with both connected and automated technologies will result in the greatest safety benefits. Therefore, connected vehicle technologies should be considered when developing a jurisdiction's approach to AVs.

It will be largely up to manufacturers and the federal government to support vehicle-to-vehicle (V2V), V2I, and vehicle-to-everything (V2E) or (V2X) communications because this will be dependent on the vehicles' designs. However, jurisdictions can play an important role in encouraging the joint use of connected and AVs through the development of infrastructure. Jurisdictions can support the combined use of connected and automated technologies by

11 Edmonds, Ellen (2019, March). *Three in Four Americans Remain Afraid of Fully Self-Driving Vehicles.* AAA. https://newsroom.aaa.com/2019/03/americans-fear-self-driving-cars-survey

facilitating communication between jurisdictional and local officials concerning the intersection of automated and connected vehicle technologies and including both automated and connected vehicle technologies in a jurisdiction's transportation planning efforts.

Guidelines for Testing Vehicles

Jurisdictions should require AVs, with or without connected vehicle technologies, to follow the same permitting and registration process (see Section 4.1). CVs with no or little automated technologies (Levels 0–2) should follow the regular registration process, or if the jurisdiction has one, a registration process specifically for CVs. The deciding factor for AVs should be the level of automated technologies present in the vehicle and not the vehicle's connected technologies.

Recommendations for Jurisdictions

7.4.1. Jurisdictions should require vehicles with connected and automated technologies to follow the permitting and registration process for AVs of the same SAE Level.

7.4.2. Jurisdictions with an ADS-equipped vehicle committee should require the committee members to stay abreast of connected vehicle technologies deployed in the jurisdiction and to inform jurisdiction and local officials involved in connected vehicle technology infrastructure planning and implementation.

Guidelines for Deployed Vehicles

Even after deployment, jurisdictions should keep in mind the capabilities of deployed AVs when continuing plans for improving connected vehicle technology infrastructure.

Recommendations for Jurisdictions

7.4.3. Jurisdictions with an ADS-equipped vehicle committee should require the committee to continue providing updates on ADS-equipped vehicles to jurisdiction and local officials involved in planning and implementing connected vehicle technologies.

Benefits of Implementation

A connected and AV has the benefit of additional information through connected technologies and advanced, non-impaired decision making by automated technologies. This combination can address two of the most basic factors impacting vehicle safety: knowledge of the road environment and driver awareness. By supporting the simultaneous introduction and deployment of connected and AV technologies, jurisdictions should see significantly more safety improvements from the use of both types of technology as opposed to the use of just one.

Challenges to Implementation

Significant barriers exist to implementing the transportation environment necessary to support CVs. First, infrastructure updates to allow for the communication between vehicle and infrastructure fixtures is time consuming and costly. It is difficult for jurisdictions to know what infrastructure changes to support, in light of rapidly changing technology.

Second, coordination between manufacturers such that numerous vehicles types could communicate with each other fluidly will likely be very challenging to achieve. Although there has been an increase in company partnerships in recent years, this has yet to result in vehicle systems that communicate easily across multiple manufacturers.

Finally, jurisdictions, localities, and private entities may not have the same goals when implementing connected vehicle technology. This will make it difficult for jurisdictions to know what projects to support.

Because implementing connected vehicle technologies alone is challenging, managing the combined integration of connected and AVs will prove difficult for jurisdictions.

7.5 Platooning

Background

Vehicle platooning is the linking of two or more vehicles using V2V communication technology. The first vehicle in the platoon sets the speed and direction for the rest of the vehicles, enabling them to follow at a close distance on highways. Platooning has the potential to improve safety, create efficiencies, reduce fuel consumption, and improve travel time and road capacity. The role of the driver in a following vehicle is dependent on the level of automation in the vehicles.

Currently, some jurisdictions regulate the following distance of vehicles by indicating the minimum number of feet or meters required between vehicles. Other jurisdictions do not have an actual numeric value as a minimum following distance but indicate there must be a safe or reasonable and prudent distance between vehicles.

Guidelines for Testing Vehicles

The emphasis on the development of the technology is currently placed on commercial truck platooning; however, other applications of platooning technology being explored include military transportation and busing. Platooning will likely include vehicles with ADAS equipment that require a driver or may include ADS-equipped vehicles, making automated following a possibility.

To limit safety risks associated with testing, the following recommendations are provided.

Recommendations for Jurisdictions

7.5.1. Review and update statutes to allow vehicles that are platooning to follow at a reasonable and prudent distance.

7.5.2. Require platoon testing entities to submit an application packet for testing as described in Section 4.1 and issue a permit to test when satisfied with the application and other submitted information.

7.5.3. Require the motor carrier's safety rating to be in good standing.

7.5.4. Allow testing only on approved routes, including limited access highways.

7.5.5. Require ADS to respond and adjust as necessary to allow vehicles to enter or exit the highway, in a work zone, in tunnels, and in weigh stations, traveling past an incident scene or through toll plazas.

7.5.6. Do not allow testing in lanes where trucks are prohibited.

7.5.7. Do not allow testing in adverse weather conditions.

7.5.8. Jurisdictions should reserve the right to suspend testing for any reason.

7.5.9. Prohibit carrying hazardous materials, oversize or overweight loads, fluids, loose loads, and livestock.

7.5.10. Consider limiting the number of vehicles allowed in a platoon.

7.5.11. Each vehicle combination should be limited to a truck or tractor and one trailer combination unit.

7.5.12. Require an identifier on the outside of the vehicle to indicate when the platoon technology is actively engaged.

7.5.13. Commercial transportation of passengers (i.e., school bus or motor coach) should not be permitted.

7.5.14. Consider requiring escort vehicles with conspicuous lighting in the front and rear of the platoon.

7.5.15. Require all drivers to hold an appropriately endorsed and valid CDL.

7.5.16. Require all drivers to receive appropriate training provided by the testing entity.

7.5.17. Drivers must comply with all applicable jurisdictional and federal regulations.

7.5.18. Require a driver be in each platoon vehicle, seated in the driver's seat, continually monitoring the driving environment and prepared to take over control of the vehicle at any time.

7.5.19. Require route planning take into consideration minimizing traffic interaction.

7.5.20. Require route planning take into consideration prevention of driver fatigue, task monotony, and highway hypnosis.

7.5.21. Require platoon formation be initiated when speed variability between the lead and following vehicles can be standardized to reduce safety risks.

Guidelines for Deployed Vehicles

While advanced platooning is being tested, it is premature to provide guidance for deployed vehicles.

Benefits of Implementation

These recommendations will facilitate communication between jurisdictional officials and entities engaged in platoon operations on their roadways and address many of the associated risks with platooning.

Challenges to Implementation

Jurisdictional laws may need to be updated. Policy makers and jurisdiction regulators may need to be educated on platooning to understand the benefits and risks. A process should be established to permit platoon testing.

References

The following are recommendations or resources from leading entities.

Ontario Ministry of Transportation. http://www.mto.gov.on.ca/english/trucks/cooperative-truck-platooning-conditions.shtml

Pennsylvania Department of Transportation. https://www.penndot.gov/ProjectAndPrograms/ResearchandTesting/Autonomous%20_Vehicles/Pages/Platooning.aspx

U.S. Department of Transportation. https://rosap.ntl.bts.gov/view/dot/1038

U.S. Department of Transportation. Automated Vehicles: Truck Platooning. ITS Benefits, Costs, and Lessons Learned: 2018 Update Report. https://www.itskrs.its.dot.gov/sites/default/files/executive-briefings/2018/BCLL_Automated%20Vehicles%20(CMV)%20Final%20Draft%20v4.pdf

Volpe Center. https://www.volpe.dot.gov/news/how-automated-car-platoon-works

7.6 Automated Delivery Vehicles and Personal Delivery Devices

Automated delivery vehicles and personal delivery devices (PDDs) are equipped with automated driving technology, operate in pedestrian and bicycle spaces, and transport small cargo to homes or businesses but do not meet the jurisdictional definition and requirements of a motor vehicle. Therefore, PDDs present a unique challenge to federal and state, provincial, territorial, and local government regulators. PDDs aim to fill existing gaps in last-mile product delivery and courier services, promise to make product delivery more efficient and convenient for consumers, and save time and money for businesses. PDDs, as they are being developed today, come in various sizes and dimensions, with diverse potential applications. PDDs are designed for shorter distance off-road trips along trails and sidewalks, may be half the size of a standard public mailbox, and can transport small items, such as groceries and packages, in dense urban centers.

In May 2021, the AAMVA Automated Vehicles Subcommittee published a white paper titled *Automated Delivery Vehicles and Devices* that provides more detailed information on this issue.

Chapter 8 Next Steps

The foundation of this report and the recommendations herein are based on a combination of research, experience, and knowledge accumulated over the past several years by the members of the Automated Vehicles Subcommittee. Because the technology is rapidly evolving, it is critical that the subcommittee continues to learn and share their expertise for the benefit of AAMVA's members and community. Their continued efforts are supported by the AAMVA Board of Directors, federal, jurisdictional, and other stakeholder partners.

The subcommittee is committed to keeping pace with the evolution of vehicle technology, providing timely information, and sharing its expertise. To advance its knowledge of the progression of ADAS- and ADS-equipped vehicle technology, the subcommittee will:

- continue to work closely with government entities, industry, and research stakeholders;
- maintain close contact with jurisdiction government officials and national associations supporting transportation agencies, such as AASHTO, CVSA, NCSL, and GHSA;
- work closely with federal, jurisdiction, and local transportation agencies to understand the impacts on government programs and responsibilities and to share their expertise;
- follow up with manufacturers and NHTSA to discuss recommendations made within this report;
- attend conferences, seminars, and other forums focused on technology and public policy;
- continue to assist the AAMVA TMS to update model driver's manuals, knowledge tests, and skills tests to address the use of vehicle technology during driver testing; and
- continue to assist the AAMVA IDEC Board to update driver's license examiner training materials to address vehicle technology as it emerges.

Members of the subcommittee are available to assist jurisdictions to understand ADAS- and ADS-equipped vehicle technology, its impact on government programs, and the recommendations in this report. They will participate individually or in groups as attendees, presenters, and panelists because sharing their expertise remains a priority.

The subcommittee will continue to assist the AAMVA TMS to update model driver's manuals, knowledge tests, and skills tests to address the use of vehicle technology during driver testing. The subcommittee will also continue to assist the AAMVA IDEC Board to update driver's license examiner training materials to address vehicle technology as it emerges.

To keep this report relevant and to provide the best possible guidance to the AAMVA community, it is expected the subcommittee will update this report periodically. Updates will continue to address MVA and law enforcement concerns related to ADAS- and ADS-equipped vehicle testing and deployment.

Appendix A Summary of Recommended Jurisdictional Guidelines for the Safe Testing and Deployment of Automated Driving System-Equipped Vehicles

The following is a summary of guidelines to support a framework of consistent regulation and oversight of ADS-equipped vehicles throughout the jurisdictions for their safe testing and deployment and to encourage uniformity among jurisdictions. Jurisdictions are not required to follow these guidelines; they are provided as recommendations for jurisdictions that choose to regulate ADS-equipped vehicles.

These guidelines apply to SAE Level 3, 4, and 5 vehicles, described as Conditional Automation, High Automation, and Full Automation, unless otherwise stated.

Chapter 3. Administrative Considerations

3.1 Administration: Recommendations for Jurisdictions

3.1.1. Identify a lead agency to manage the ADS-equipped vehicle committee and its efforts.

3.1.2. Establish an ADS-equipped vehicle committee.

3.1.3. Develop strategies for addressing testing and deployment of ADS-equipped vehicles in the jurisdiction.

3.1.4. Examine jurisdictional laws and regulations to consider barriers to safe testing, deployment, and operation of ADS-equipped vehicles.

3.1.5. Jurisdictions that regulate the testing of ADS-equipped vehicles are encouraged to take necessary steps to establish statutory authority and to use NHTSA's *Automated Driving Systems: A Vision for Safety 2.0* and *Preparing for the Future of Transportation: Automated Vehicles 3.0*, *Ensuring American Leadership in Automated Vehicle Technologies: Automated Vehicles 4.0* published in January 2020, and later updates to frame the regulations.

3.1.6. ADS-equipped vehicle committee members, regulators, and policy makers are encouraged to perform knowledge-gathering and information-sharing functions.

3.1.7. The MVA should designate an AV lead staff person if the agency is not the jurisdictional lead AV agency. As the jurisdiction becomes more engaged in the regulation of ADS-equipped vehicles, the lead person may eventually become dedicated to the project. Therefore, funding may be needed in the future for a dedicated position.

3.2 Advanced Driver-Assistance Systems: Recommendations for Jurisdictions

3.2.1. Use SAE International terminology to describe ADAS technology in vehicles as national standards are developed.

Chapter 4. Vehicle Considerations

4.1 Application and Permit for Manufacturers and Other Entities to Test Vehicles on Public Roadways: Recommendations for Jurisdictions

4.1.1. Require all MOEs testing ADS-equipped vehicles to apply for and be issued vehicle specific permits before testing on public roadways.

4.1.2. Establish a test registration permit application process for ADS-equipped vehicles that does not create unnecessary barriers for MOEs and requires the completion or attachment of the information listed in Section 4.1.

4.1.3. Implement a process for denying an application, as well as an appeal process for applicants or permittees whose applications have been denied.

4.1.4. Require test registration permit information be available for verification at the time of vehicle registration issuance (new and renewal) either by presentation from the holder or through electronic means in jurisdictions where MOE-owned vehicles are required to be individually registered.

4.1.5. Require test registration permits to be carried in the test vehicle while present on public roadways until or unless an electronic process has been created by jurisdictions that will allow permit information to be made readily available to law enforcement.

4.2 Actions on Permit Process: Recommendations for Jurisdictions

4.2.1. Develop provisions for suspension, revocation, or fining of any permit holder to test on public roads if permit holders violate permit conditions and for reporting such actions to the jurisdiction's lead law enforcement agency.

4.2.2. Consider the imposition of penalties if the testing entity continues to operate or test in violation of a suspension or revocation order.

4.2.3. Establish a process for reporting traffic law violations to the permit issuing agency.

4.2.4. Have an appeal process for administrative actions taken against a MOE.

4.3 Automated Driving System-Equipped Vehicle Information on the Manufacturer's Certificate of Origin and Manufacturer's Statement of Origin: Recommendations for Jurisdictions

4.3.1. Jurisdictions should not initiate a process for titling test vehicles if the jurisdiction does not already require this protocol.

4.4 Titling and Designating New and Aftermarket Automated Driving System-Equipped Vehicles: Recommendations for Jurisdictions

4.4.1. Record and maintain the test vehicle information in the vehicle record through the normal titling process, through a titling exception process unique to ADS-equipped vehicles or recording vital information in the database without titling. If a jurisdiction titles an ADS-equipped vehicle used for testing, the title should carry an appropriate "ADS" designation, and the SAE Level of automation should be included within the titling and/or registration system.

4.4.2. Title all ADS-equipped vehicles, pursuant to the jurisdiction's laws or policies; each title should be "ADS" designated, and the SAE level of automation should be included within the titling and or registration system.

4.4.3. Titles for vehicles with added aftermarket components enabling ADS-equipped vehicle functionality should also be "ADS" designated and the SAE Level of automation should be included within the titling and/or registration system. Since there is currently no readily available central source of ADS-equipped vehicle information, jurisdictions should consider requiring self-reporting of this information during the titling and registration process.

4.5 Vehicle Registration: Recommendations for Jurisdictions

4.5.1. Record and maintain test vehicle information in the vehicle record through the normal registration process, through a registration exception process unique to ADS-equipped vehicles or recording vital information in the database without titling.

4.5.2. Establish uniform language that will benefit law enforcement, the MVA, and other stakeholders for testing ADS-equipped vehicles. Use "Automated Driving System" on the vehicle registration record.

4.5.3. Recognize the registration, title, and plate issued by another titling jurisdiction for purposes of testing.

4.5.4. Establish a field on the registration credential or record for deployed vehicles that indicates "Automated Driving System" for motor vehicles with ADS. See Section 4.4 for more information.

4.5.5. Establish uniform language to aid law enforcement, the MVA, and other stakeholders. Use "Automated Driving System" on the vehicle record.

4.6 License Plates: Recommendations for Jurisdictions

4.6.1. If a jurisdiction chooses to require a special license plate for ADS-equipped vehicles, the plates should adopt the administrative, design, and manufacturing specifications contained in the *AAMVA License Plate Standard, Edition 2*.

4.7 Financial Responsibility also known as Mandatory Liability Insurance Recommendations for Jurisdictions

4.7.1. Require all ADS-equipped vehicles permitted for on-road testing to have at a minimum liability insurance (many jurisdictions have implemented a $5 million requirement) in the form and manner required by the jurisdiction and/or FMCSA regulations.

4.7.2. Consider minimum liability insurance requirements for commercial vehicles not covered by the federal regulations that are distinctive from the requirements for personal and private vehicles.

4.7.3. Jurisdictions with higher liability insurance requirements for vehicles used for public transportation, including ridesharing and peer-to-peer motor vehicle rentals, should give special consideration to liability insurance requirements for test vehicles that are designed and manufactured to provide similar transportation services. Additional consideration should be given to adjusting insurance liability limits based on vehicle design and application.

4.7.4. Jurisdictions should consider the challenges described above when establishing minimum insurance liability on deployed ADS-equipped vehicles.

4.7.5. Consider liability insurance requirements for commercial vehicles not covered by the federal regulations that are distinctive from rates for personal or private vehicles.

4.9 Federal Motor Vehicle Safety Standards and Canadian Motor Vehicle Safety Standards: Recommendations for Jurisdictions

4.9.1. Consider requiring MOEs testing ADS-equipped vehicles within the jurisdiction to certify the vehicles comply with all applicable FMVSS or CMVSS, and no required safety devices have been made inoperable. In lieu of the certification, require manufacturers to provide evidence the vehicle(s) have received an exemption from the FMVSS or CMVSS.

4.10 Periodic Motor Vehicle Inspections: Recommendations for Jurisdictions

4.10.1. Jurisdictions should not be expected to create new safety inspection programs for ADS-equipped vehicles during the testing stages. A jurisdiction that currently has such a program should apply its same standard.

4.10.2. Until a national standard (FMVSS, CMVSS, or established MOE consensus standard) is developed, jurisdictions should not incorporate ADAS- or ADS-specific components (e.g., software, sensors) as part of their motor vehicle inspection programs. However, any vehicle abnormality noticed should be documented and provided to the vehicle owner.

4.10.3. Jurisdictions should continue to work closely with MOEs to understand mechanisms for verifying the safety and functionality of current ADAS and ADS technology components, and how safety might be discerned in the future.

Chapter 5. Driver Licensing Considerations

5.1 Driver and Passenger Roles Defined: Recommendations for Jurisdictions

5.1.1. Use the SAE International definitions provided in Chapter 2.

5.1.2. As discussed in Section 3.1, jurisdictions should review the resource *Implications of Automation for Motor Vehicle Codes*, which may be a useful guide for updating laws and regulations.

5.2 Driver's License Requirements for Testing by Manufacturers and Other Entities: Recommendations for Jurisdictions

5.2.1. Review and develop or adapt existing rules, if applicable, regarding vehicle operation to ensure ADS-equipped vehicle testing is permitted.

5.2.2. Require test ADS-equipped vehicles be operated solely by employees, contractors, or other persons designated by the manufacturer of the ADS-equipped vehicle or any such entity involved in the testing of the ADS-equipped vehicle.

5.2.3. Require test drivers to receive training and instruction related to, but not limited to, the capabilities and limitations of the vehicle and be subject to a background check as described in Section 6.3.

5.2.4. Require training provided to the employees, contractors, or other persons designated by the manufacturer or entity to be documented and a summary of the training be submitted to the jurisdiction's AV lead agency along with other required information.

5.2.5. Support safe testing without a human driver inside of the vehicle by requiring a user designated by the manufacturer of the ADS technology or any such entity involved in the driverless testing of the ADS-equipped vehicle to be capable of assuming control of the vehicle's operations or require that the ADS can achieve a minimal risk condition.

5.2.6. Take steps to ensure motor vehicle laws allow for the manufacturer to safely test Level 4 and 5 vehicles without a licensed driver, provided a user designated by the manufacturer or any such entity involved in the driverless testing of the ADS-equipped vehicle, can assume control of the vehicle's operations or require that the ADS can achieve a minimal risk condition.

5.2.7. Consider requiring manufacturers or other entities testing ADS-equipped vehicles within the jurisdiction to certify the vehicles comply with all applicable FMVSS or CMVSS and no required safety devices have been made inoperable. In lieu of the certification, evidence may be needed indicating the vehicle has received an exemption from the FMVSS or CMVSS. See Section 4.9.

5.3 Remote Driver: Recommendations for Jurisdictions

5.3.1. Define "remote driver" in statutes by adopting the SAE International

definition and review the SAE International document J3016 dated April 2021 *Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles* for additional information and further explanation of the definition.

5.3.2. Define "remote assistance" in statutes by adopting the SAE International definition and review the SAE International document J3016 dated April 2021 Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles for additional information and further explanation of the definition.

5.3.3. Define "remote driving" in statutes by adopting the SAE International definition and review the SAE International document J3016 dated April 2021 Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles for additional information and further explanation of the definition.

5.3.4. Require the testing entity to agree in writing that a remote driver would be subject to an operator fitness evaluation by law enforcement in the event of an incident or crash.

5.3.5. Clarify in law that all laws applicable to drivers also apply to remote drivers.

5.3.6. Review current license restrictions and endorsements to determine which apply to a remote driver and when a remote driver must comply with the restriction or endorsement. For example, restrictions that could apply include corrective lenses, hearing devices, and accommodations for missing limbs.

5.3.7. Ensure driver's license program staff and law enforcement understand remote driving and are well versed in responding to inquiries.

5.3.8. Require MOEs testing vehicles using a remote driver to notify the jurisdiction's lead AV agency, comply with all other testing requirements and to provide the names and driver's license information for all remote drivers.

5.3.9. Require documentation from the MOEs that remote drivers have been trained to safely operate the vehicle remotely, including but not limited to, appropriate law enforcement and first responder interaction plans.

Recommended Requirements for Remote Test Drivers

5.3.10. Comply with all federal and jurisdictional laws unless otherwise exempt.

5.3.11. Hold the class of license for the vehicle they are remotely driving with appropriate endorsements and restrictions.

5.3.12. Be physically located in the same jurisdiction as the vehicle they are remotely driving.

5.3.13. Inform their employer and/or test entity immediately of any moving violations or testing permit condition violations that occur whether they are remotely driving a vehicle or driving any other vehicle.

5.3.14. Be fit to remotely drive and not be impaired or distracted.

5.3.15. Remotely drive only one vehicle at a time.

5.3.16. Ensure that the location, communication method, and control interface can allow uninterrupted control of remotely controlled vehicles.

5.3.17. Make available to law enforcement, upon request, their name, physical location, license number, and jurisdiction of issue, as well as the name and contact information of their employer.

5.3.18. Report a crash immediately to the appropriate law enforcement in the jurisdiction in which the vehicle is located.

Recommended Requirements for Test Vehicle Owners

5.3.19. Post the responsible party's name and contact information within a remotely driven vehicle.

5.3.20. Testing entities should verify remote test driver's driving records at least annually or participate in an Employer Notification System offered by the jurisdiction.

Recommendations for Law Enforcement

5.3.21. Support the enactment of laws that require the officer to charge the remote driver with the violation and, if convicted, to hold the remote driver responsible. For other nondriving violations, such as lights not working, the remote driver should be held responsible unless they provide the registered owner's name and contact information and the registered owner is charged with the violation.

5.4 Endorsements and Restrictions for Deployed Vehicles: Recommendations for Jurisdictions

5.4.1. Do not establish ADS endorsements or restrictions on driver's licenses at this time.

5.4.2. Take steps to ensure jurisdictional motor vehicle laws allow for the operation of Level 4 and 5 ADS-equipped vehicles without a driver only if the vehicle cannot be operated in manual mode.

5.4.3. Do not limit the operation of Level 4 and 5 ADS-equipped vehicles to individuals who are licensed as drivers.

5.4.4. Do not impose any other requirements, such as licensure, sobriety, or clean driving history, for nondrivers to use Level 4 and 5 ADS-equipped vehicles.

5.4.5. Review jurisdictional laws and regulations related to unsupervised children in motor vehicles to ensure safety.

5.5 Driver Training for Drivers on Vehicle Technologies: Recommendations for Jurisdictions

5.5.1. Promote driver training on the use of ADAS- and ADS-equipped vehicle functions.

5.5.2. Encourage communication between dealers and drivers including, but not limited to, acknowledgement of the sections in the vehicle "owner's manual" related to the ADAS- and ADS-equipped vehicle functions.

5.5.3. Encourage manufacturers, dealers, and insurance companies to provide incentives for drivers to receive proper training on the use of ADAS- and ADS-equipped vehicle functions from a fully qualified driver educator.

5.5.4. Encourage aftermarket system manufacturers and dealers to provide education materials and resources to drivers.

5.6 Training for Driver Educators, Driver Education and Driver Training Programs: Recommendations for Jurisdictions

5.6.1. Require driver education curricula to contain information on ADAS- and ADS-equipped vehicles.

5.6.2. Provide behind-the-wheel instruction on the use of ADAS if equipped.

5.6.3. Require all definitions and language on ADAS- and ADS-equipped vehicles provided in driver education to use the SAE International or AAMVA's guidelines for consistency.

5.6.4. Establish standardized materials for the training of driver educators on the use of ADAS- and ADS-equipped vehicles.

5.6.5. Continually review materials and revise curricula to reflect current ADAS features.

5.7 Driver's License Skills Testing with Vehicle Technologies: Recommendations for Jurisdictions

5.7.1. Include ADAS and ADS information on vehicle technologies in the jurisdiction's driver's manual when provided by the AAMVA TMS.

5.7.2. Include questions addressing ADAS and ADS in the jurisdictional knowledge test when provided by the AAMVA TMS.

5.7.3. Jurisdictions should not allow the applicant to use convenience technologies, such as the parking assist feature, for skills examination or parking maneuvers during the skills examination.

5.7.4. Allow the applicant to use active safety system technologies during skills examinations. These technologies, such as backup or other cameras, should not be disengaged during examinations.

5.7.5. Jurisdictions should not require applicants to deactivate active safety system technologies during the skills examination process.

5.8 Training Motor Vehicle Agency Examiners on Vehicle Technologies: Recommendations for Jurisdictions

5.8.1. Provide training to driver's license examiners on vehicle technologies, including the operation of ADAS- and ADS-equipped vehicles. AAMVA's *Guidelines for Testing Drivers in Vehicles with Advanced Driver-Assistance Systems* resource guide, published in 2019, should be used in examiner training.

5.8.2. Use AAMVA's IDEC model training materials, when updated, to assist with ADAS and ADS examiner training requirements.

5.8.3. Require driver's license examiners to use the definition and language on

ADAS- and ADS-equipped vehicles from AAMVA's guidelines (adopted from SAE International).

5.9 Training Motor Vehicle Agency Staff on Vehicle Technologies: Recommendations for Jurisdictions

5.9.1. MVA senior managers and applicable staff should be aware of MOE ADS-equipped vehicle testing and their jurisdiction's regulatory approach.

5.9.2. Provide general training to MVA staff on vehicle technologies, including what the technology does and how it works. AAMVA's *Guidelines for Testing Drivers in Vehicles with Advanced Driver-Assistance Systems* resource guide, published in 2019, should be used when training driver licensing staff (see Section 5.9.)

5.9.3. Require all definitions and language on ADAS- and ADS-equipped vehicles provided to MVA staff use the SAE International and AAMVA's guidelines for consistency.

5.9.4. Begin to expose staff to vehicle technology by incorporating some general education in staff meetings. This could include showing videos, graphics, and pictures of vehicles equipped with ADAS and ADS.

5.10 Commercial Driver Licensing: Recommendations for Jurisdictions

5.10.1. Require commercial vehicle test drivers to have a CDL and appropriate endorsements and restrictions for the vehicles they are testing.

5.10.2. Require the CDL test driver to be located inside the vehicle unless specifically approved to test the vehicle with the CDL test driver outside the vehicle or remotely located.

5.10.3. Require MOEs that are testing ADS technologies on commercial vehicles to follow all regulations for companies that hire CDL drivers are required to follow.

5.10.4. Require compliance with all regulations related to the vehicle and the load being transported.

5.10.5. Engage in the review and development of federal regulations by FMCSA.

5.10.6. Review and adopt amendments to jurisdictional laws as federal regulations are updated.

Chapter 6. Law Enforcement Considerations

6.2 Crash and Incident Reporting: Recommendations for Jurisdictions

6.2.1. Require ADS test entity to submit to the jurisdiction, at a minimum, the NHTSA crash reporting requirements for ADAS- and ADS-equipped vehicles (NHTSA Standing General Order 2021-01 [Amended August 2021]).

6.2.2. U.S. jurisdictions should adopt the MMUCC 5th Edition (August 2017) recommendation as soon as practicable.

6.3 Criminal Activity: Recommendations for Jurisdictions

6.3.1. Jurisdictions that have ADS-equipped vehicle permitting requirements as described in Section 4.1 should require the designated test users (employees, contractors and other persons) to pass a background check, including, but not limited to, a driver history review and a criminal history check, prior to authorization to operate an ADS-equipped test vehicle.

6.3.2. Jurisdictions that have ADS-equipped vehicle permitting requirements as described in Section 4.1 should establish provisions which disqualify a test user who has a criminal record or a driving history that includes driving under the influence, reckless driving, or other significant conviction history from operating an ADS-equipped test vehicle in a test environment.

6.4 Distracted Driving: Recommendations for Jurisdictions

6.4.1. Consider strengthening a jurisdiction's distracted driving laws by utilizing the model legislation provided in the *Distracted Driving White Paper* as a template.

6.4.2. Utilize the best available distracted driving educational materials in proactive public education efforts. One such source is the IACP Distracted Driving Toolkit.

6.5 Establishing Operational Responsibility and Law Enforcement Implications: Recommendations for Jurisdictions

6.5.1. Define what enforcement actions can be taken and who or what is responsible when there is no human onboard an automated test vehicle.

6.5.2. Clearly establish legal responsibility for every vehicle operating on public roads.

6.6 Law Enforcement and First Responder Interaction Plans: Recommendations for Jurisdictions

6.6.1. Maintain communication with manufacturers to ensure the latest version of the applicable LEIPs are available to law enforcement and other first responders.

6.6.2. Designate the lead law enforcement agency in the jurisdiction as a liaison to vehicle MOEs for the distribution of the LEIP to all law enforcement agencies and other first responders within that jurisdiction.

6.7 Law Enforcement Protocols for Level 4 and 5 Vehicles: Recommendations for Jurisdictions

6.7.1. LEPs should be developed by the lead law enforcement agency in cooperation with the vehicle manufacturer and test entity and may be vehicle specific. In addition, the protocols should outline any specific federal, jurisdictional, or local laws, regulations or policies governing Level 4 and 5 ADS-equipped vehicles operating within the law enforcement agency's jurisdiction.

6.7.2. Designate a liaison within the lead law enforcement agency to be responsible for developing and maintaining the LEP and ensuring its distribution to the law enforcement and first responder community. The liaison should review the LEP continually and ensure consistency with:

- jurisdictional laws and regulations,
- recommendations from the manufacturer, and
- enforcement guidelines.

6.7.3. Ensure the LEP and LEIP are available to law enforcement officers and first responders with or without an internet connection.

6.8 Law Enforcement and First Responder Safety and Training: Recommendations for Jurisdictions

6.8.1. Work with manufacturer driver training programs to make ADS training available to law enforcement and other first responders at no cost to agencies.

6.9 Adherence to Traffic Laws: Recommendations for Jurisdictions

6.9.1. Refer to Transportation Research Board NCHRP20-102(07) *Implications of Automation for Motor Vehicle Codes* to identify traffic and other laws that may need to be repealed or revised to accommodate ADS technology.

6.9.2. Jurisdictions should not modify current traffic laws specifically to accommodate SAE Level 5 ADS-equipped vehicles until their development advances to the extent that such amendments and statutes are warranted.

6.9.3. Jurisdictions should conduct a comprehensive review of legal definitions related to their traffic laws and adopt definitions from SAE J3016 Standard as applicable. This effort should be ongoing with the continued advancement of vehicle technology.

6.9.4. Support legislation that allows an officer to charge a remote driver with a violation. And, for nondriving violations, such as defective equipment, the registered owner should be charged with the violation.

Chapter 7. Other Considerations

7.2 Data Collection: Recommendations for Jurisdictions

7.2.1. Conduct a thorough review of jurisdictional laws pertaining to the collection and dissemination of data. Particular attention should be given to personally identifiable information and under what circumstances it may appropriately be recorded, maintained, and released. In addition, the issue of transparency should be evaluated: what data are permitted to be collected, how the individual is informed about the collection and use of the data, and whether an affirmative consent be considered.

7.2.2. Provide information about vehicle data collection resources on the jurisdiction's website to encourage drivers to check with their vehicle manufacturer for

information about the collection of data by the systems in their vehicle.

7.3 Low-Speed Automated Shuttles: Recommendations for Jurisdictions

7.3.1. Treat low-speed automated shuttles similar to other AVs for the purposes of permitting and on-road testing (see Section 4.1.)

7.3.2. Give special consideration to the application of additional measures to ensure safety is preserved in test applications (e.g., slow-moving vehicle signage; requirement for shuttles to travel in designated lanes or along the far right-hand side of the roadway; restriction of the shuttle to low-speed municipal roads).

7.3.3. Understand the capabilities, limitations, and performance standards of shuttles before shuttles are tested on public roads, including but not limited to safety mechanisms and features, prior testing, vehicle crashworthiness and crash testing, ODD and OEDR, emergency fallback, and the ability of vehicles to operate in mixed traffic.

7.3.4. Require testing entities to confirm that shuttles are constructed to meet all applicable vehicle equipment laws and standards set by federal, state, and provincial governments; shuttles must continue to meet these laws and standards while operating on roadways.

7.3.5. Work closely with the testing entity or manufacturer throughout testing to address technical issues, receive relevant hardware and software upgrades, and receive technical support.

7.3.6. Confirm the vehicle can operate safely on public roads.

7.3.7. Only operate the shuttle in accordance with the manufacturer's instructions.

7.3.8. Only operate the shuttle on routes that conform to the manufacturer's instructions and account adequately for weather, traffic, and road conditions; physical infrastructure and other factors that might compromise safety.

7.3.9. Ensure information on law enforcement interaction is adequately distributed and understood by all relevant parties. (This may include the creation and distribution of an LEIP.)

7.3.10. Confirm that safety drivers are adequately trained in all aspects of shuttle operation and are fully capable of safely operating the shuttles as intended by the manufacturer.

7.3.11. Confirm that safety drivers have been trained to abide by all applicable jurisdictional laws while operating or overseeing the operation of shuttles, including those related to driver licensing and rules of the road.

7.3.12. Outfit the shuttle with appropriate equipment to protect occupants' safety, which may include, but not be limited to, occupant restraints, hand holds, and appropriate lighting.

7.3.13. Be cautious to accommodate on-road deployment of low-speed automated shuttles absent federal safety standards

and a corresponding definition for this vehicle type.

7.4 Connected Vehicles: Recommendations for Jurisdictions

7.4.1. Jurisdictions should require vehicles with connected and automated technologies to follow the permitting and registration process for AVs of the same SAE Level.

7.4.2. Jurisdictions with an ADS-equipped vehicle committee should require the committee members to stay abreast of connected vehicle technologies deployed in the jurisdiction and to inform jurisdiction and local officials involved in connected vehicle technology infrastructure planning and implementation.

7.4.3. Jurisdictions with an ADS-equipped vehicle committee should require the committee to continue providing updates on ADS-equipped vehicles to jurisdiction and local officials involved in planning and implementing connected vehicle technologies.

7.5 Platooning: Recommendations for Jurisdictions

7.5.1. Review and update statutes to allow vehicles that are platooning to follow at a reasonable and prudent distance.

7.5.2. Require platoon testing entities to submit an application packet for testing as described in Section 4.1 and issue a permit to test when satisfied with the application and other submitted information.

7.5.3. Require the motor carrier's safety rating to be in good standing.

7.5.4. Allow testing only on approved routes, including limited access highways.

7.5.5. Require ADS to respond and adjust as necessary to allow vehicles to enter or exit the highway, in a work zone, in tunnels, and in weigh stations, traveling past an incident scene or through toll plazas.

7.5.6. Do not allow testing in lanes where trucks are prohibited.

7.5.7. Do not allow testing in adverse weather conditions.

7.5.8. Jurisdictions should reserve the right to suspend testing for any reason.

7.5.9. Prohibit carrying hazardous materials, oversize or overweight loads, fluids, loose loads, and livestock.

7.5.10. Consider limiting the number of vehicles allowed in a platoon.

7.5.11. Each vehicle combination should be limited to a truck or tractor and one trailer combination unit.

7.5.12. Require an identifier on the outside of the vehicle to indicate when the platoon technology is actively engaged.

7.5.13. Commercial transportation of passengers (i.e., school bus or motor coach) should not be permitted.

7.5.14. Consider requiring escort vehicles with conspicuous lighting in the front and rear of the platoon.

7.5.15. Require all drivers to hold an appropriately endorsed and valid CDL.

7.5.16. Require all drivers to receive appropriate training provided by the testing entity.

7.5.17. Drivers must comply with all applicable jurisdictional and federal regulations.

7.5.18. Require a driver be in each platoon vehicle, seated in the driver's seat, continually monitoring the driving environment and prepared to take over control of the vehicle at any time.

7.5.19. Require route planning take into consideration minimizing traffic interaction.

7.5.20. Require route planning take into consideration prevention of driver fatigue, task monotony, and highway hypnosis.

7.5.21. Require platoon formation be initiated when speed variability between the lead and following vehicles can be standardized to reduce safety risks.

Appendix B Summary of Recommendations for Manufacturers and Other Entities for the Safe Testing and Deployment of Automated Driving System-Equipped Vehicles

The Subcommittee offers the following recommendations for MOEs for the safe testing and deployment of ADS-equipped vehicles. These guidelines come from the recommendations provided in the report. MOEs are not required to follow these recommendations; however, they are provided to ensure the safe testing and deployment of ADS-equipped vehicles.

These guidelines apply to SAE Levels 3, 4, and 5, described as conditional automation, high automation, and full automation, respectively, unless otherwise stated.

Chapter 3. Administrative Considerations

3.1 Administration: Recommendations for Manufacturers and Other Entities

MOE 1. MOEs should interact with and respond to jurisdictional ADS-equipped vehicle committee questions and requests.

3.2 Advanced Driver-Assistance Systems: Recommendations for Manufacturers and Other Entities

MOE 2. MOEs should adopt SAE International terminology to describe ADAS technology in vehicles.

Chapter 4. Vehicle Considerations

4.3 Automated Driving System-Equipped Vehicle Information on the Manufacturer's Certificate of Origin and Manufacturer's Statement of Origin: Recommendations for Manufacturers and Other Entities

MOE 3. Vehicle manufacturers should indicate it is an ADS-equipped vehicle on the MCO, MSO, or NVIS. This functionality should be listed in a new field on the MCO, MSO, or NVIS to avoid confusion with existing information.

4.4 Designating and Titling New and Aftermarket Automated Driving System-Equipped Vehicles: Recommendations for Manufacturers and Other Entities

MOE 4. The OEM or the installer of the aftermarket automated technology, either parts or software systems, should notify the MVA when a motor vehicle has been altered by adding or removing an AV technology.

4.10 Periodic Motor Vehicle Inspections: Recommendations for Manufacturers and Other Entities

MOE 5. MOEs should ensure all technology being tested on public roads is safe.

Chapter 5. Driver Licensing Considerations

5.1 Driver and Passenger Roles Defined: Recommendations for Manufacturers and Other Entities

MOE 6. MOEs should use the SAE International definitions provided in Chapter 2.

5.2 Driver's License Requirements for Testing by Manufacturers and Other Entities: Recommendations for Manufacturers and Other Entities

MOE 7. MOEs should complete a background check and provide or ensure appropriate training for ADS-equipped vehicle test drivers. See Section 6.3 on background checks.

5.5 Driver Training for Drivers on Vehicle Technologies: Recommendations for Manufacturers and Other Entities

MOE 8. Manufacturers and dealers should take steps to make training available to drivers to ensure they understand the functionality of the vehicle and are prepared to properly operate them.

5.7 Driver's License Skills Testing with Vehicle Technologies: Recommendations for Manufacturers and Other Entities

MOE 9. MOEs that develop an ADS-equipped dual-mode vehicle should consider taking steps to prevent the manual mode from being engaged in error.

Chapter 6. Law Enforcement Considerations

6.2 Crash and Incident Reporting: Recommendations for Manufacturers and Other Entities

MOE 10. MOEs should design ADS to record vehicle location, behavior sensor data, and the HMI. Manufacturers should record 360-degree video data of the vehicle's operating environment. Law enforcement should be provided with access to this information as well as a minimum of 30 seconds pre-crash through the end of the crash event (cessation of involved vehicle movement) for completing a proper investigation.

MOE 11. In addition to complying with the requirements of 49 CFR Part 563, manufacturers should make DCM information retrievable in a standard, nonproprietary format for ready access by those duly authorized.

MOE 12. MOEs should include time stamping and GPS location in DCM data.

6.3 Criminal Activity: Recommendations for Manufacturers and Other Entities

MOE 13. The MOE, operating in jurisdictions not requiring ADS-equipped vehicle permits, should require the designated test user to pass a background check, including, but not limited to, a driver history review and a criminal history check, prior to authorization to operate an ADS-equipped test vehicle.

MOE 14. The MOE, operating in jurisdictions not requiring ADS-equipped vehicle permits, should disqualify a test user

who has a criminal record or poor driving history from operating an ADS-equipped test vehicle.

MOE 15. MOEs should ensure ADS-equipped vehicles leave an electronic fingerprint that can allow tracing of input data to whomever initiated the activity.

6.4 Distracted Driving: Recommendations for Manufacturers and Other Entities

MOE 16. MOEs should minimize distractions in ADS-equipped vehicles.

MOE 17. MOEs should prohibit users from all added distracting activities when testing any ADS-equipped vehicle.

MOE 18 MOEs should incorporate technology to alert the "driver" when the ADS cannot maintain or complete the driving task and the "driver" needs to assume control of vehicle operation.

MOE 19. MOEs should design ADS-equipped vehicles with a means of identifying when a vehicle is in automated mode to facilitate effective enforcement of distracted driving laws (e.g., so an officer knows if using a hand-held device is legal at the time of observation).

MOE 20. MOEs should minimize distractions in ADS-equipped vehicles with part time self-driving features.

MOE 21. Manufacturers should incorporate technology that monitors the driver's awareness (e.g., monitoring the eyes or hand placement) with the vehicle prompting disengagement of activated self-driving mode if the driver is not paying sufficient attention to the DDT.

6.6 Law Enforcement and First Responder Interaction Plans: Recommendations for Manufacturers and Other Entities

MOE 22. MOEs, in partnership with law enforcement and other first responders, should develop a LEIP in a standardized format for each ADS-equipped model deployed.

MOE 23. The LEIP should be reviewed regularly and updated as necessary but at least annually.

6.8 Law Enforcement and First Responder Safety and Training: Recommendations for Manufacturers and Other Entities

MOE 24. MOEs should ensure ADS-equipped vehicles have safety systems or procedures that allow law enforcement and other first responders to immobilize or otherwise disable the vehicle post-crash, or during certain law enforcement contacts to prevent movement or subsequent ignition of the vehicle.

MOE 25. MOEs, in partnership with highway safety stakeholders, should develop national or international standardized first responder training on safely interacting with vehicles and users in both the testing and deployment of ADS-equipped vehicles.

6.9 Adherence to Traffic Laws: Recommendations for Manufacturers and Other Entities

MOE 26 Manufacturers or other entities should ensure users of vehicles designed to operate in either automated mode or manual mode do not have the ability to override the

ADS settings, without transitioning out of automated mode into manual mode, unless faced with a legally acceptable exigent circumstance.

6.10 Vehicle Response to Emergency Vehicles, Manual Traffic Controls and Atypical Road Conditions: Recommendations for Manufacturers and Other Entities

MOE 27. MOEs should ensure that vehicles operated on public roads, both during testing and deployment, are able to recognize and properly respond to all temporary traffic controls and hazards in the roadway environment. Toward that end, manufacturers should use publicly available traffic data such as crash notifications, traffic congestion, and construction zone information.

6.11 System Misuse and Abuse: Recommendations for Manufacturers and Other Entities

MOE 28. MOEs, such as researchers and developers, should always record the behaviors of the vehicle and the HMI during operation because extensive testing occurs on public roads.

MOE 29. MOEs should design ADS-equipped vehicles to record both vehicle behaviors and the driver–vehicle interface to identify the actions of the vehicle and the actions (or lack thereof) by the human at all times.

MOE 30. MOEs should ensure the EDR and CPU information that accomplishes *Recommendation MOE 29* is stored and retrievable in some recognized, standard, nonproprietary, format with a commercially available tool, making the data readily accessible by those duly authorized.

Chapter 7. Other Considerations

7.1 Cybersecurity for Vehicles with Automated Driving Systems: Recommendations for Manufacturers and Other Entities

MOE 31. MOEs should use best practices, design principles, and guidance based on or published by NIST, NHTSA, Auto ISAC, and recognized standards-setting bodies such as SAE International standard J3061 *Cybersecurity Guidebook for Cyber-Physical Vehicle Systems.*

MOE 32. All cyber threats, vulnerabilities, or incidents should be reported to the nearest fusion center and to the lead law enforcement agency in the affected jurisdiction if one has been so designated.

7.2 Data Collection

MOE 33. MOEs should comply with industry privacy principles relating to data collection and sharing. Guidelines may include those developed by trade associations that represent vehicle manufacturers and the Automotive Privacy Principles published by the National Automobile Dealers Association, which affirms commitments in three key areas: Transparency, Affirmative Consent for Sensitive Data, and Limited Sharing with Government and Law Enforcement.

Appendix C Automated Vehicles Subcommittee Roster

(FY2022; Updated January 24, 2022)

MEMBERS

Bernard Soriano PhD, Chair
Deputy Director
California Department of Motor Vehicles

James Fackler, Vice Chair
Director, Office of Program Support
Michigan Secretary of State

Captain Richard Arnold
Michigan State Police

Chief Jeff Dixon
Florida Highway Patrol

Wendy Doyle
Executive Director, Office of Traffic Safety
Alberta Transportation

Technical Sergeant James Gregory
New York State Police

Dezbah Hatathli
Community Outreach Manager
Arizona Department of Transportation

Assistant Chief David Jenkins
California Highway Patrol

Staff Lieutenant Christopher Kinn
Ohio State Highway Patrol

Christopher Koermer
Director
Maryland Public Service Commission

Jason Kuo
Vehicle Standards Engineer
Alberta Transportation

J. Kevin Lacy
State Traffic Engineer
North Carolina Department of Transportation

Steve Madrak
Division Chief
Pennsylvania Department of Transportation, Bureau of Motor Vehicles

Ronald Rysavy
Senior Dealer Agent
South Dakota Motor Vehicle Division

Major Robert Sawyer
North Carolina DMV

Courtney Saxon
Deputy Director Field Services
South Carolina Department of Motor Vehicles

Nanette Schieke
CAV Program Manager
Maryland Motor Vehicle Administration

Angela Schneider
Policy Analyst, Senior
Virginia Department of Motor Vehicles

Rick White
Deputy Director, Program Operations
Florida Department of Highway Safety and Motor Vehicles

Daniel Yeh
Manager, Vehicle Services
Iowa Department of Transportation

FEDERAL PARTNERS

Anne Collins
Associate Administrator for Enforcement
National Highway Traffic Safety Administration

Thomas Kelly
Innovative Technology Deployment Program
Federal Motor Carrier Safety Administration

Jacqueline Milani
Senior Highway Safety Specialist
Enforcement & Justice Services Division
National Highway Traffic Safety Administration

Debbie Sweet
Program Analyst
Enforcement & Justice Services Division
National Highway Traffic Safety Administration

AAMVA STAFF

Brian Ursino
Director, Law Enforcement Programs
Project Manager

Michael McCaskill
Director, Identity Management

Paul Steier
Director, Vehicle Programs

Marcy Coleman
Manager, Vehicle Programs

OUR VISION

Safe drivers
Safe vehicles
Secure identities
Saving lives!

AAMVA

American Association of Motor Vehicle Administrators
4401 Wilson Blvd, Suite 700
Arlington, Virginia 22203
703.522.4200 | **aamva.org**