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Texas A&M Transportation Institute

First Responder Interactions with Automated Vehicles: An Identification of Needs and Strategies

Technical Report 0-7199-R1

Cooperative Research Program

TEXAS A&M TRANSPORTATION INSTITUTE

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16. Abstract The rapid deployment of automated vehicles presents both opportunities and challenges, especially for first responders tasked with ensuring public safety during emergencies. This research project, led by the Texas A&M Transportation Institute, in partnership with the Texas A&M Engineering Extension, addressed critical needs and strategies for interactions between first responders and automated vehicles. This report details work that led to the development of a first responder guide to automated vehicle interactions and an automated vehicle recognition guide and identifies gaps in knowledge, operational challenges, and policy deficiencies for first responder interactions with automated vehicles. This report is useful for state and federal regulators, automated vehicle developers, first responders, traffic management organizations, local communities, homeland security personnel, and elected officials in the conduct of their duties.		
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DISCLAIMER

Significant changes in regulation and among automated vehicle operators in Texas and the United States occurred throughout the conduct of this study. Additionally, several operators mentioned in this report either ceased or initiated operations in Texas during the conduct of this study. As such, the information in this report is accurate only as of the date of its submittal to the Texas Department of Transportation (TxDOT) in April 2025. Further, the Texas state legislature, the incoming presidential administration, and the incoming Congressional representatives continued to change, develop, and issue new regulations and rules as this project concluded.

Given this project's 20-month duration, researchers attempted to keep information current when preparing this draft final report. Task reports previously provided to TxDOT and incorporated into this report may include out-of-date or no longer relevant information, despite researchers' best efforts to keep the information current for this report. Given the rapidly changing nature of the subject, this report may contain information no longer valid or information that will become invalid after completion of the project. As such, the authors of this report recommend that its users verify any information they cite from this report to ensure its accuracy.

This research was sponsored by the Texas Department of Transportation (TxDOT) and the Federal Highway Administration (FHWA). The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official view or policies of FHWA or TxDOT. This report does not constitute a standard, specification, or regulation.

The U.S. Government and the State of Texas do not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of this report.

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NOTE ON TERMINOLOGY AND ABBREVIATIONS

Most literature published in the United States related to autonomy in vehicles uses the terms *autonomous vehicles* (AVs) or *connected autonomous vehicles* (CAVs). The Texas Transportation Code uses the term *automated vehicles*. This report uses the terms *autonomous vehicles* and *automated vehicles* interchangeably. Likewise, the acronyms AV and CAV (connected AV) may represent both automated and autonomous vehicles. While the acronyms AV or CAV and the term *autonomous vehicles* may refer to any level of autonomy, Texas law defines autonomous vehicles as only those vehicles possessing SAE International Level 3–5 automation capabilities. When required, the proper terminology will appear in place of the AV or CAV acronyms.

ACRONYMS AND ABBREVIATIONS

AAMVA	American Association of Motor Vehicle Administrators
ADAS	Advanced driver-assistance system
ADOT	Arizona Department of Transportation
ADPS	Arizona Department of Public Safety
ADS	Automated driving system
AI	Artificial intelligence
ANPRM	Advanced notice of proposed rulemaking
ANSI	American National Standards Institute
Ariz. Rev. Stat.	Arizona Revised Statutes
AV	Autonomous or automated vehicle
AVIA	Autonomous Vehicle Industry Association
AVSC	Automated Vehicle Safety Consortium
Cal. Code Regs.	California Code of Regulations
CAV	Connected autonomous vehicle
CBP	Customs and Border Protection
CEO	Chief executive officer
CFR	Code of Federal Regulations
CISA	Cybersecurity and Infrastructure Security Agency
CMV	Commercial motor vehicle
CPUC	California Public Utilities Commission
CR-100	Instructions to police for reporting crashes
CR-3	Texas peace officer’s crash report form
CR-3CS	Texas peace officer’s crash report form code sheet
CRIS	Crash Reporting Information System
CVSA	Commercial Vehicle Safety Alliance
DMV	Department of Motor Vehicles
DoD	Department of Defense
DOT	Department of Transportation
DPS	Department of Public Safety
DL	Driver’s License
DSRC	Dedicated short-range radio communication
DV	Dedicated vehicle
EDR	Event data recorders
ELD	Electronic logging device
EMS	Emergency medical services
ERG	Emergency response guide
EU	European Union
EV	Electric vehicle
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FMCSR	Federal Motor Carrier Safety Regulation
FMVSS	Federal Motor Vehicle Safety Standard
FRIP	First responder interaction plan
GM	General Motors
GPS	Global positioning system
HAV	Highly automated vehicle
HB	House bill
HERO	Highway emergency response operator
ICE	Internal combustion engine
ID	Identification

IIJA	Infrastructure Investment and Jobs Act
ISO	International Standards Organization
Kan. Stat.	Kansas Statutes
Ky. Rev. Stat.	Kentucky Revised Statutes
LEIP	Law enforcement interaction plan
LOGINK	Chinese National Transportation Logistics Public Information Platform
MCSAP	Motor Carrier Safety Assistance Program
Me. Code	Maine Code
MS Code	Mississippi Code
MUTCD	Manual on Uniform Transportation Control Device for Streets and Highways
NCHRP	National Cooperative Highway Research Program
NFPA	National Fire Protection Association
NH Rev. Stat.	New Hampshire Revised Statutes
NHTSA	National Highway Traffic Safety Administration
N.M. Admin. Code	New Mexico Administrative Code
NPRM	Notice of proposed rulemaking
ODD	Operational design domain
ODPS	Oklahoma Department of Public Safety
OEM	Original equipment manufacturer
OK Stat.	Oklahoma Statutes
Pa. Cons. Stat.	Pennsylvania Consolidated Statutes
PHMSA	Pipeline and Hazardous Materials Safety Administration
PIA	Public Information Act
SAE	Society of Automotive Engineers
SB	Senate bill
SOP	Standard operating procedure
TCFP	Texas Commission on Fire Protection
TCOLE	Texas Commission on Law Enforcement
TDLR	Texas Department of Licensing and Regulation
TEEX	Texas A&M Engineering Extension Service
Tex. Admin. Code	Texas Administrative Code
Tex. Bus. Com. Code	Texas Business and Commerce Code
Tex. Civ. Prac. Code	Texas Civil Practice and Remedies Code
Tex. Gov't. Code	Texas Government Code
Tex. Occ. Code	Texas Occupations Code
Tex. Transp. Code	Texas Transportation Code
TIM	Traffic incident management
TMC	Traffic management center
TNC	Transportation network company
TPW	Transportation and public works
TTCA	Texas Torts Claims Act
TTI	Texas A&M Transportation Institute
TxDOT	Texas Department of Transportation
UL	UL Solutions (formerly Underwriters Laboratories)
USC	United States Code
USDA	United States Department of Agriculture
USDOT	United States Department of Transportation
V2V	Vehicle to vehicle
VBIED	Vehicle-borne improvised explosive device
VoR	Value of research
W. Va. Code	West Virginia Code

I. INTRODUCTION

The rapid deployment of automated vehicles (AVs) presents both opportunities and challenges, especially for first responders tasked with ensuring public safety during emergencies. The Texas Department of Transportation's (TxDOT's) Research Project 0-7199, led by the Texas A&M Transportation Institute (TTI), in partnership with the Texas A&M Engineering Extension Service (TEEX), addressed critical needs and strategies for interactions between first responders and AVs.

This project identified gaps in knowledge, operational challenges, and policy deficiencies for first responder interactions with AVs.

PROJECT TASKS

This project's tasks included the following:

- Task 1: Project management.
- Task 2: Literature review.
- Task 3: Policy and needs assessment.
- Task 4: AV Summit.
- Task 5: Catalog of scenarios and best practices.
- Task 6: Catalog of first responder/law enforcement interaction plans (FRIPs/LEIPs).
- Task 7: First responder AV interaction guide.

DELIVERABLES

Key deliverables from this project included the following:

- Monthly progress reports (19 reports delivered).
- First responder AV interaction guide comprising the following three documents (provided separately):
  - *Texas Automated Vehicle Recognition Guide for First Responders.*
  - *Texas First Responder Guide for Interactions with Automated Vehicles.*
  - *Texas Automated Vehicle Operator Contact Sheet* (for official use- limited distribution).
- Project research report (this report).
- Project summary report (provided separately).

SUMMARY OF FINDINGS

Task 2: Literature Review

Key findings from a review of the literature included the following:

- The absence of consistent standards and regulations regarding safety measures, first responder protocols, and training results in widely varied levels of first responder capabilities for AV interactions, which are largely dependent on the vehicle model, developer, and jurisdiction.
- Consumers who own vehicles with Level 2 or Level 2+ advanced driver assistance systems (ADASs), as defined by the Society of Automotive Engineers (SAE) International, may mistakenly perceive a higher degree of autonomy in their vehicles, leading to an increased risk of roadway incidents.
- The availability and quality of AV and electric vehicle (EV) first responder guides varies significantly by manufacturer and vehicle make.
- Many AVs are also EVs, posing additional response considerations due to the hazards associated with battery fires and thermal runaways.

- Traffic incident management (TIM) forms a central focus of first responder concerns, particularly regarding AV navigation at active incident scenes or through other unusual traffic patterns that deviate from roadway rules (e.g., around construction zones or special events). Many of these issues relate to the ability of current AVs to process and correctly interpret human-provided directions that deviate from normal roadway rules, signals, or markings.
- Responders requested clear, conspicuous markings on or in vehicles identifying them as AVs and providing operator contact information. Automotive industry representatives expressed concerns that such markings on the exterior of vehicles may lead to aberrant driving behavior around AVs.
- A lack of data availability and a hesitancy by companies to share data with investigators may hamper crash investigations.
- Foreign-operated AVs may pose unique security risks for individuals, security-sensitive sites, and national defense related locations.
- Some nongovernmental responders (e.g., highway emergency response operator [HERO], Tow and Go) reported not receiving joint first responder AV training provided by the AV companies.
- The Texas Commission on Fire Protection (TCFP) and the Texas Commission on Law Enforcement (TCOLE) have yet to publish training standards or requirements for AV interactions.

Task 3: Policy and Needs Assessment

The TTI research team performed an analysis of policies regarding first responder interactions with AVs to develop an assessment of operational, legal, and other mechanisms that would address first responder awareness and safety concerns when interacting with AVs. The work involved interviewing state first responder and HERO stakeholders and reviewing state laws and regulations governing AVs in Texas, in other states, and at the federal level. These efforts resulted in the development of policy suggestions federal rulemaking authorities.

Federal Policy

Federal policy suggestions included the following:

- Modify the National Highway Traffic Safety Administration's (NHTSA's) Federal Motor Vehicle Safety Standards (FMVSSs) to address the unique features of AVs and provide consistency across all AVs that first responders will interact with in the United States.
- Modify the Federal Motor Carrier Safety Administration's (FMCSA's) Federal Motor Carrier Safety Regulations (FMCSRs) to address first responder interaction needs with automated trucks.
- Adopt a federal rule that provides a minimum standard for (LEIPs).
- Amend rules around federal grant programs administered by NHTSA and FMCSA to allow use of highway and commercial motor vehicle (CMV) grant program funds to develop and deliver targeted training for first responder interactions with AVs.

State Policy

State policy suggestions included the following:

- Amend existing AV law to grant TxDOT and the Texas Department of Public Safety (DPS) authority to implement and enforce the law through standard procedures and rules that are not unreasonable or unduly burdensome.
- Amend 7 Texas Transportation Code (Tex. Transp. Code) § 545.454 to require LEIPs as a condition of deployment and mandate training for first responders.

- Collaborate with the Commercial Vehicle Safety Alliance (CVSA) and the American Association of Motor Vehicle Administrators (AAMVA) to draft federal standards for AVs (including trucks) that inform federal rulemaking.
- Evaluate and resolve conflicting laws governing AVs and transportation network companies (TNCs).
- Amend the TNC law to account for the fact that digitally prearranged rides could be provided by a driver or a vehicle equipped with an automated driving system (ADS).
- Amend the Texas statutes that extend immunity to HERO personnel by expanding the definition of first responders in Texas Civil Practice and Remedies Code (Tex. Civ. Prac. Code) § 78A.
- Add a provision to 7 Tex. Transp. Code Subtitle C Subchapter J to clarify that autonomous trucks are subject to state CMV safety laws.

Texas State Operations

Operational policy suggestions at the state level included the following:

- Maintain formal channels of communication between the government and AV companies through the Texas Connected Autonomous Vehicle (CAV) Task Force.
- Establish a formal means of public reporting for AV-involved incidents and provide information about such incidents statewide via publicly accessible data tracking.
- Continue collaboration with other state agencies and local governments.
- Establish statewide guidelines for AV companies.
- Coordinate and standardize in-person training conducted by AV companies to familiarize all first responders with AVs that will operate on Texas roadways.
- Adopt and implement CVSA's Enhanced CMV Inspection Program for Autonomous Trucks.

Task 4: AV Summit

In April 2024, TTI and TEEX hosted a first-of-its-kind summit, bringing together autonomous vehicle developers, researchers, regulators, and first responders. The goal of the *First Responder Interactions with Automated Vehicle Summit* was to bring together stakeholders to develop information for subsequent tasks, specifically the development of interaction scenarios and best practices and the review of existing interaction plans and guidance to support development of a first responder guide for AV interactions. Summit participants engaged in a positive, collaborative set of discussions that resulted in significant findings that the project team utilized for further tasks.

The following were common points of discussion across breakout groups and in the larger group:

- The need for a two-way information-sharing portal that:
  - Communicates roadway and traffic management center (TMC) information to AV companies from first responders and vice versa.
  - Allows for the exchange of information regarding issues and solutions between industry and first responders.
- Issues involving AVs and human-directed traffic; standard hand and arm signals for human-directed traffic in Texas, as defined in the Texas Administrative Code (Tex. Admin. Code), may not be adequate for AVs.
- First responder difficulty identifying AVs and obtaining contact numbers for vehicle operators; wait times to reach remote operators or emergency contacts may be lengthy.
- Standardization of training and procedures for industry and first responders rather than each company and jurisdiction developing separate training and procedures.

- First responder ability to determine autonomy status (i.e., autonomy engaged indicator lights) and manually override/disable autonomy.

Task 5: Catalog of Scenarios and Best Practices

Several recommendations emerged during Task 5's work and previous task efforts. Several recommendations correlated to efforts occurring during this project, including the establishment of new first responder advisory councils to the AV industry/associations and ongoing federal-level efforts to explore some of this project's same issues related to automated CMVs. These early-stage efforts may play a role in addressing some of the needs identified below:

- Creation of established forums for the exchange of information between first responders and AV developers to address scenarios and best practices as they develop.
- Involvement of law enforcement and fire training standard authorities, like TCOLE and TCFP, in the creation and establishment of training standards and programs for first responders regarding AV interactions.
- Ongoing studies leveraging incident data (as it develops over time) to assess first responder interaction scenario relevancy and the emergence of new scenarios.
- Validation of best practices to determine adequacy to address scenarios identified using first responders in simulated conditions with operational AVs.
- Development of a single source, unified training program for Texas first responders in AV interactions.

Task 5 identified a number of first responder- AV interaction scenarios and developed best practices for addressing those scenarios based on input from first responders and established protocols for such situations involving normal (nonautomated) vehicles, which were reviewed independently by TxDOT and several key stakeholders prior to approval. These scenarios and best practices included the following:

- Conduct a Traffic Stop of an SAE Level 1–3 Vehicle.
- Conduct a Traffic Stop of an SAE Level 4–5 Automated Vehicle (with a Safety Driver).
- Conduct a Traffic Stop of an SAE Level 4–5 Automated Vehicle (without a Safety Driver).
- Conduct Emergency Disablement of an SAE Level 4–5 Automated Vehicle (without a Safety Driver).
- Conduct an SAE Level 4–5 Automated CMV Inspection (with a Safety Driver).
- Conduct an SAE Level 4–5 Automated CMV Inspection (without a Safety Driver).
- Conduct a Vehicle Pursuit of an SAE Level 4–5 Automated Vehicle (without a Safety Driver).
- Respond to an SAE Level 4–5 Automated Vehicle with an Incapacitated Passenger.
- Respond to an SAE Level 1–3 Passenger Vehicle Traffic Crash.
- Respond to an SAE Level 4–5 Automated Passenger Vehicle Traffic Crash.
- Respond to an SAE Level 4–5 Automated CMV Traffic Crash.
- Respond to a Sodium- or Lithium-Ion Battery Fire in a Vehicle.
- Conduct Driver/Passenger Extrication from an SAE Level 4–5 Automated Vehicle.
- Complete Texas CR-3 Crash Report Form for Automated Vehicle Involved Crashes.
- Move or Tow a Damaged, Malfunctioning, Abandoned, or Illegally Parked SAE Level 4–5 Automated Vehicle.
- Direct an SAE Level 1–3 Vehicle Under Abnormal Road Conditions.
- Direct an SAE Level 4–5 Automated Vehicle Under Abnormal Road Conditions (with a Safety Driver).
- Direct an SAE Level 4–5 Automated Vehicle Under Abnormal Road Conditions (without a Safety Driver).
- Directing Traffic in a School Zone with Automated Vehicles Present.

Task 6: Catalog of FRIPs/LEIPs

Key findings from a review of catalogued FRIPs/LEIPs included the following:

- An established standard, format, or model design for emergency response guides (ERGs) and FRIPs/LEIPs would improve uniformity and ease of use across all guides reviewed during this project.
- In the absence of such a standard, a guidebook describing their development may assist the AV industry in improving and standardizing the quality and content of their ERGs and FRIPs/LEIPs.
- Such a guidebook may also address the differences in focus between ERGs and FRIPs/LEIPs; FRIPs/LEIPs should focus on how operators and vehicles interact with the transportation network and first responders and ERGs should focus on how first responders interact with vehicles and operators.
- California's standards for FRIPs/LEIPs currently exceed the Autonomous Vehicle Industry Association's (AVIA's) model standard and may provide the basis for a nationwide standard, pending federal or other state action to further define the requirements of AV LEIPs.
- Current FRIPs/LEIPs focus mostly on systems and vehicles under testing and development, which limits the scalability of the solution. As more vehicles and more systems enter the market, the number of FRIPs/LEIPs and ERGs will grow. Without standardization of systems and response measures, this market may exceed the capacity of first responders to account for the many variations between companies and vehicles.
- FRIPs/LEIPs may provide a temporary solution to the problem, but the longer-term implications and changes to emergency response procedures require coordination, standardization, and unified training solutions to meet the needs of first responders.
- An online centralized system or database containing copies of all ERGs and FRIPs/LEIPs accessible to first responders could provide a single, vetted source for responders to obtain manufacturer-specific information in an emergency and a valuable supplement to the first responder guide developed as a final deliverable for this project.
- To maintain such a database/single-source information portal, states could require submission of a FRIP/LEIP, an ERG, and a cut guide (for EVs) as part of any vehicle licensing process.
- Development of a combined ERG for AVs could model the North American *Emergency Response Guidebook* (Pipeline and Hazardous Material Safety Administration [PHMSA], 2024) for hazardous materials emergencies, which groups together materials with shared properties that affect response, thus limiting the number of separate response procedures for a wider array of materials.
- The project team experienced difficulties when contacting or receiving responses from some AV companies. Because an AV company is not required to have a FRIP/LEIP to operate in Texas, failing to submit one for this project is not a deficiency. However, the difficulty in contacting a company representative to discuss submitting a plan for the project could be a deficiency if it affects the ability of first responders to contact companies for nonemergency questions or to conduct coordination efforts. Companies should consider providing both emergency and nonemergency contact information for responders that is not tied to an individual email account that may cease functioning if that individual leaves the company. Some companies already do this; this is a best practice identified during this review.

Task 7: First Responder AV Interaction Guide

The first responder AV interaction guide comprises the following three separate documents, provided to TxDOT as the Product 1 deliverable:

- *Texas Automated Vehicle Recognition Guide for First Responders.*
- *Texas First Responder Guide for Interactions with Automated Vehicles.*
- *Texas Automated Vehicle Operator Contact Sheet* (for official use-limited distribution).

The *Texas Automated Vehicle Recognition Guide for First Responders* provides information to responders to assist them in identifying AVs, their level of autonomy, and important manufacturer-specific information regarding the vehicle (when provided by the company). For AV operators that did not provide information, diagrams, or photos of their vehicles, the researchers developed line art diagrams of generalized AV types to provide some guidance regarding the identification of vehicles.

The *Texas First Responder Guide for Interactions with Automated Vehicles* incorporates the scenarios developed in Task 5 into a ready-to-use manual that responders and their organizations can reference quickly or utilize to develop departmental level policies and procedures. It also contains information of interest to communities on actions they can take to integrate AVs safely into their communities and prepare for their deployment, as well as additional resources of interest to first responders related to AV response scenarios.

The *Texas Automated Vehicle Operator Contact Sheet* is a limited-distribution document for official use only and contains emergency and nonemergency contact information for some of the AV operators in Texas. The contact list does not include this information for every operator in Texas because several operators did not respond to requests for that information and/or do not publish it.

II. LITERATURE REVIEW

When conducting the literature review, the project team examined information gathered during Task 2 of this project. The team analyzed the information to identify commonalities, gaps, and needs across various topic areas, reflected in the subject headings of this chapter.

During Task 2's research phase, the project team examined traditional source materials available through the Texas A&M University System library and online source materials available through the Transportation Research Board's Transport Research International Documentation database, the United States Department of Transportation's (USDOT's) Repository and Open Science Access Portal, Lexis-Nexis, Westlaw, and the Elton B. Stevens Company database. Additionally, team members examined information and safety notices published by the U.S. Department of Energy Vehicle Technology Office, the Federal Highway Administration (FHWA), FMCSA, NHTSA, the National Transportation Safety Board, and the National Fire Protection Association (NFPA).

Project team members also reviewed information published by fleet operators and automobile manufacturers; first responder trade publications; and publications, safety notices, and training materials for first responders published by the International Association of Fire Chiefs, the Fire Safety Research Institute, UL Solutions (formerly Underwriting Laboratories, [UL]), the National Insurance Institute for Highway Safety, SAE International, AVIA, and the Electric Vehicle Association.

The project team listed all source materials gathered and evaluated them according to a simplified high or low relevancy scale. Given the limited published literature on first responder interactions with AVs and the frequency with which new information and publications emerged during the literature review, this document represents a snapshot of information at the time of preparation.

To fully identify issues and concerns for first responder interactions with AVs beyond the information identified in the literature, the project team included an analysis of available NHTSA autonomous vehicle incident data and crash reports in the TxDOT Crash Records Information System (CRIS). The Task 2 literature review team also coordinated with the Task 3 policy and needs assessment team to simultaneously share relevant information gathered.

Additionally, researchers examined traditional media reports and social media regarding AV incidents and AV companies to assess the state of the industry and identify issues. Because any AV company may test their vehicles in Texas without licensing or permission, researchers found it challenging to identify the AV companies operating in Texas. To address this issue, researchers utilized input from the TxDOT 0-7199 Project Monitoring Committee, the Texas CAV Task Force, professional networks, contacts, and web searches.

During later tasks, the project team identified additional companies operating in Texas not captured in the literature review. The original list included only those companies publicly acknowledged to operate in Texas or those known to operate in Texas by the Texas CAV Task Force and TxDOT. Because some AV operators may not publicize or publicly acknowledge their operations in Texas, the list—updated for this final report—was not all-inclusive and underwent several changes as companies entered and exited the state during the performance of this project. This dynamic is likely to continue in the future. Without a licensing regime or other regulatory procedure requiring notification to the state, no list of AV operators in Texas will be all-inclusive.

Researchers searched AV company websites for response guides related to specific vehicles. This material informed the creation of a contact list for the summit conducted during Task 4 of the project and supplied material for creating a first responder AV interaction guide as part of the project's final deliverables. Additionally, upon completion of Task 4 and during Tasks 5 and 6, project team members reevaluated the list of operators and requested information and photos directly from operators in Texas. An updated summary of operators in Texas used for Task 6 was incorporated into the *Texas Automated Vehicle Recognition Guide for First Responders* and the *Texas First Responder*

Guide for Interactions with Automated Vehicles developed in Task 7, replacing the list of operators provided in the technical memorandum provided to TxDOT upon completion of Task 2 and 3 (prior to the Task 4 summit).

DEFINITION OF AUTONOMY

A vehicle's level of autonomy relates to its capacity to operate and navigate with limited or no human intervention. SAE International created an evolving framework consisting of five distinct levels of autonomy. These levels, outlined in SAE J3016 *Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles* (SAE International, 2021), represent a hierarchical advancement in automation based on the extent to which the motor vehicle can independently perform driving tasks (see Figure II-1).

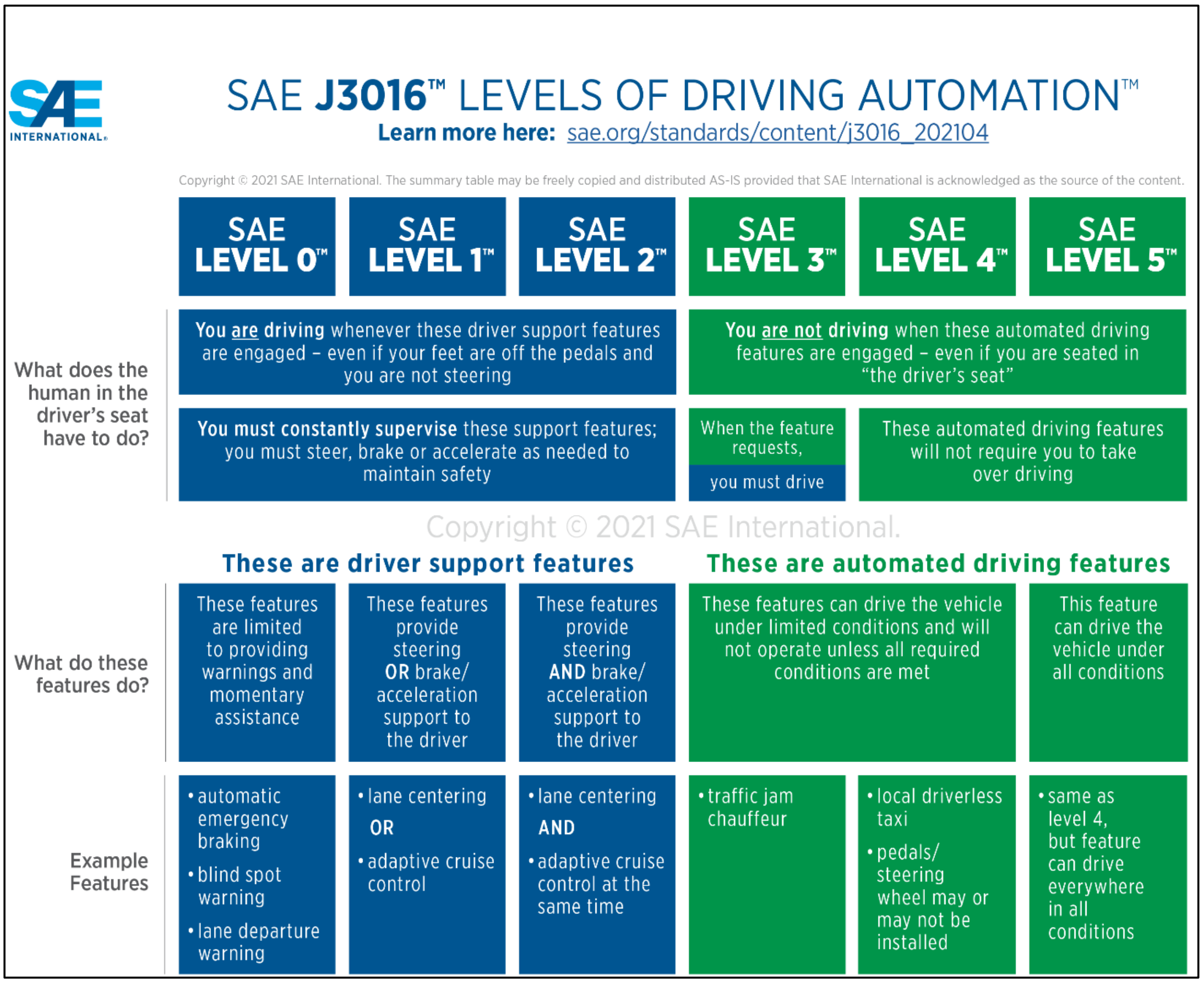


Figure II-1. SAE J3016 Levels of Driving Automation (SAE International, 2021).

Manufacturers, developers, and federal and state regulators use SAE International's automation levels to describe the vehicle development stage. Additionally, since April 2023, law enforcement officers must identify a vehicle's level of autonomy when preparing Texas crash reports for submission into the state's CRIS database (TxDOT, 2024).

SAE International's Five Levels of Driving Automation

SAE International's defines the five levels of driving autonomy as follows:

- **SAE Level 0—No Driving Automation**: The human driver performs all vehicle tasks and must always remain aware. The driver may still receive assistance from active safety features such as blind spot and lane departure warnings.
- **SAE Level 1—Driver Assistance**: Certain vehicle operation tasks, such as steering or braking, are automated, but the driver remains engaged and responsible for overall vehicle operation.
- **SAE Level 2—Partial Driving Automation**: Multiple vehicle operations, such as steering and braking, are automated, but the driver remains attentive and ready to intervene and take full control.
- **SAE Level 3—Conditional Driving Automation**: The vehicle can manage most aspects of driving in most operating environments, allowing a driver to disengage from monitoring. However, the driver must prepare to intervene if necessary.
- **SAE Level 4—High Driving Automation**: The vehicle can perform all driving tasks without requiring human intervention. However, human control may still be necessary in a limited number of circumstances.
- **SAE Level 5—Full Driving Automation**: Without human intervention, the vehicle can perform all driving tasks across all conditions and environments. A human presence within the vehicle for oversight or control is optional.

Currently, no vehicles available for sale to consumers meet SAE International's requirements for Level 4–5 autonomy. However, many auto manufacturers recently released vehicles—or provided firmware updates for existing vehicles—that can enable SAE Level 2 or 3 autonomy for limited driving conditions (NHTSA, n.d.).

Level 2+ and SAE Level 3 Autonomy

Level 2+ Autonomy

The transition from SAE Level 2—Partial Driving Automation (i.e., an alert human operator is responsible for all motor vehicle operations) to SAE Level 3—Conditional Driving Automation (i.e., a human driver can temporarily disengage from the driver operation) marks a significant leap in required capabilities of AVs. The difficulty in achieving this transition prompted some industry officials to introduce an unofficial Level 2+ or 2-plus that bridges the stages of automation (Brooke, 2020). A vehicle equipped with Level 2+ driving systems enables a driver to delegate some parts of the driving operation in some circumstances (e.g., on limited access highways in clear weather).

However, a driver using a Level 2+ system must remain fully alert and be able to intervene and take control at any time. As of 2024, no manufacturer is currently using the terms *Level 2+* or *2-plus* to advertise the capabilities of their vehicle. Tesla, who previously stated it would be able to provide an SAE Level 3–5 autonomous system by the end of 2021, still markets its Full Self-Driving (Supervised), Autopilot, and Enhanced Autopilot systems as only capable of SAE Level 2—Partial Driving Automation (Hyatt, 2021; Tesla, n.d.). In 2023, NHTSA issued a recall of Tesla's Model 3, S, Y, and X vehicle software, prompted by concerns about insufficient controls to prevent driver misuse of the Autosteer technology (Krisher, 2023; NHTSA, 2023).

Tesla updated its Autosteer software packages to incorporate additional measures to detect when drivers remove their hands from the steering wheel for extended periods or become inattentive (NHTSA, 2023). However, concerns remain about the Autosteer feature regarding the degree to which the solution addressed driver attentiveness as well as the system's lack of geofencing to prevent activation outside of controlled access highways (Krisher, 2023). In comparison, other SAE Level 3 vehicles in the United States operating in California and neighboring states are geofenced based on mapped roads, like the systems utilized by current SAE Level 4 operators in Texas (KVUE Staff, 2024; Mercedes-Benz, n.d.).

Problematically, drivers may treat SAE Level 2 and Level 2+ vehicles as SAE Level 3 or higher. Several methods to defeat hands-on wheel detection and other driver detection defeat devices remain available via popular online ordering websites (Gilboy, 2024). Drivers also complain about measures designed to detect driver inattention and about SAE Level 2 systems performing poorly because drivers believe the system is capable of Level 3 or higher performance (Irwin, 2024). For example, a complaint filed with NHTSA by a 2021 Tesla Model Y owner noted that the autopilot feature lost control in the rain and swerved off the road at 80 mph. In addition to driving at an unsafe speed in wet conditions, heavy precipitation is a significant limitation for current SAE Level 1 and SAE Level 2 systems due to interference with forward-facing sensors, as noted by most manufacturers in their instructions to drivers (Irwin, 2024; NHTSA, 2024a; Tesla, 2024).

In September 2024, Tesla rebranded its Full Self-Driving mode as *Full Self-Driving (Supervised)* and updated its marketing to emphasize that vehicles equipped with the service "will be able to drive itself almost anywhere with *minimal driver intervention*" (Volenik, 2024). This change in the services name and the newly added disclaimer text suggests an effort to clarify the system's capabilities to drivers who may have otherwise misused the software in situations for which it is currently unable to operate safely.

SAE Level 3 Autonomy

SAE Level 3 autonomy enables the vehicle control unit to control the driving operation under limited conditions. Still, the driver must remain alert and able to take control of the vehicle when prompted. The limited introduction of SAE Level 3 vehicles to the consumer market in 2023 marks the beginning of a potential transformation concerning the interactions between first responders and AVs. As of January 2024, only four operators had regulatory approvals from national or subnational governments to market Level 3 ADS-equipped vehicles to consumers (see Table II-1).

Table II-1. Commercially Available SAE Level 3–4 AVs.

Manufacturer	ADS Name	Government(s) Granting Approval (Year)
BMW	Personal Pilot	Germany (2023)
Honda	Honda Sensing Elite	Japan (2021)
Hyundai	Highway Driving Pilot	South Korea (2023)
Mercedes-Benz	Drive Pilot	Nevada (2023), California (2023), China (2023), Germany (2024)

This number may increase as more manufacturers seek and receive government approvals for SAE Level 3 consumer sales, although timelines slipped recently to accommodate a more extended rollout for SAE Level 4 and 5 (McKinsey and Company, 2024).

In June 2023, the California Department of Motor Vehicles (DMV) authorized Mercedes-Benz to offer its Drive Pilot system for use on public roadways, allowing the company to market its system as the first SAE Level 3 conditional ADS available to consumers (California DMV, 2023; Mercedes-Benz, 2023). While this is the first ADS available for consumer purchase in the United States, drivers may only enable the software in limited conditions (i.e., traveling over 40 mph on public freeways with low-density traffic). Additionally, the features are geofenced so that the SAE Level 3 system will only function on roads within the vehicle's operational design domain (ODD). As of 2025, Mercedes-Benz markets the system to consumers in California and Nevada; however, Mercedes-Benz intends to expand system availability to consumers in other markets soon (Hawkins, 2023).

Outside of the United States, other companies also obtained regulatory approval for SAE Level 3 AV consumer sales. In the fall of 2023, the Deutsches Kraftfahrt-Bundesamt (German Federal Motor Transport Authority) approved BMW's Personal Pilot system for sale to German consumers (Boeriu, 2023). Similarly, the governments of South Korea and Japan approved SAE Level 3 autonomy systems developed by Hyundai and Honda, respectively (Bishop, 2024). As of the writing of this report, none of these operators had a timeline for SAE Level 3 vehicle approval and introduction to consumers within the United States (Slovick, 2023).

Currently, dealers do not offer consumer-owned SAE Level 3 AVs for sale in Texas. However, they will eventually appear on Texas roadways. Consumers can also travel into Texas with a California- or Nevada-purchased SAE Level 3-capable Mercedes-Benz AV, although the system should not function at SAE Level 3 outside of the vehicle's current ODD (the vehicle's ODD may expand over time and eventually include parts of Texas). Further, several developers and start-ups test SAE Level 3 and higher systems in Texas (with or without safety drivers).

Driving and Driver Assistance Systems

A simplified taxonomy for AVs makes only two distinctions: ADAS and ADS. These terms—used by various authorities such as NHTSA and as shorthand by manufacturers and developers—combine SAE Levels 1 and 2 (and 2+) into ADAS and Levels 3–5 into ADS. However, these distinctions may blur. For example, NHTSA mixes reports from SAE Level 2 vehicles with ADAS vehicles in its reporting system but codes them differently (NHTSA, 2024b). Likewise, some debate exists regarding whether Level 2+ is SAE Level 2 or SAE Level 3.

ADAS

ADAS encompasses various potential features and functionalities, including warning systems, automatic braking, lane keeping, and adaptive cruise control, augmenting parts of vehicle operation without human intervention. Vehicles with ADAS capabilities aid in driving, and a human driver must always remain fully aware and in charge of the vehicle. Per 7 Tex. Transp. Code § 545.451, ADAS-equipped vehicles are not AVs.

ADS

Per 7 Tex. Transp. Code § 545.451, all ADS-equipped vehicles are AVs. An ADS is a more advanced level of automation. ADS-equipped vehicles include a wide range of software and hardware, including lidar, computer-vision cameras, and external sensors that can process and interpret environmental and roadway conditions. At SAE Level 3 autonomy, vehicles operate under limited automated control and drivers must maintain awareness and perform some part of the driving. As ADS capabilities progress to SAE Levels 4 and 5, human involvement diminishes, and vehicle control systems can complete more of a trip without any human input.

Autonomy in the Texas Transportation Code

With the rapid advancement of AV technology, federal and state policymakers created legislation and regulations defining AVs and establishing their usage. As of 2020, 29 states passed legislation (and 7 governors issued executive orders) authorizing the testing and consumer use of AVs with some level of autonomy along public roadways (National Conference of State Legislatures, 2020).

> During the writing of this report, the Texas Legislature met to consider changing the transportation code governing AV operations in Texas. Consequently, the information presented here may not reflect current regulations.

Some commonalities between these regulatory structures exist. For example, states with AV-related laws use language mirroring the SAE and NHTSA definitions of AVs. However, states differ in their approaches regarding which state agency or department can make additional regulations, the extent to which the vehicles may operate, and where they may operate. States also differ regarding liability for owners, operators, occupants, and vehicle repair mechanics.

Texas lawmakers first passed legislation authorizing and regulating AVs in 2017, when the 85th Legislative Session passed House bill (HB) 1791 and Senate bill (SB) 2205 (Stoeltje et al., 2017). A more limited piece of regulatory legislation, HB 1791, authorized the use of connected braking systems—a feature of platooning trucks that coordinates braking among vehicles. SB 2205 established an autonomous vehicle regulatory regime into state law under the Texas Transportation Code. Significant provisions of SB 2205 included:

- Defining terms related to the operation of AVs (and what distinguished these systems and vehicles from vehicles with human operator[s]).
- Authorizing the use of AVs on Texas roadways with or without a human driver.
- Initially granting Texas DPS exclusive oversight and authority over AVs and preempting municipal jurisdictions from taking independent regulatory actions related to AVs. In 2021, the Texas Legislature amended the code to remove reference to Texas DPS; the code now states "governed exclusively by: [1] this subchapter."

Under 7 Tex. Transp. Code § 545.451, any AV designated SAE Level 3 and above is an ADS. Vehicles with the capabilities needed to meet SAE Levels 1 and 2 for partial autonomy (e.g., adaptive cruise control, lane correction), are not automated vehicles under Texas law. According to 7 Tex. Transp. Code § 545, automated vehicle systems encompass both the hardware and software that collectively have the ability—without human intervention—to manage "all aspects of the entire dynamic driving task for the vehicle on a sustained basis" and to execute "any fallback maneuvers necessary to respond to a failure of the system."

To meet this definition, equipped motor vehicles must be able to execute essential motor vehicle operations such as steering, braking, accelerating, and monitoring the vehicle and roadway. Additionally, the vehicles must manage the drive operation's tactical aspects, including responding to events, making lane changes and turns, using and responding to signals, and otherwise complying with all existing rules of the road.

CONTEXTUALIZATION OF AV INTERACTIONS WITH FIRST RESPONDERS

AVs represent a critical technological leap in transportation, integrating artificial intelligence (AI), sensor technology, and advanced computing systems into consumer vehicles. The transition from traditional automobiles and trucks to AVs has the potential to revolutionize our perception of highway and intercity mobility. The potential impacts could parallel the impacts of the earlier transportation revolution in the 20th century during the second industrial revolution when the United States transitioned from horse and steam-powered transportation to automobiles and internal combustion engines. Today, AV technology and electrification mark a new revolution with far-reaching consequences for the entire transportation system of the United States.

Such revolutionary changes—even if they take many decades to reach their full potential—also create significant implications for the role and duties of first responders working to protect the safety of the public amidst such change. As a historical example, the role of traffic policing emerged in the 1920s in the United States as automobiles reached mass adoption. AVs/CAVs may reduce the need for traffic enforcement over time as fewer and fewer vehicles have human operators and the number of traffic violations and crashes decrease.

Such changes remain in a more distant future. The interim period—much as experienced throughout the 20th century—poses unique and uncertain safety challenges for communities, drivers, and responders. The previous period of vehicle safety development and the system of traffic enforcement in the United States evolved significantly between the 1908 introduction of the Ford Model T and the present. Twentieth century transportation history includes several significant milestones like the criminalization of traffic offenses and the introduction of traffic policing in the 1920s, the creation of the interstate highway system in 1956, and improved vehicle safety regulation following the publication of Ralph Nadar's *Unsafe at any Speed* in 1965.

The ongoing revolution in transportation around AVs/CAVs and electrification will again change transportation in many significant and unforeseen ways, marked by significant shifts in infrastructure, policing, and vehicle design. The United States is still in the earliest phase of that revolution, and like the preceding era, it poses significant safety challenges for drivers and first responders. During this literature review, the following two key factors emerged that limit understanding of the current challenges:

- **Data issues:** Researchers and governments currently maintain a century's worth of data and study human driving behaviors and crash statistics in all types of driving conditions, roadways, and weather. Vehicle design and safety regulation after 1965 dramatically increased vehicle occupant safety. Road infrastructure, signals, and safety measures designed to increase the survivability of crashes all advanced significantly over the past century. Conversely, data on AV-related operations are minimal by comparison. Significant amounts of data are controlled by manufacturers who may not release internal data on their system's performance that they consider proprietary. AV companies closely guard their unique AV control system designs as each developer seeks competitive advantage in the emerging marketplace. AV operations (SAE Level 3–5) currently occur in limited environments (e.g., urban streets in San Francisco or Austin) or on defined routes (e.g., AV truck corridors). AV accident data are largely anecdotal and unique to the circumstances of current testing, making comparisons to the voluminous data and studies on human driving safety problematic at best (like comparing apples to oranges).
- **Robot mistakes:** The control systems for AVs can respond incorrectly (i.e., make mistakes) to detected conditions if the system programming does not adequately address the situation. Given the number of tests and evaluations for AVs currently underway, this potential for error is not surprising. Further, from the admittedly limited available data, AVs can and do cease to function in novel situations or act unpredictably in ways human drivers would not.

Robot mistakes are unique to AVs. Human drivers in similar situations can rely upon experience and knowledge to devise a solution, while fallback measures for AVs might lead the vehicle to stop in traffic or take other actions that a human might not. Human responses are not always perfect, but humans can adapt their responses as they identify novel situations.

By comparison, AV responses are both perfect and perfectly consistent. They can only act as their programming and training model instruct them to act. For example, a human driver may not see or ignore instructions from a human directing traffic. Still, most humans can and will follow such instructions, even in a confused or chaotic situation. Current AVs struggle in such situations, even straightforward ones. The software cannot make the intuitive leaps a human can, it can only react according to its programming. Until a novel situation arises, developers may not know the system's limitations. Once informed, developers can quickly implement a solution for such situations; however, such a solution may introduce additional novel situations. For example, the implementation of the pull-over maneuver by Cruise to address concerns about stopping in traffic (an identified problem) led to further injury of a pedestrian that ended up beneath Cruise vehicle after they were struck by another driver. The AV then executed the pull-over maneuver in accordance with its programming following detection of a *minor* collision with no way of detecting or understanding that the individual was underneath the vehicle, thus dragged them some distance.

Adaptations to AV operational and crash data collection will help provide better performance comparisons between AV control systems and human drivers. Recent modifications implemented in April 2023 to the TxDOT CR-3 form and the corresponding instructions to police for reporting crashes

(CR-100)—initially released in October 2023 with the latest version published in September 2024—provide law enforcement officers with clearer guidance on documenting crashes. These updates will likely improve data quality over time, allowing for more accurate comparisons of AV performance against human drivers and aiding in the identification of AV issues and limitations.

However, until the dataset grows and data quality improves, any comparisons between human driver performance and AV performance must ensure that the comparisons are correct and based on the same or similar datasets, avoiding an apples-to-oranges comparison. Improvements in data quality will eventually help highlight robot mistakes and assist in resolving the underlying issues unique to AVs. Distinguishing them from human-driver issues will become easier. AVs will operate more widely and in more conditions, generating more data that will allow for better comparisons to human drivers. However, given the speed with which AV developers can correct such mistakes, data analysis of AV incidents should also show more rapid shifts away from identified robot mistakes than with human-based errors, some of which were problematic for most of the last century and continue to be problematic today.

Robot mistakes have a growing operational and safety significance in AV development and will continue to form a major focus for AV developers for the foreseeable future. Testing and evaluations are part of the iterative process of system improvement. While the situations that create robot mistakes are not new, they are novel for AV systems. No developer can anticipate every situation, and the solution to a robot mistake may be different from human driving behavior.

Just as human drivers adapted to changing conditions over the last century, so too must AVs. In the early days of the automobile, one major type of crash involved motor vehicles striking horse-drawn carriages and pedestrians. These occurrences led to opposition to early automobiles as inherently dangerous (Norton, 2011; Seo, 2019). Eventually, opposition diminished as the automobile increased its share of road users and the horse-drawn carriage disappeared from roadways outside of a few religious communities (where vehicle versus horse-drawn carriage crashes still occur).

Likewise, the rules of the road for those early 20th century drivers did not exist, nor did any enforcement mechanisms to ensure compliance with those rules. Police departments began to expand in size and assume more responsibility for vehicular traffic enforcement (Norton, 2011; Seo, 2019). Traffic enforcement over the next century fundamentally changed policing in the United States to the point where the traffic stop became one of the primary interactions between law enforcement and the public (Seo, 2019).

Because AVs may diminish the need for traffic enforcement, another sea-change in traffic policing may occur over time. In Berkeley, California, change is already underway to address concerns about equity in traffic enforcement. The Berkeley Police Department was a national leader in the 1920s shift to policing traffic, and the city is now one of the first to attempt to shift traffic enforcement to a municipal transportation agency, the Berkeley Department of Transportation (Raguso, 2021).

However, current California law does not authorize civilian enforcement of the traffic code. In the 2023–2024 California legislative session, a bill to authorize civilian enforcement passed through committee but died on the floor. Still, as AVs expand their market share, it is likely that traffic enforcement will fundamentally change, and that change may involve a shift in traffic code enforcement. The challenge in the interim—much like that faced by cities and states in the early 20th century—is how to address the situation in which the old and new mix.

In many ways, the period of automotive development in the 1920s mirrors our own when it comes to AVs. Innovative technology operates in an environment where the rules, vehicle designs, and vehicle features are in flux. Further, these new vehicles exist within an environment still dominated by the preceding generation of motive transport. The interactions between these two systems (human versus AV) are like the interactions in the early 20th century (horse/pedestrian versus car).

AV systems may trigger unforeseen changes beyond the vehicle, including changes to roads, signage, legal liability, insurance, and traffic enforcement, just as the early 20th century adoption of the automobile changed infrastructure requirements to accommodate the new technology and make it safer. Such changes may also attract significant media attention and some level of public opposition, much as it did in the early 20th century (Norton, 2011). This opposition is already occurring with attacks against AVs, as discussed later in this document.

While engineers and developers can adapt their systems to prevent robot mistakes in the future at a faster pace and more uniformly than humans adapt to change, it is likely that AVs will continue to make novel mistakes for an extended period (at least several decades, if not more). In comparison to the earlier era, it was 57 years from the introduction of the Model T in 1908 to the publication of Ralph Nader's *Unsafe at Any Speed* that marked the beginning of change in automotive safety engineering and regulation.

Widespread adoption of the automobile also took decades. Public funding for highways and the development of the interstate highway system was mostly a post-World War II development, marked by significant changes to road infrastructure and standardization with the creation of new federal regulatory agencies. Standardization of traffic control devices began in 1935 with the publication of the first *Manual of Uniform Traffic Control Devices for Streets and Highways* (MUTCD). That change continues today, with the publication of the 11th edition of the MUTCD in December 2023. Future editions of the MUTCD will include increased traffic control measures designed for AVs, rather than the human operator focus of present standards.

AV development is currently in a phase where some risks remain unknown, much like automobile development in the early 20th century. Few AV injury crashes occur because relatively few SAE Level 3–5 AVs are currently in operation, but that number will change as the industry moves from development into production. While there are no known fatalities currently blamed on SAE Level 3–5 AVs, a serious injury did occur in San Francisco, California, in 2023. Note that several fatal crashes appear in crash data involving vehicles with ADAS/Level 2+ systems, although the ADAS causality of the crash is disputed. This report describes the related issue of drivers treating ADASs as ADSs, resulting in crashes. Further, as more AVs operate on American roads, it is not a question of *if* an AV will kill a human driver or pedestrian, it is a question of *when*. Fortunately, the nature of the technology may result in far fewer fatalities and serious injuries than in the early 20th century, which saw a much higher serious accident rate than the present (Norton, 2011).

Such crashes may not prevent AV development any more than the death of pedestrians, horses, and carriage riders prevented the adoption of the automobile. In fact, while AVs may eventually produce fatal crashes, the repeatability of those crashes will likely diminish at a much faster pace than the decline in crashes associated with any change in human driving since the Model T appeared on American streets in 1908.

In other words, while serious injuries and fatalities may occur associated with AV development, they may result in fewer deaths over shorter periods as AV engineers adapt their systems, states make infrastructure changes, and both states and the federal government increase regulatory oversight to address the causal factors. Simply put, it is much easier to fix a robot mistake by pushing out a software update than it is to fix the same human errors that persist despite 116 years of effort.

While time will take care of the data problem, and engineers can address robot mistakes when they occur, the greatest period of danger for humans interacting with AVs—either as fellow road users or as first responders—is the current period, and that will continue for several decades as AV technology and adoption advances.

EXPLORATORY AV CRASH DATA ANALYSIS

As previously noted, data issues pose severe challenges for evaluating present performance. Further, due to the nature of AV development and the speed at which engineering solutions can resolve issues resulting in crashes or near crashes, any analysis of AV-involved crash data are rearward facing and may include issues AV companies addressed since the crash.

For example, human driving behaviors and mistakes appear repeatedly in crash data. Human drivers still drive drunk, tired, or distracted and make poor judgments about speed and road conditions—all reflected in decades of crash data. Educational efforts and safety engineering can only reduce such mistakes so much over extended periods of time given the resistance of collective human behavior to change. Conversely, once developers identify a robot mistake, engineers can quickly develop and implement a solution across an entire ADS fleet to prevent its recurrence.

Crash data analyses during this current AV developmental period typically reflect issues that manufacturers and engineers need to address as well as issues already addressed. At present, only the manufacturers know which issues they remedied and which issues still require actions, unless NHTSA orders such remedies. This occurred, for example, with Tesla recalls in December 2023 and January 2024 (since the original literature review, NHTSA opened several new investigations of Tesla vehicles not reflected in this research report).

AV-involved crash data limitations also exist, both in quantity and quality. The two primary sources of data examined during this literature review included the NHTSA data related to NHTSA's *Standing General Order on Crash Reporting for Incidents Involving ADS and Level 2 ADAS* for manufacturers and operators (NHTSA, 2024b) and the Texas CRIS database. Both sources contain data issues.

NHTSA notes its data come with the following data issues/limitations:

- Reporting requirements are different for an ADS and Level 2 ADAS.
- Access to vehicle crash data may affect crash reporting (due to wide variances in data and telemetry captured and reported by manufacturers and ADSs, and the timeliness of those reports).
- Incident report data may be incomplete or unverified.
- Data may include redacted confidential business information and personally identifiable information.
- The same crash may have multiple reports.
- A lack of norming exists in summary incident report data.

Texas CRIS data issues and limitations include officer reporting errors on the CR-3 forms, some of which are attributable to confusion regarding recent changes to the CR-3 form and CR-100 instructions. The new CR-3 form and CR-100 instructions includes fields and codes for AV-related reporting, but many law enforcement officers do not have training on the new crash report yet. This lack of training led to errors in reporting related to the level of autonomy.

For example, *unknown* autonomous level engaged was the most frequently used code (6=unknown) based on recent CRIS data (see Table II-2). In instances where an officer reported an autonomous unit present on the vehicle (1=yes in field 8), *unknown* autonomous level engaged was marked in nearly half (45.5 percent) of all reports.

Table II-2. Autonomous Level Engaged during Crash Based on CRIS Data (As of August 29, 2024).

Autonomous Level Engaged	1	2	3	4	5	6	Total
Number of Responses	546	375	22	2	4	1,630	**3,579**

Prior to May 2023, the CR-3 had no field for AV-involved crash reporting, so identifying AV-involved crashes in the older data is difficult. The new CR-3 form also has no field that indicates an AV-involved crash. Instead, the new CR-3 form includes a field that identifies a vehicle as an AV. Further, while the CRIS theoretically contains most ADS- and ADAS-involved crashes in Texas meeting the crash reporting threshold (crashes on public roadways that result in an injury, death, or $1,000 in damages), the NHTSA data do not include Level 1 ADAS crashes. Note that the CRIS database and CRIS data analyses do not include all vehicle crashes; many crashes do not meet the estimated damage threshold for reporting, occur on private property, and/or are not reported based on officer and/or jurisdictional discretion. Further, crash reporting quality and compliance can vary across jurisdictions, and some crash reports—due to data entry errors—may end up excluded from analyses. Considering these factors, analysis of AV crash data from the NHTSA and Texas CRIS databases revealed the following issues of relevance to first responders and crash data researchers:

- **SAE Level 2 automation confusion:** Consumers buying vehicles with SAE Level 2 automation may believe their vehicle offers more capabilities than it does. leading to drivers using ADAS features on roadways and in situations where the systems are ill equipped to operate safely. Further, drivers may engage in other activities or distractions that limit their ability to intervene in emergencies.
- **Record matching:** Researchers matched 85 of the 122 (70 percent) Texas AV crash incidents in the NHTSA database to CRIS records using the year, month, 11-digit vehicle identification number, and city. The city link required a manual review of the data due to the different methods of finding the event in the two datasets. If the NHTSA data included a narrative, comparison to the CRIS narrative allowed validation of the linkage. Limiting the researchers' ability to link the data, the NHTSA data included only the month and year (not the day) of crash and the times reported for the crashes were difficult to correlate between the NHTSA and CRIS databases.

Level 2 ADAS Crash Data Analysis

Of the 122 linked crashes, 69 crashes (57 percent) involved an ADAS unit. These crashes included 1 fatal crash, 6 suspected severe injury crashes, and 62 minor or no injury crashes (51 percent). Table II-3 lists the count and percentage of ADAS vehicle-involved crashes by crash severity.

Table II-3. Texas ADAS Vehicle Crashes (January 2021–August 2023).

Crash Severity	Crash Count	Percentage of Total Crashes
Fatal Injury	1	1.5%
Suspected Serious Injury	6	8.7%
Suspected Minor Injury	15	21.7%
Possible Injury	13	18.8%
Not Injured	34	49.3%
Total	**69**	**100.0%**

Researchers analyzed the crashes identified in Table II-3 and identified the following information as significant:

- The fatal crash was an angular crash resulting from the ADAS unit not yielding the right-of-way at an intersection. The crash occurred at an intersection with a stop sign and on a rural roadway with a speed limit of 55 mph or higher. The crash occurred during daylight hours, and visibility was not an issue. The ADAS vehicle was a personal vehicle and crashed into a heavy truck.
- The six serious injury crashes included two single-vehicle crashes and four multivehicle crashes. All occurred during daylight hours. Four crashes were the result of actions taken by the ADAS vehicle or its driver. Three of the six crashes were intersection-related crashes on

roadways with speed limits of 40 mph or higher and the result of the actions of the ADAS vehicle or its driver.
- Both single-vehicle serious injury crashes had narratives that indicated the loss of control of the ADAS vehicle. One crash incident narrative from the NHTSA database indicated that the driver claimed they activated the Lane Tracing Assist. However, the event data recorder and the vehicle control history showed that the Dynamic Cruise Control and the Lane Tracing Assist were not engaged. Both crashes occurred in areas defined as urban by TxDOT.
- There were 76 minor injury, possible injury, or noninjury crashes. Among these crashes, 34 percent were single-vehicle crashes, and 66 percent were multivehicle crashes. Most (91 percent) were single-vehicle crashes that crashed off the roadway. Approximately one third (23 crashes or 35 percent) of the multivehicle crashes involved vehicles traveling in the same direction, resulting in rear-end and sideswipe-type crashes.
- All ADAS units in these crashes were personal or rental vehicles.

SAE Level 3–5 ADS Crash Data Analysis

The linked CRIS/NHTSA crash dataset included five crashes involving ADS vehicles. Crash reporters reported no injuries related to the crashes, and all crashes involved more than one vehicle. All crashes occurred on the roadway. Two crashes involved cars running remotely without a driver in the unit, and the other crashes involved Class 8 tractor-trailers. Reports indicated that none of the ADS vehicle actions caused the crashes. Table II-4 lists typical characteristics of the crashes based on ADS unit type.

Table II-4. Common Characteristics of ADS-Related Incidents.

ADS Unit (No. of Crashes)	Vehicle Body Style	Driver Type	Collision Type	Location	Speed Limit
ADS-Car (2)	Four-door car	Remote	Angle, intersection-related	Urban area	25 mph
ADS-Truck (3)	Class 8 truck tractor-trailer	In-vehicle	Same-direction	Rural area	≥60 mph

Researchers analyzed the five crashes involving ADS vehicles and identified the following information as significant:

- Two ADS-truck crashes occurred after the safety driver disengaged the ADS in response to events on the roadway in front of them. These crashes resulted when vehicles behind the ADS-equipped trucks failed to control their speed and rear-ended the ADS-equipped trucks. The other ADS-truck crash resulted when a tandem tractor-trailer truck moved into the ADS-equipped truck's traffic lane before sufficiently clearing the vehicle.
- The two crashes involving ADS-equipped cars did not have drivers in the vehicles. In both incidents, the other vehicles disregarded a signal light displayed in their direction of travel and struck the ADS-equipped cars in the intersection.

Other AV Crashes

The remaining 11 vehicle crashes in the dataset included personal or rental vehicles not identified as ADAS or ADS but suspected as ADAS. These 11 crashes included one fatal crash, one suspected severe injury crash, and nine minor or noninjury crashes. Researchers identified the following information as significant:

- The fatal crash occurred at an intersection on a roadway with a 45-mph speed limit. The suspected ADAS vehicle was not part of the first harmful event in the crash and was not related to the fatality in the crash. The driver stated that the Lane Keep Assist System and Adaptive Cruise Control were active during the crash.
- The suspected serious injury crash occurred at an intersection on a roadway with a 35-mph speed limit. The driver of the suspected ADAS vehicle disregarded a stop sign and struck the other vehicle at an angle. The driver stated that the Lane Keep Assist System and Adaptive Cruise Control were active during the crash.
- The remaining nine crashes resulted in three suspected minor-injury crashes, two possible-injury crashes, and four noninjury crashes. Three crashes were single-vehicle run-off-road crashes, and six were multivehicle crashes on the roadway. Six of the crashes resulted from actions by the suspected ADAS vehicle. Table II-5 details the actions of the suspected ADAS vehicle for these six crashes.

Table II-5. AV Incidents Not Classified by Researchers.

Detail	Crash Count
Driver claimed Lane Keep Assist System and Adaptive Cruise Control engaged (unconfirmed in NHTSA data)	2
Driver accidentally disengaged Super Cruise	1
Driver claimed Lane Trace Assist failed when driving over a puddle on the road while it was raining	1
Driver claimed automatic brakes failed while the Lane Keep Assist System and Adaptive Cruise Control were engaged	1
Driver claimed auto drive engaged	1

COMMUNITY RESPONSES TO AV TESTING

As AV testing began in Texas, different communities responded to the challenges presented by AV testing based on lessons learned by the City of San Francisco and elsewhere. In California and Texas, state law preempts local regulation of AV testing. However, California and Texas use different regulatory models for state regulation of AV testing and operation. Texas House Bill 3026 and Senate Bill 2205 created a state-wide permissive model that allows any company to test within Texas. In contrast, 13 California Code of Regulations (Cal. Code Regs.) § 227.38(e) *Manufacturer's Permit to Test Autonomous Vehicles That Do Not Require a Driver*, requires permits for testing and operating AVs through the California DMV. Yet even though states differ in their regulatory approach, the effects on local communities and community response to the challenges posed were similar due to the commonality of state preemption: the formation of safety task forces and tracking of crash data.

Texas CAV Task Force

In 2019, TxDOT created the Texas CAV Task Force to provide the state with a unified resource for information regarding the coordination and advancement of CAV technologies (Texas CAV Task Force, 2024).

Task Force Mission

The Texas CAV Task Force's mission is to prepare the state for CAV advancements by:

- By serving as the primary coordination and information source for CAV technology use and testing in Texas.

- By exploring and serving as the source to inform the public and leaders on current and future CAV advancements and what they mean in Texas.
- By reporting on status, future concerns, and how these technologies are changing future quality of life and well-being.
- By championing Texas as a leader and knowing how to prepare and positively integrate these technologies.
- By promoting positive development and experiences for the state.

Task Force Scope

The Texas CAV Task Force conducts biannual meetings—synchronized with the legislative cycle—to define specified tasks such as tracking surface and air transportation CAV technologies and enablers such as telecoms and future infrastructure. Future considerations could include alternative fuel vehicles/EVs because of their potential as AVs and road-usage charging.

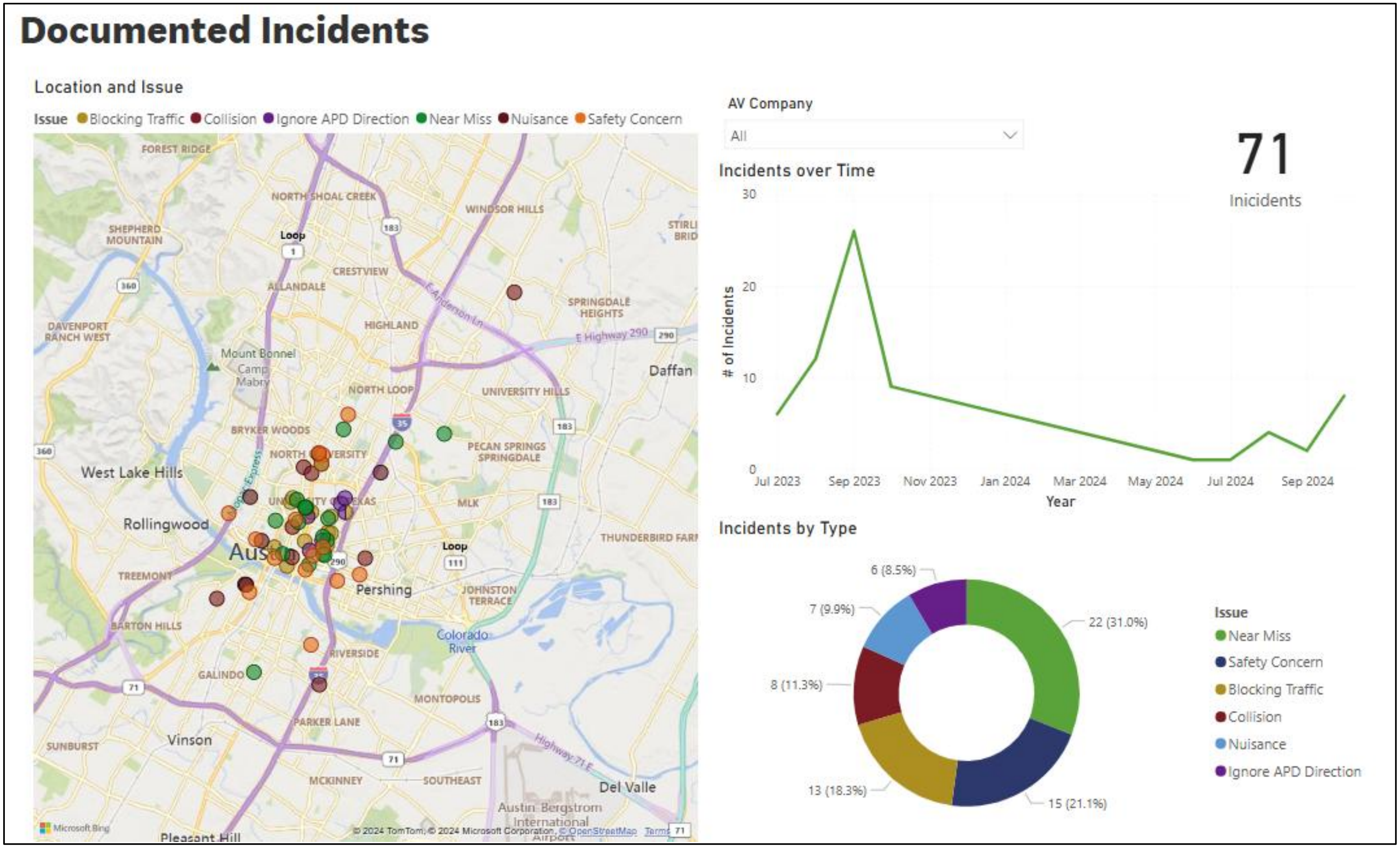
Local AV Safety Task Forces

The Austin Transportation and Public Works (TPW) Department began fielding and tracking citizen complaints and AV-related incidents in the fall of 2023. In September 2023, the city formalized an AV Safety Task Force made up of personnel from the Austin TPW Department, Austin Police Department, Austin Fire Department, and Austin-Travis County Emergency Medical Services (EMS). The AV Safety Task Force provides an information-sharing mechanism across city and county emergency services based on a collaborative approach to identify and communicate AV safety issues in Austin with the public and AV companies (Mendoza, 2023). Specifically, the AV Safety Task Force:

- Collects feedback from residents (via 311, Council Offices, directly to TPW, etc.).
- Collects feedback from public safety (via email and incident reports).
- Gathers data from all incidents and communications to create maps, analyze trends, and communicate issues with AV companies.
- Facilitates training with public safety and AV companies.
- Works with AV companies to improve data, identify safety concerns, communicate about special events, and ensure they have proper charging facilities for their fleets.
- Meets with peer city entities to discuss policy and procedures.

This approach to AV safety at a community level mirrors an approach developed in San Francisco, California. The AV Safety Task Force in Austin communicates and coordinates with similar entities in the United States (Mendoza, 2023). A significant focus for the Austin AV Safety Task Force includes communicating with AV operators about any identified issues, providing data about city facilities like fire stations to coordinate routes and procedures to keep areas around emergency facilities clear, and addressing issues and concerns regarding AV responses to human-directed traffic during emergencies or in construction zones.

Additionally, the AV Safety Task Force in Austin, in collaboration with TTI researchers, developed a centralized website and incident dashboard for reporting incidents involving AVs and sharing information with the public regarding the community's response to AVs operating in the city (see Figure II-2). This dashboard identifies six issues (blocking traffic, collisions, ignoring police direction, near misses, nuisance complaints, and safety concerns) and the reporting source (the public, Austin Fire Department, Austin Police Department, Austin TPW Department, and Austin-Travis County EMS). Most incidents reported in Austin occurred downtown, south of the University of Texas and north of Lake Travis, bounded by Mopac and I-35.



NOTE: A screenreader capable version is available at https://www.austintexas.gov/page/autonomous-vehicles.

Figure II-2. Austin's AV Documented Incident Dashboard (December 2024)

CONCERNS REGARDING FIRST RESPONDER-AV INTERACTIONS

First responders encounter AVs during their duties and interact with them in various routine situations. However, the routine nature of the situation is complicated by actions of the AV or the nature of the crash, which may be novel or new. The procedures and policies governing how a first responder will interact with an AV during their duties are in their infancy—if they exist at all. Many procedures and policies are untried or unproven in practice.

For this review, researchers examined the limited available literature regarding first responders' interactions with AVs and attempted to categorize them into the following general areas:

- **Law enforcement interactions:** Law enforcement officers interact with AVs in traffic enforcement situations when:
  - An AV is the vehicle of concern for a traffic stop.
  - An AV reacts adversely to law enforcement action not involving the AV (e.g., not yielding during officer pursuit or impeding an emergency vehicle enroute to an emergency).
  - Assigning fault/liability during crash reporting and accident investigation when the accident involves an AV.
- **Roadside assistance:** Law enforcement officers, towing personnel, HERO and other assistance providers, and other responders and private contractors interact with AVs experiencing mechanical or other problems on the road or roadside.
- **Accident/incident interactions:** Fire personnel, law enforcement officers, EMS personnel, and other responders interact with AVs at an accident scene (or other event that impacts roadway access, like a roadblock or a housefire) while performing TIM. Potential interactions include:
  - Crashes involving an AV.
  - Accident or other response scenes encountered by AVs where the AV responds adversely to the scene and places responders or other motorists in danger by its actions (e.g., obstructing emergency vehicles, entering an active response scene, or failing to respond to human-directed traffic).
- **General routing and parking impacts to response:** Available information suggests that AVs may struggle to respond appropriately to a variety of situations that impact first responders, including:
  - Impeding emergency response vehicles en route to an emergency.
  - Parking in areas that prevent emergency vehicles from leaving or entering facilities (e.g., fire stations, police stations, medical facilities).
  - Responding to human direction in novel traffic patterns created by particular events or emergencies. Many AVs stop when unable to determine the appropriate action in a novel situation and may become traffic impediments.

Common Concerns among First Responders

This section identifies common concerns among first responders regardless of the department/agency. Subsequent sections address concerns specific to particular disciplines (e.g., fire, law enforcement, etc.).

In recent years, operators and developers deployed growing AV test fleets to city streets in states that authorized such testing. These vehicles—whether operating with a human safety test driver or operating entirely autonomously along previously designated and mapped corridors—were encountered by first responders. These interactions formed the basis of growing concerns within the minds of emergency responders, elected and appointed officials, and the public.

The following subsections examine specific concerns that first responders communicated, or identified in the literature regarding the adoption and expanded use of AVs on public highways. In some circumstances where firsthand reports or the literature proved insufficient, researchers used media reports, crash data analysis, and other sources appear. Researchers recognized the limitations of these alternate sources. When available, researchers utilized official sources and documents, relying on media reports or other source material only to address emerging issues or expand on issues identified in literature.

Training Gaps

The introduction of SAE Level 3 and 4 AVs to American roadways is relatively new but expanding rapidly. Most operators and manufacturers identified as operating in Texas began limited testing in the last few years. During this period, responders had limited encounters with AVs; a large percentage of their encounters that occurred during testing included a company-provided safety or test driver that was able to take manual control of the vehicle. As companies began running vehicles without drivers, interactions became more complex and drew more attention. As such, a general sense of novelty and uncertainty associated with driverless vehicles and AVs emerged that is reflected by responders in their answers to research surveys.

Liu et al. (2023) found that just 5.6 percent of emergency response officials they surveyed held moderate trust in the technology. Meanwhile, 67.2 percent of these officials held low or no trust at all in the vehicle technology (Liu et al., 2023). The Transportation Safety Advancement Group surveyed a sampling of public safety officials and found that 33.3 percent were not so confident or not at all confident that AV developers considered the potential impacts the technology may have on public safety responses (Transportation Safety Advancement Group, 2020).

While this distrust exists, responders also expressed curiosity and a desire to learn more. From the 2020 Transportation Safety Advancement Group survey, 31.3 percent of the officials surveyed cited additional training for public safety responders as one of their biggest concerns for autonomous vehicle technology. Similarly, Liu et al. (2023) found that 82 percent of officials reported receiving no AV operational or safety training. Of those individuals who had not received experience or training concerning AVs, 68 percent answered that doing so would increase their trust in the vehicles. Goodison et al. (2020) found in a survey of workshop participants that participants believed training would improve their understanding of the technology.

One potential challenge first responders might face as they seek training on interacting and responding to AVs is the significant disparity in procedures and tasks necessary to interface with the technology depending on the developer and vehicle make. First responders must quickly and safely navigate through their actions during emergencies. However, with a lack of standardization between companies and even between vehicles operated by the same company, the complexities of current measures and an expected increase in the number of operators and models of cars—each potentially developing company- and vehicle-specific guidance and safety features—will challenge first responders to maintain training on each vehicle's protocol, especially when they may widely differ.

Eleven of the AV operators in Texas (Aurora Innovation, Gatik, Kiwibot, Kodiak Robotics, May Mobility, Nuro, Stack, Torc Robotics, Volkswagen, Waymo, and Zoox) developed first responder guides, interaction plans, or emergency response quick sheets for their vehicles. In addition to variations between companies and even between company models, available guides for first responders on how to contact the vehicle operator and safely navigate through potential emergency scenarios differ from one another in a variety of critical aspects. These differences resulted in different answers to the same responder questions, including:

- How can an officer contact the operator's safety team?
- Can an officer use their mobile phone, or can they communicate with remote operators from within the vehicle?
- How will safety operators verify that the officer is *bona fide*?

- Where is the vehicle documentation and guidance located?
- Does the vehicle contain guidance for first responders, and where is it located?
- Is the vehicle clearly recognizable as an AV, and is the operator contact information prominent enough for responders to obtain without looking for documents?
- Can responders access information in the vehicle safely in an emergency, especially in circumstances when the autonomy remains engaged?
- How can an officer determine the status of autonomy and disengage it if necessary?
- Does the vehicle require a trained safety driver or company representative to operate the vehicle, or can officers disable the autonomy and move the vehicle?
- Will making a vehicle's current status publicly known encourage erratic driver behavior, as suggested by AV developers during interviews?
- Does the vehicle include an autonomy disengage button or switch and an indicator showing the current status of the vehicle's autonomy?

Training and Certification Agencies and Standards

The following three primary certification structures exist in Texas for first responders:

- TCFP certifies firefighters in Texas.
- TCOLE certifies law enforcement officers.
- Texas Department of State Health Services certifies EMS personnel.

These certification agencies may apply national standards to their curriculums and standards in addition to any statutory or other state-level requirements. For example, the TCFP certification follows the NFPA standards for most firefighter training. Likewise, EMS personnel from National Registry states can transfer their license to Texas if they complete additional Texas-specific training without taking the Texas certifying exam through the National Registry.

Currently, training programs for Texas law enforcement, fire, and EMS personnel do not include AV interactions or require instruction on AVs. Nor does any Texas-recognized training partner for certifying agencies (e.g., TEEX) currently offer a course in AV interactions for first responders. A common course that addresses AV response across manufacturers and models could provide a common operating picture for first responders that increases awareness and reduces response issues for incidents involving AVs. Including such a course or material in first responder certification training and exams might substantially increase responder capabilities statewide, in the absence of national or industry standardization.

Cybersecurity

Responsibility for ensuring and protecting the cybersecurity of AVs falls primarily to the manufacturers and operators of the technology. The Cybersecurity and Infrastructure Security Agency (CISA)—the lead federal agency tasked with protecting the nation's cyber and computing assets from malicious actors—devised a series of suggestions that AV operators should consider implementing as they test and offer their vehicles for consumer usage (CISA, 2021). Such strategies for protecting the technology include:

- Prevent unauthorized physical access to the vehicles and monitor for tampering or unknown devices.
- Implement and regularly update the vehicle's security software.
- Ensure the system hardware configuration offers the most secure system appropriate for the operating environment.

Additionally, espionage concerns related to foreign-operated AVs and foreign-acquired automation systems continue to grow in the United States over concerns about cybersecurity and the use of AV systems to collect intelligence or conduct infrastructure attacks in the United States. This issue is not new. For example, China banned Tesla vehicles from some places within the country after previously expressing similar cybersecurity concerns (Tabeta, 2021).

The U.S. Congress recently expressed concerns regarding Chinese companies conducting AV testing in the United States (Graham, 2023). In 2022, U.S. Representative August Pfluger (Republican-Texas-11) sent a letter to NHTSA expressing concerns regarding collecting and storing data gathered on American roadways. Similarly, in November of 2022, a bipartisan group of 14 House members sent letters to Chinese firms licensed to operate AV vehicles in California, including Baidu, AutoX, Deeproute.ai, Didi Chuxing, Inceptio, Nio, Pony.ai, Qcraft, WeRide, and Xpeng.

The letters identified lawmakers' concerns regarding the companies' potential connections to the Chinese government and issues regarding data collected by those firms on American roadways. They requested a response from those firms regarding their data privacy practices and connections to the Chinese government (Graham, 2023). Several cases involving industrial espionage by Chinese nationals related to Apple's self-driving proprietary information also occurred, drawing attention to the problem in recent years (Ingram, 2023).

In addition to ongoing rulemaking, several executive orders issued recently impact AV development in the United States. On February 29, 2024, the White House announced a Department of Commerce investigation into connected vehicles from China that may pose national security risks and issued Executive Order No. 14117, *Preventing Access to Americans' Bulk Sensitive Personal Data and United States Government-Related Data by Countries of Concern*, which sought to prevent access to American's sensitive personal data and U.S. Government–related data by countries of concern, including data gathered by connected AVs (Executive Order No. 14,117, 2024).

On March 1, 2024, the U.S. Department of Commerce Bureau of Industry and Security issued an Advance Notice of Proposed Rulemaking (ANPRM), *Securing the Information and Communications Technology and Services Supply Chain: Connected Vehicles*, under the authority of Executive Order No. 13873*, Securing the Information and Communications Technology and Services Supply Chain*, issued on May 15, 2019.

On September 23, 2024, the Commerce Department Bureau of Industry and Security published a Notice of Proposed Rulemaking (NPRM) that would effectively ban the sale of connected and autonomous vehicles in the United States equipped with Chinese and Russian software and some hardware. The software ban would take effect for the 2027 model year, and the hardware ban would take effect for the 2030 model year; both bans would take effect on January 1, 2029, for units without a model year (Securing the Information and Communications Technology and Services Supply Chain: Connected Vehicles, 2024).

Regarding port automation, President Joe Biden issued Executive Order No. 14116, *Amending Regulations Relating to the Safeguarding of Vessels, Harbors, Ports, and Waterfront Facilities of the United States* on February 21, 2024 (Executive Order No. 14,116, 2024). This order assigned responsibility for U.S. maritime cybersecurity to the U.S. Coast Guard. In particular, this order focused on threats of cyberattacks and foreign interference that endanger vessels, waterfront facilities, harbors, and ports. In part, this action related to concerns about supply chains, automated cranes, and other systems originating in China that might pose cybersecurity problems.

Additionally, the 2024 National Defense Authorization Act prohibited federal funding for use of the Chinese National Transportation Logistics Public Information Platform (LOGINK), and a bill proposed in Congress would prohibit U.S. ports from using LOGINK.

Related to these actions, on April 22, 2024, the Office of the United States Trade Representative issued a Section 301 Notice of Investigation initiation, hearing, and request for comments into *China's Acts, Policies, and Practices Targeting the Maritime, Logistics, and Shipbuilding Sectors for Dominance*.

Most of foreign-owned AV firms in the United States currently operate in California. A review of operators in Texas identified the following four current or former foreign-owned or foreign-linked firms with operations in Texas:

- **Avride**: Formerly a Russian-connected firm known as the Yandex Self Driving Group, Avride was recently spun off as an independent European Union (EU) based firm (Behrndt, 2024).
- **Waabi**: Waabi is an autonomous semi-truck developer based out of Toronto, Canada (Wessling, 2023).
- **TuSimple**: TuSimple is a Chinese-linked autonomous semi-truck developer (TuSimple, 2021).
- **Bot Auto TX, LLC**: Bot Auto TX, LLC is a newly formed company in Texas made up of former TuSimple employees operating under the direction of the former chief executive officer (CEO) and cofounder of TuSimple at the time of incorporation (Bellan, 2024).

TIM Concerns

According to FHWA, TIM is the “planned and coordinated multidisciplinary process to detect, respond to, and clear traffic incidents so that traffic flow may be restored as safely and quickly as possible” (FHWA, 2023). In Texas, responders from fire departments, law enforcement agencies, roads and public works departments, TxDOT, private towing companies, and driver assistance contractors (HERO, Tow and Go, and the Dallas-Fort Worth Mobility Assistance Patrol, and other courtesy patrol programs) have a role in implementing TIM practices. In major metropolitan areas, TIM may also include TMCs like DalTrans or Houston TranStar.

As documented in the National Cooperative Highway Research Program (NCHRP) Research Report 1104, Son et al. (2024) examined several crucial aspects of TIM and the implications for and impacts to first responders because of the introduction of nonhuman operated vehicles. This study identified eight scenarios in which AVs/CAVs may interact with the TIM process occurring in three of eight TIM timeline points. The majority of these interactions occur when responders first arrive on the scene and before all traffic lanes reopen.

One common issue in the identified AV interactions with TIM is whether AVs respond correctly to human direction, traffic control devices, and delineations from standard traffic patterns. Also, an apparent necessity exists for first responders to quickly identify AVs and take the appropriate measures based on information known about those AVs.

Humans can quickly comprehend information provided by signage or the commands of responding personnel, but a . However, this may require new means of communication to transmit similar messaging to AVs. Further, redirecting traffic patterns can lead to vehicles operating in conditions that would otherwise violate highway designs and laws. These situations tax most AVs presently operating in Texas. The interaction points identified in the NCHRP study mirror many of the concerns identified by first responders. According to City of Austin representatives, the Austin AV Safety Task Force worked with developers and city dispatch centers to implement a temporary geofence system to help AV operators and their vehicles avoid incidents that might lead to AV-related issues.

TxDOT HERO Program Concerns

TxDOT operates the HERO program—a contractor-based cost-free service to motorists—to enable the quick reopening of highways and public roadways following a vehicle incident (TxDOT, n.d.; White, 2023). The stated goal of the HERO program is to safely enable motorists to move their vehicle out of a travel lane; 20 percent of total national roadway incidents are secondary crashes that occur due to a previous crash or vehicle breakdown. Currently, TxDOT operates HERO personnel in three Texas metropolitan regions: Austin, El Paso, and San Antonio. Under the HERO program, trained operators:

- Safely remove crashed and disabled vehicles from the roadway.
- Assist first responders in directing traffic at an incident scene.

- Provide gasoline, air, and jumpstarting services to stranded motorists.
- Provide water and cell phone services to stranded motorists.

During interviews conducted as part of this project, HERO contractors expressed concerns regarding their contractor status and inclusion in first responder training. HERO personnel are not direct employees of TxDOT and therefore may not have the sovereign immunity that governmental units in Texas enjoy. Such issues could affect other courtesy patrol programs like Houston's Tow and Go and the Dallas-Fort Worth Mobility Assistance Patrol.

Additionally, first responder training and exposure events provided by AV operators and manufacturers, according to interviews, did not include HERO. Given the increasing number of companies testing ridesharing services and the near-term introduction of consumer ADS vehicles, HERO operators will likely require such training to safely interact and communicate with AVs during their duties. Chapter III. Policy and Needs Assessment of this report further analyzes immunity and insurance issues and policy associated with courtesy patrol involvement in AV-related response.

Law Enforcement Concerns

Law enforcement officers from various political jurisdictions, including local police, county and county equivalent sheriff's departments, and state public safety and highway enforcement agencies, experience frequent and routine interactions with motorists along the nation's highways. These stops include a variety of routine procedures, such as traffic enforcement, stopping suspect vehicles and drivers, assisting motorists, assisting with TIM responses during crashes and other road incidents, and preparing crash reports and conducting crash investigations. As the number of AVs increases, law enforcement will remain the initial and primary response agency regularly interacting with AVs.

However, law enforcement officers are skeptical about AV technology, much like other first responders. Dempsey et al. (2023) found that 70 percent of the law enforcement officers sampled during the study reported being ambivalent or negative in their views of self-driving technologies currently available on the market. When questioned on their exact concerns over the mass adoption of AV technology, officers cited concerns over:

- General sense of confusion in determining accountability and fault after a roadway incident.
- Malicious actors hacking connected and autonomous vehicles.
- Software or technical malfunctions (which could place responding officials or the public at risk).

Fault and Liability

One common concern cited by officers surveyed by Dempsey, et al. (2023) was ongoing and unanswered questions about assigning fault and liability in crashes involving one or more AVs. The novel nature of AVs and the concept that one or more vehicles are without any human presence means that new precedents and case law will determine legal and financial liability in instances of crash or injury. This project's Task 3 research team found no known cases involving AVs that reached trial resulting in precedent.

As was the case following mass adoption of internal combustion engine vehicles in the early 20th century, legal precedent and procedures for AVs will develop gradually as municipalities and states begin to experiment with solutions and make determinations independently. Likewise, insurance companies and the courts will make decisions that affect AV operations and crash investigations. Eventually these will develop into shared common frameworks, national standards, and a body of case law. Until that occurs, wide differentiation and uncertainty will likely continue.

Cybersecurity and Technology Reliability

Law enforcement officers also cited concerns stemming from the potential vulnerabilities CAVs possess due to their reliance upon interconnected software and interlinks with wider computer systems. While the connectivity features of a CAV's computing systems enable the onboard system to complete many driving operation tasks, communicate with monitoring safety officials, and relay information about the roads, these connections also inherently open the vehicle up as a target for malicious actors (CISA, 2021).

CISA and Goodison et al. (2020) identified the following potential ways malicious actors could target AV technology and the potential risks to the operators and the public at large:

- Turning off automated vehicle fleets.
- Vehicles become stolen, inaccessible, or an obstacle to the flow of people and goods.
- Theft involving keyless relay systems.
- Disrupting autonomous vehicle sensors.

Examples of cybersecurity concerns noted in other research and media reports included the following:

- **Removing vehicle autonomy**: When AVs become inoperable and block traffic, they are a potential safety hazard. Creating these hazards deliberately may not require a cyberattack. For example, videos released on social media platforms show disgruntled San Francisco, California, residents placing traffic cones on top of a Cruise autonomous taxi, temporarily removing the vehicle's ability to operate autonomously (Griswold, 2023).
- **Data security and misuse**: Storage of an AV's data and data exfiltration from company servers create national security concerns. For example, many vehicles have sensitive lidar and digital mapping of public roadways that might facilitate espionage or intelligence collection activities by malicious actors and foreign nations.
- **Spoofing**: Austin Police Department officials reported that a Cruise official contacted remotely refused a responding officer's permission to move a disabled vehicle because the Cruise operator did not believe the officers were law enforcement (Austin TPW Department, 2024). While this action demonstrated awareness of a potential threat, it also highlights the threat of AV interference in emergency procedures. In some ways, this scenario may resemble harassment through *swatting*—the criminal harassment of an individual or organization by sending emergency services to the targeted individual's or organization's address. Likewise, individuals or organizations might hijack or spoof connected data provided by external devices (i.e., roadway sensors or other telemetry sources) to affect AV operations and create disruption or carry out attacks.

Crash Investigation and Accident Reporting

In 2023, TxDOT updated its CR-3 form, associated code sheet (CR-3CS), and CR-100 instructions to include fields related to vehicle autonomy. Revision of the CR-3 form included two new fields (circled in red in Figure II-3) and new coding for select other fields (e.g., 95=Autonomous), with linkages to other fields requiring specific entries or use of the 95=Autonomous code.

> Information provided here may differ from current instructions because the CR-3, CR-3CS, and CR-100 changed during the project.

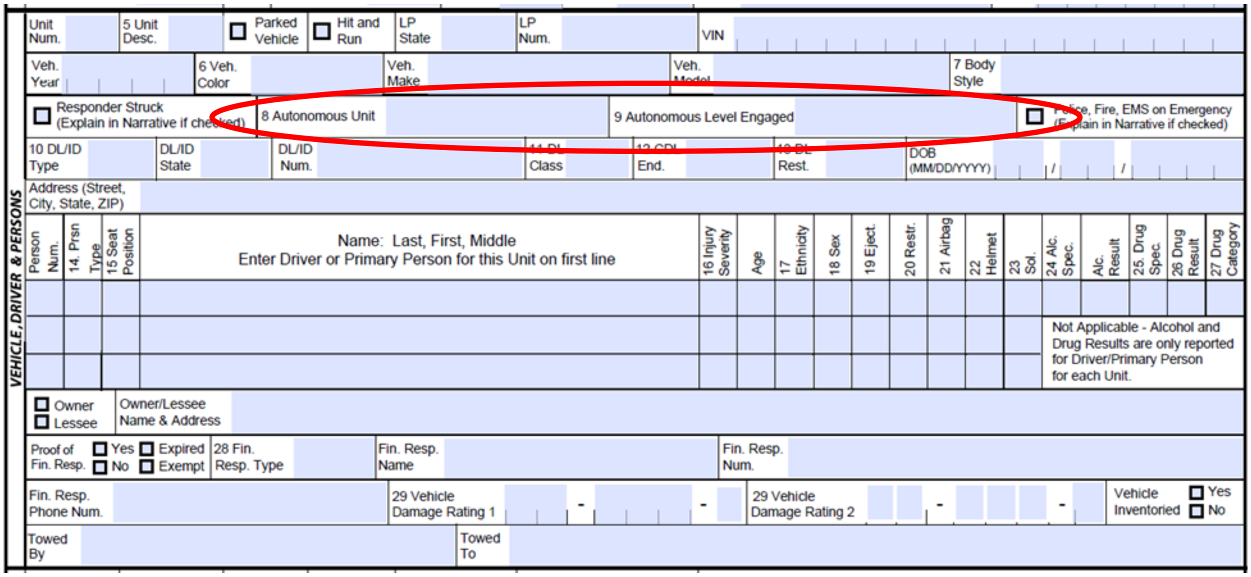


Figure II-3. TxDOT's Revised CR-3 Form for AVs (TxDOT, 2023).

As noted on the revised CR-3CS (see Figure II-4 and Figure II-5), Field 8-Autonomous Unit and Field 9-Autonomous Level Engaged have multiple codes. Likewise, Code 95=Autonomous is a conditional code across select additional fields.

8. Autonomous Unit 1 = Yes 2 = No 99 = Unknown **9. Autonomous Level Engaged** 0 = No Automation 1 = Driver Assistance 2 = Partial Automation 3 = Conditional Automation 4 = High Automation 5 = Full Automation 6 = Automation Level Unknown 99 = Unknown **10. Driver License/ID Type** 1 = Driver License 2 = Commercial Driver Lic. 3 = Occupational 4 = ID Card 5 = Unlicensed 95 = Autonomous 98 = Other 99 = Unknown	**11. Driver License Class** A = Class A AM = Class A and M B = Class B BM = Class B and M C = Class C CM = Class C and M M = Class M 5 = Unlicensed 95 = Autonomous 98 = Other/Out of State 99 = Unknown

Figure II-4. TxDOT's Revised CR-3CS for AVs (TxDOT, 2023).

12. Commercial Driver License Endorsements
H = Hazardous Materials
N = Tank Vehicle
P = Passenger
S = School Bus
T = Double/Triple Trailer
X = Tank Vehicle with Hazardous Materials
5 = Unlicensed
96 = None
95 = Autonomous
98 = Other/Out of State
99 = Unknown

13. Driver License Restrictions
A = With corrective lenses
B = LOFS 21 or over
C = Daytime driving only
D = Speed not to exceed 45 mph
E = No manual transmission equipped CMV
F = Must hold valid learner lic. to MM/DD/YY
G = TRC 545.424 applies until MM/DD/YY
H = Vehicle not to exceed 26,000 lbs GVWR
I = MC not to exceed 250cc
J = Licensed MC operator 21 or over in sight
K = Intrastate only
L = No air brake equipped CMV
M = No Class A passenger vehicle
N = No Class A and B passenger vehicle
O = No tractor-trailer CMV
Q = LOFS 21 or over vehicle above Class B
R = LOFS 21 or over vehicle above Class C
S = Outside rearview mirror or hearing aid
T = Automatic transmission
U = Applicable prosthetic devices
V = Medical Variance
W = Power steering
X = No cargo in CMV tank vehicle
Y = Valid TX vision or limb waiver required
Z = No full air brake equipped CMV
P1 = For Class MTRC 545.424 until MM/DD/YY
P2 = To/from work/school
P3 = To/from work
P4 = To/from school
P5 = To/from work/school or LOFS 21 or over
P6 = To/from work or LOFS 21 or over
P7 = To/from school or LOFS 21 or over
P8 = With telescopic lens
P9 = LOFS 21 or over bus only
P10 = LOFS 21 or over school bus only
P11 = Bus not to exceed 26,000 lbs GVWR
P12 = Passenger CMVs restrict to Class C only
P13 = LOFS 21 or over in veh equip w/airbrake
P14 = Operation Class B exempt veh authorized
P15 = Operation Class A exempt veh authorized
P16 = If CMV, school buses interstate
P17 = If CMV, government vehicles interstate
P18 = If CMV, only trans personal prop interstate
P19 = If CMV, trans corpse/sick/injured interstate
P20 = If CMV, privately trans passengers interstate
P21 = If CMV, fire/rescue interstate
P22 = If CMV, intra-city zone drivers interstate
P23 = If CMV, custom-harvesting interstate
P24 = If CMV, transporting bees/hives interstate
P25 = If CMV, use in oil/water well service/drill
P26 = If CMV, for operation of mobile crane
P27 = HME Expiration Date MM/DD/YY
P28 = FRSI CDL valid MM/DD/YY to MM/DD/YY
P29 = FRSI CDL MM/DD/YY - MM/DD/YY or exempt B veh
P30 = FRSI CDL MM/DD/YY - MM/DD/YY or exempt A veh
P31 = Class C only - no taxi/bus/emergency veh
P32 = Other
P33 = No passengers in CMV bus
P34 = No express or highway driving
P35 = Restricted to operation of three-wheeled MC
P36 = Moped
P37 = Occ/Essent need DL-no CMV-see court order
P38 = Applicable vehicle devices
P39 = Ignition Interlock required
P40 = Vehicle not to exceed Class C
5 = Unlicensed
95 = Autonomous
96 = None
98 = Other/Out of State
99 = Unknown

14. Person Type
1 = Driver
2 = Passenger/Occupant
3 = Pedalcyclist
4 = Pedestrian
5 = Driver of Motorcycle Type Vehicle
6 = Passenger/Occupant on Motorcycle Type Vehicle
95 = Autonomous
98 = Other (Explain in Narrative)
99 = Unknown

15. Seat Position
1 = Front Left or Motorcycle Driver
2 = Front Center or Motorcycle Sidecar Passenger
3 = Front Right
4 = Second Seat Left or Motorcycle Back Passenger
5 = Second Seat Center
6 = Second Seat Right
7 = Third Seat Left
8 = Third Seat Center
9 = Third Seat Right
10 = Cargo Area
11 = Outside Vehicle
13 = Other in Vehicle
14 = Passenger in Bus
16 = Pedestrian, Pedalcyclist, or Motorized Conveyance
95 = Autonomous
98 = Other (Explain in Narrative)
99 = Unknown

16. Injury Severity
A = Suspected Serious Injury
B = Suspected Minor Injury
C = Possible Injury
K = Fatal Injury
N = Not Injured
95 = Autonomous
99 = Unknown

17. Ethnicity
W = White
B = Black
H = Hispanic
A = Asian
I = Amer. Indian/Alaskan Native
95 = Autonomous
98 = Other
99 = Unknown

18. Sex
1 = Male
2 = Female
95 = Autonomous
99 = Unknown

19. Ejected
1 = No
2 = Yes
3 = Yes, Partial
97 = Not Applicable
99 = Unknown

20. Restraint Used
1 = Shoulder and Lap Belt
2 = Shoulder Belt Only
3 = Lap Belt Only
4 = Child Seat, Facing Forward
5 = Child Seat, Facing Rear
6 = Child Seat, Unknown
7 = Child Booster Seat
96 = None
97 = Not Applicable
98 = Other (Explain in Narrative)
99 = Unknown

21. Airbag
1 = Not Deployed
2 = Deployed, Front
3 = Deployed, Side
4 = Deployed, Rear
5 = Deployed, Multiple
97 = Not Applicable
99 = Unknown

Figure II-5. TxDOT's Revised CR-3CS Codes (TxDOT, 2023).

In the revised CR-100 instructions to officers, Field 8-Autonomous Unit is a mandatory reporting field for all crash records input into the TxDOT CRIS database. In 2024, TxDOT updated the CR-100 to provide further guidance on completing Field 8 and Field 9 (Figure II-6 and Figure II-7), among other changes.

3.3.14 – *AUTONOMOUS UNIT – see Code Sheet: 8

This field is intended to capture whether a unit was equipped with driving automation capabilities.

MANDATORY DATA FIELD: If left blank or both Yes and No is selected, report will be returned to the officer.

8 Autonomous Unit

CODE SHEET VALUES FOR AUTONOMOUS UNIT
1 = Yes
2 = No
99 = Unknown

TIP:

- If the Unit Description is NOT 1 – Motor Vehicle, or 7 – Non-Contact, then 'Autonomous Unit' must be set to 'No'.
- If the vehicle year is less than 2000, then 'Autonomous Unit' must be set to 'No'.
- If 'Autonomous Unit' is set to 'Yes' for a unit, the 'Make' and 'Model' must be populated for that unit and cannot be 'Unknown'.
- If the Hit and Run is set to Yes and Vehicle Make is Unknown or blank, then the Autonomous Unit must be set to Unknown.

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- If the Hit and Run is set to Yes and Vehicle Model is Unknown or blank, then the Autonomous Unit must be set to Unknown.
- If the entered unit VIN has the autonomous features of Adaptive Cruise Control, Lane Centering Assistance or Lane Keeping Assistance, set to Standard, then Autonomous Unit field should be set to 'Yes'.

Figure II-6. TxDOT's CR-100 Instructions for Field 8-Autonomous Unit (TxDOT, 2024).

3.3.15 – AUTONOMOUS LEVEL ENGAGED – **see Code Sheet: 9**

Using only the values listed on the code sheet for Autonomous Level Engaged, list the selection that best describes degree of driving automation a unit had engaged at the time of the crash.

9 Autonomous Level Engaged

CODE SHEET VALUES FOR AUTONOMOUS LEVEL ENAGAGED	
0 = No Automation	4 = High Automation
1 = Driver Assistance	5 = Full Automation
2 = Partial Automation	6 = Automation Level Unknown
3 = Conditional Automation	99 = Unknown

CONDITIONAL FIELD:

- If Autonomous Unit is Yes, Autonomous Level Engaged must be 1 - Driver Assistance, 2 - Partial Automation, 3 - Conditional Automation, 4 - High Automation, 5 - Full Automation, or 6 - Automation Level Unknown.
- When Autonomous Unit is No, then the Autonomous Level Engaged must be 0 - No Automation.
- When Autonomous Unit is Unknown, Autonomous Level Engaged must be 99 - Unknown.
- Unit Description is 2-Train, 3-Pedalcyclist, 4-Pedestrian, 5-Motorized Conveyance, 6-Towed/Pushed/Trailer, or 98-Other, therefore the Autonomous Level Engaged must be 0 - No Automation.

Figure II-7. TxDOT's CR-100 Instructions for Field 9-Autonomous Level Engaged (TxDOT, 2024).

AV Company Data Sharing and Security Concerns

Goodison et al. (2020) identified additional issues related to crash reporting and crash investigation related to AVs. That study noted that law enforcement lacked a thorough understanding of how information is collected by AVs and AV developers, how long AV operators retain such information, and how crash reconstruction specialists and investigators may request such information for accident reconstruction.

This issue surfaced publicly shortly after researchers began this literature review. On October 2, 2023, a fully autonomous Cruise vehicle in San Francisco, California, struck and dragged a pedestrian after a human-driven vehicle struck the pedestrian and placed them in the path of the Cruise vehicle (California Public Utilities Commission [CPUC], 2023). Following the accident, Cruise employees shared a video with the CPUC and crash investigators that showed the initial accident involving the human driver and the subsequent victim strike by the Cruise vehicle. However, the video and accounts Cruise initially released did not include a subsequent maneuver by the Cruise vehicle—the Cruise vehicle attempted to execute a pull-over action during which it dragged the victim beneath the car for some distance.

Cruise did not mention or release information regarding the subsequent maneuver for 15 days. The CPUC, informed by a federal agency of the additional maneuver, formally requested the additional footage from Cruise, which Cruise provided on October 19, 2023 (CPUC, 2023). In response, CPUC documented the incident and Cruise's delayed disclosure, proposing a potential fine of $100,000 per day for each of the 15 days, amounting to $1.5 million. However, in June 2024, a judge approved a settlement between Cruise and CPUC for $112,500, along with a commitment from Cruise to enhance transparency with state regulators moving forward (Wolverton, 2024).

The aftermath of a high-profile accident and the subsequent CPUC investigation brought further challenges. In December 2023, Cruise's chief technology officer announced the company's commitment to a heightened safety bar and a renewed focus on delivering exceptional service (Cruise, 2023). This strategic shift prompted Cruise to slow its commercialization and expansion efforts, placing greater emphasis on safety and regulatory compliance. The company paused its driverless taxi operations and undertook significant restructuring, including the layoffs of nearly 900 employees and nine executives, among them CEO, Kyle Vogt, and cofounder, Dan Kan (Kelly, 2024). In response, General Motors (GM)—Cruise's parent company—withdrew hundreds of millions in funding from the venture, marking a major realignment of its priorities for autonomous technology (Bote, 2023).

In October 2024, NHTSA entered into a consent order agreement with Cruise and fined the company $1.5 million dollars over its actions following the October 2023 accident (Bender, 2024). As part of this consent order, Cruise agreed to issue a corrective action plan detailing how the company will better comply with NHTSA's *Standing General Order on Crash Reporting for Incidents Involving ADS and Level 2 ADAS* (NHTSA, 2024b). Additionally, Cruise was required to meet quarterly with NHTSA to discuss the company's actions regarding implementation of the corrective measures and compliance with the standing general order.

In December 2024, as this final report neared completion, GM announced an immediate halt to funding Cruise's robotaxi development. The decision reflected the considerable time and resources needed to scale the business alongside the challenges posed by an increasingly competitive robotaxi market (GM, 2024). Instead, GM revealed plans to integrate Cruise's technical teams with its own, shifting focus to developing the Super Cruise ADAS and restructuring Cruise's remaining operations. While the specifics of this restructuring remain unclear, GM's CEO emphasized in the same announcement that this decision did not represent a total abandonment of fully autonomous vehicles (Isidore, 2024).

Fire Department Concerns

Echoing some of the first responder concerns reported previously, researchers identified the following fire department concerns in the literature:

- AVs blocking critical sites (e.g., fire stations, ingresses and egresses, incident sites).
- AVs obstructing emergency vehicles or striking emergency vehicles enroute to an incident.
- AVs entering active incident scenes and failing to respond to human direction.
- Concerns related to EV hazards.

The City of Austin identified the first concern—AVs blocking fire stations—early during the testing of AV taxi services in the city, a concern mirrored by other cities with active testing (Austin TPW Department, 2024). While looking for empty parking spaces where they could await calls, noncommitted AV taxis parked or stopped in spaces at the entrances of fire stations and other emergency response facilities, obstructing response vehicle ingress or egress from the property. The solution—reflecting a coordinated effort by city and AV developer representatives—was to identify and share data regarding emergency facility locations with AV companies so that developers could geofence those facilities and prevent AVs from parking or stopping in such locations in the future (Medoza, 2023).

The second concern involved AV actions that interfered with response. AVs either stopped or otherwise obstructed the roadway at the approach of an emergency vehicle, or AVs failed to recognize emergency vehicles and clear the roadway, leading to collisions (Eskenazi and Jarrett, 2023). These issues—known to AV developers—present a unique challenge that is not isolated to AVs. Researchers did not find information about solutions to this problem in the literature.

The third concern was AVs entering active incident scenes or not responding to law enforcement or fire department instruction/direction. This concern mirrors law enforcement concerns. Several incidents of note included an AV stopping behind a fire engine as it attempted to back into a fire station, AVs making abrupt moves around fire engines responding to scenes, and AVs having multiple near misses with Austin Fire and Police Department officials directing traffic around active incident locations (Austin TPW Department, 2024). To address this concern, City of Austin officials requested that AV operators voluntarily implement a *temporary geofence* when an incident occurs in their operational areas, allowing their vehicles to avoid the scene. Operators obtain information about incidents by monitoring city and response organization social media feeds.

Finally, the growing adoption of AVs and EVs presents significant challenges for emergency responders—particularly firefighters—as they adapt to these new technologies. Most AVs, including those developed by Waymo, Cruise, and Nuro, operate as EVs powered by lithium-ion batteries. While these batteries allow for a transition away from fossil fuels, they introduce distinct hazards that complicate fire response and roadway incident management.

Lithium-ion battery fires burn hotter and longer and can impact the infrastructure, environment, public, and first responders differently than fires involving internal combustion engine (ICE) vehicles. As a result, first responders, state departments of transportation (DOTs), traffic management organizations, and emergency management organizations increasingly seek methods to adequately prepare for potential EV fire impacts, including fire mitigation and response strategies.

Regarding TIM timelines, response to a traditional gasoline powered passenger vehicle fire is much shorter (from the time of arrival on scene until the road is cleared) and involves less fire apparatus and resources than longer and more resource-intensive EV fires. Hazmat cleanup for traditional vehicle fires is also straightforward and requires limited training. Towing for burned and damaged traditional vehicles is straightforward, and patients and responders seldom require decontamination on scene.

EV fires on the other hand may burn for hours; are not extinguishable by current technology; may produce significant, complex contamination of air, water, and soil; and may require multiple fire engine companies and significant quantities of water. Response crews to such fires may also require decontamination of bunker gear and equipment. Extricated vehicle occupants may also require some level of decontamination. Towing companies may require a fire department escort in case the battery reignites while in transit. These actions require additional time and resources that can significantly stretch TIM timelines and tax response organization resources. Further, extended responses that close busy roadways may produce secondary incidents and crashes, which can further tax response capabilities.

Additionally, a lithium-ion battery fire produces significantly more heat in a concentrated space for an extended period. Because most EV batteries sit close to the road at the bottom of the vehicle beneath the passenger compartment, the potential impact to the steel and road surface both above and below the vehicle is of concern. Research conducted by the Fire Safety Research Institute found that "in some EV designs, connections between the battery pack and the chassis failed, causing the battery to fall onto the ground while on fire, potentially leading to increased heat transfer to the road surface" (Fire Safety Research Institute, 2024).

In contrast, ICE vehicles contain flammable liquids that tend to disperse during a crash due to gravity and topography. This presents challenges and can result in significant infrastructure damage when it involves large quantities of flammable liquids. For example, significant damage occurred along the I-95 corridor when a fuel truck burned below an underpass recently, resulting in the partial collapse of the overhead roadway and significantly impacting traffic along the entire northeastern corridor. Yet, such extensive impacts do not usually occur with passenger or even CMV fires given the short duration and limited quantity of fuel.

Water suppression can reduce or put out fires involving traditional ICE vehicles—meaning that water sprinkler systems, fire extinguishers, and traditional firefighting equipment can quickly suppress and put out such fires. Similarly, an equipped bystander may extinguish some ICE vehicle fires with a fire extinguisher. It is not currently possible to fully extinguish a lithium-ion battery fire. Current means of battery fire suppression like blankets or water only delay or contain the effects of the chemical reaction that—once started—must occur to release the energy stored in the system.

While efforts exist to examine the feasibility of rapid discharge before thermal runaway generates a fire, these efforts remain in the early stages of development. While blankets, water suppression to cool battery packs, and even complete submersion only delay the reaction or contain its effects, these techniques do not stop the chemical reaction and subsequent fire, they may allow for movement of the vehicle away from critical infrastructure. For example, traditional fire response actions administered to an EV beginning thermal runaway may give responders time to pull the EV away from at-risk structures or other vehicles or to limit fire spread and reduce wildfire risk.

The high temperatures of lithium-ion fires can impact the structural integrity of EVs. For example, carbon steel begins to lose yield strength at 400°F. At temperatures between 1,300°F and 1,550°F, structural steel—if quickly cooled by water during fire suppression—will transform into Martensite and become brittle (Pańcikiewicz et al., 2023). In one study, researchers measured the maximum temperature from an EV fire at 1,770°F (966°C) in the passenger compartment (Cui et al., 2022). Other studies suggest higher temperatures within the battery packs, which sit close to the road in most vehicle designs. While many factors can affect heat diffusion above a fire, EV fire temperatures may deform or damage steel above and below the roadway.

The concentrated effects at or near the roadway surface beneath the vehicle may reach temperature levels necessary to damage structural steel components, especially when cooling water from fire suppression washes down the vehicle onto the road surface. Additionally, water used to cool battery fires will contain numerous contaminants dangerous to human health and the environment. Runoff from such fires—contaminated with heavy metals and other toxins from the battery—can seep into road surfaces and drainage systems, contaminating surrounding soils and waterways, and necessitating costly repairs and environmental remediation. The battery materials also release particulate matter and chemical residues that settle into surrounding soil, leading to localized soil pollution. Over time, these contaminants can bioaccumulate in ecosystems, impacting plants, animals, and human health if the contaminants enter the food chain (Mrozik et al., 2021).

Given these factors, EV fires have the potential to impact roadway infrastructure in ways that ICE vehicles typically do not. Further, given past events involving container ships and parking structures, EVs can ignite other vehicles and create additional, secondary impacts that exacerbate infrastructure impacts. The most significant impacts could occur in road tunnels where the effects of an EV fire could be catastrophic.

Likewise, battery fires can pose other secondary risks. Given the concentrated heat, EVs have the potential to serve as a primary ignition source for larger fires involving structures (e.g., an EV in a garage igniting a structure fire) or in areas with heightened wildfire risk. For example, a recent crash on I-80 in California involving a large electric-powered CMV resulted in a fire that burned for 17 hours. The water required to prevent fire spread only formed part of the solution. To prevent the risk of a wildfire, responders required fire retardants dropped from airplanes on the surrounding area. Also complicating the response, responders closed the interstate in both directions for an extended period (Associated Press, 2024).

EV fires pose other challenges due to the placement of the battery packs. Many current EVs and hybrid vehicles incorporate the battery pack into the vehicle body or chassis under the passenger compartment. Conversely, ICE vehicles separate the fuel and the engine (where fire most often occurs) from the passenger compartment. As evidenced in a recent crash near Houston, Texas, this battery pack location can result in a fast-moving fire that can incinerate not only the vehicle, but vehicle occupants unable to escape the vehicle quickly due to injury or physical damage to the vehicle (Galvan and Kless, 2024).

Other Responder Concerns

This literature review did not identify EMS concerns related to AV interactions beyond those identified by other responders above (e.g., interference with active scenes, impeding vehicles enroute to a scene, or blocking access from or to an EMS-related facility). Similarly, construction zone related concerns align with those identified previously regarding an AV's inability to follow human-provided directions or adapt to nonstandard roadway conventions.

EMS concerns potentially relate more to the specific hazards associated with lithium-ion battery thermal runaways associated with EVs, the gases produced by vehicle battery packs in thermal runaways, and contamination issues related to battery exposure or contaminated runoff from firefighting (Roman, 2021; Zhou et al., 2023). EV-related AV incidents may therefore require additional medical interventions not customarily associated with fossil-fuel vehicle crashes and accidents. Similarly, EV-related incidents may require additional first responder protective measures and responses (like decontaminating patients or responders).

RECOMMENDED BEST PRACTICES AND STANDARDS

Many first responders' concerns about the introduction and widespread adoption of AVs are not new. Since the mid-2010s, researchers, policymakers, and industry officials have continuously tested various potential solutions to the challenges first responders face during AV interactions. However, there are still few industry-wide or national standards to guide these interactions.

Lee et al.'s (2023) survey of first responders' AV-related concerns highlighted the industry's lack of common standards and protocols. At present, no regulatory framework standardizing the disablement of vehicles exists. Instead, each operator has established various vehicle- or operator-specific methods for disabling and ensuring the disabled status of the vehicle.

Of the potential systems identified by Lee et al. (2023), plain text displayed in large lettering and raising the vehicle's hood ranked highest among survey participants as a means to quickly and efficiently communicate the active status of an AV's autonomy. Participants also preferred a big button readily accessible to emergency responders, allowing for the quick disablement of vehicle autonomy, which some developers utilized during their initial testing and mapping deployments.

Respondents also said that AV industry leaders should collaborate with fire and police departments to provide training on common scenarios that may occur with increased AV operation (Lee et al., 2023). Similarly, Goodison et al. (2020) found that first responders perceived a lack of knowledge among AV developers about responder operations. Responders recommended workshops and ride-a-longs for law enforcement staff and AV operators to increase industry and first responder knowledge of AV and first responder operations to facilitate standardization (Goodison et al., 2020). The same study also recommended standard procedures, guidelines, and training for law enforcement for identifying and interacting with AVs in autonomous modes and general descriptions of the behaviors law enforcement might expect to encounter during their interactions with AVs represented in the United States.

Lead industry players also made nonbinding attempts to coordinate and standardize autonomous vehicle terminology and basic emergency response procedures. In 2020, the Autonomous Vehicle

Safety Consortium (AVSC)—a combined effort of leading companies in the AV industry, including Aurora Innovation, Torc Robotics, Cruise, Uber, and Waymo—released *Best Practice for First Responder Interactions with Fleet-Managed Automated Driving System-Dedicated Vehicles (ADS-DVs)*. This report examined various scenarios first responders may encounter when interacting with AVs in emergency and nonemergency scenarios and made best practice recommendations to operators based on current experience. The AVSC recommendations included the following:

- Disabling an autonomous vehicle:
  - Developers and manufacturers should provide a guide that describes the methods responders can use to disable the AV and an indicator that informs responders the vehicle automation status (off or on).
  - Guides should include a method for first responders to contact operators to ensure the vehicle is in park and will not continue to move or drive off following a stop.
  - Ensure first responders have a means to depower autonomous vehicles.
  - Include manufacturer- or vehicle-specific information or procedures in an emergency response guide.
- Communicating with an autonomous vehicle:
  - Developers should ensure an autonomous vehicle can detect and comply with emergency response vehicles and commands given by officials.
  - Developers should include instructions in an emergency response guide informing officials how to contact the operators.
  - Developers should coordinate with local responders to create a system to verify first responders when contacted via remote monitoring in vehicles or when responders call operating company emergency hotlines.
  - Identification of an autonomous vehicle: Developers should include distinguishing features to help quickly identify autonomous vehicles and their specific owner or operators.
  - Developers should include labels or documentation identifying specific hazards or concerns of the vehicle.

Approved on March 17, 2023, the American National Standards Institute/UL Solutions (formerly Underwriters Laboratories, ANSI/UL) published its *Evaluation of Autonomous Products* standard (ANSI/UL 4600, 2023) that covers "the safety principles, risk mitigation, tools, techniques, and lifecycle processes for building and evaluating a safety argument for vehicles that can operate in an autonomous mode, whether the item is individual or part of a team such as a platoon." This standard does not explicitly address first responder interactions but guides AV developers on safety and risk issues that may impact first responders, including cybersecurity.

KNOWN GAPS IN KNOWLEDGE AND THE LITERATURE

During this literature review, several gaps emerged regarding first responder interactions with AVs and AV development. These known gaps relate to:

- Concerns about the use of AVs for human and drug trafficking.
- Questions about CMV inspections and safety regulations.
- Cybersecurity concerns related to the use of AVs in terrorist attacks (i.e., vehicles used as a weapon or self-guided vehicle-borne improvised explosive device [VBIED]).
- Cybersecurity and security concerns related to AVs and intelligence collection platforms.
- Threats to AVs.
- Considerations for responders called to ports or terminals with automated heavy machinery and freight moving technologies and the cybersecurity of such systems.

Human Trafficking and Drug Smuggling

As AV technology expands into the consumer market and the proportion of AVs grows on the road, criminals will adopt them for illegal purposes. AVs offer a unique opportunity for human trafficking and illicit goods smuggling. A fully autonomous vehicle could depart from one location and travel to another carrying trafficked persons or illicit cargos. Given that traffic enforcement may diminish as AVs become the dominant vehicles on the road and that an SAE Level 4–5 vehicle will obey the rules of the road if functioning properly and reduce the likelihood of a traffic stop, AVs may allow criminal organizations to move people and illicit goods over some distance with a lower likelihood of encountering law enforcement. While these concerns may be more distant in the future than other concerns addressed in this literature review, such scenarios may increase in importance over time and may require action now to limit their occurrence later.

Autonomous CMV Inspection Programs

Currently, automated CMV freight carriers in Texas voluntarily adhere to CVSA's Enhanced CMV Inspection Program for Autonomous Trucks (CVSA, 2022a; CVSA, 2022b). Under this program, automated trucks undergo an enhanced no- defect inspection prior to every dispatch by company employees trained and certified by CVSA. Through coordination with Texas DPS, SAE Level 4–5 automated freight vehicles can bypass inspection stations enroute to their destination. During transit, Texas DPS inspections of automated CMVs occur only when an officer observes an imminent hazard enroute or as part of a post-crash investigation. Because the vehicles must follow the rules of the road, the vehicle—if driverless—should respond to law enforcement attempting to pull over the vehicle.

Additionally, automated trucks along some corridors must navigate U.S. Customs and Border Protection (CBP) interior checkpoints. Currently, AV operators pass information to CBP informing the agency when the trucks will pass through the area. Some ADSs struggle to recognize officer hand and arm signals for directing traffic. To mitigate this issue, CBP officers at checkpoints hold up large signs directing the vehicle through the CBP checkpoint (Bigelow, 2023).

While the enhanced inspection and CBP checkpoint systems function relatively effectively at present, there remain long-term challenges to address. Primarily, CMV enforcement officers have expressed concerns about the scalability of these solutions. Additionally, because the vehicles can bypass inspection stations, only company employees inspect the vehicle unless an officer notices a defect. CMV enforcement officers have expressed concerns about how these solutions will function as they scale. While AV developers have a vested interest in their vehicles' safety, some risk exists that the enhanced inspections system may introduce conflicts of interest that could potentially reduce safety as more AVs enter wider use by common carriers, that could potentially reduce safety. Law enforcement should consider new processes for terminal inspections, as well as new and potentially more severe penalties for inspections process violations.

Additionally, more work may be necessary for less common CMV checkpoints, including U.S. Department of Agriculture (USDA) inspection points, and roadblocks established by law enforcement in some situations. While CBP may be able to conduct its inspections of automated trucks, automated trucks in the hands of third parties could present different challenges for enforcing trafficking regulations.

Further, established procedures for conducting an enroute inspection of a vehicle with an observed safety defect are not well established. Several inspection procedures used by officers may require the presence of a driver/operator. This research attempted to address this circumstance by developing best practices for officers to pull over such vehicles and conduct inspections as detailed in the *Texas First Responder Guide for Interactions with Automated Vehicles* developed in the final stage of this project and previously delivered to TxDOT.

Cybersecurity: AVs as Weapons

The use of vehicles as weapons—where radicalized drivers drive vehicles into crowds intending to kill or injure pedestrians—is a well-known terrorist tactic (Duggan, 2017; Miller and Hayward, 2018; Timsit, 2021; Tsur et al., 2022). Likewise, the use of an AV to function as a VBIED could serve as an adaptation of existing suicide VBIED tactics or drone tactics utilized in warfare against civilian targets and commercial shipping. The use of a remote-controlled or self-guided VBIED to conduct terrorist attacks within the United States could develop as a future threat.

Notably, such attacks might not require remote hacks as AV technology advances. Rather, such vehicles used as weapons might involve custom software, foreign-provided software or controls, or physical hacks by those preparing the vehicle for an attack. However, a driverless-capable AV might not require any modification to conduct an attack. Instead, attackers could program any driverless-capable AV packed with explosives for a destination and trigger the explosives upon arrival.

Cybersecurity: AVs as Foreign Intelligence Collection Platforms

Foreign-owned or operated AVs raise security concerns given the amount of data such vehicles collect and the ability to operate and exfiltrate data from such vehicles to entities outside the United States. Such concerns resulted in the announcement of a Presidential Executive Order on February 28, 2024, as researchers completed this study (The White House, 2024b). Because of the data and images AV platforms gather in routine operations and the potential for such vehicles to include additional mobile electronic intelligence, signal intelligence, and measurement and signature intelligence collection platforms while operating unobtrusively within the United States, foreign-operated AVs may pose serious security challenges.

Conceivably, foreign intelligence services could utilize AVs to collect significant amounts of data and information without exposing themselves to detection, arrest, or detention. By controlling the vehicles from overseas or exfiltrating information from American-based systems, such vehicles can gather intelligence or perform surveillance without attracting attention.

Additionally, by harvesting data from connected vehicles, foreign intelligence services could gain valuable intelligence about individuals and facilities in restricted areas like military installations by collecting photography and data in violation of the Internal Security Act of 1950. Restricted areas on military installations forbid unauthorized entry and photography of the facilities without authorization from installation commanders. AVs driving through such areas would routinely violate such prohibitions just to maintain lane position or perform other everyday operations. This concern led the Chinese government to ban Tesla vehicles from some locations in China (Tabeta, 2021).

Another recent concern involves using foreign-owned, American-based AV companies to obtain advanced technology and processors restricted by export controls. Foreign AV companies could acquire information or technology in the United States that they intend to export through third-party countries, ultimately destined for export-controlled or sanctioned countries or companies.

Moody's—the leading business analysis and data firm—recently authored a white paper based on an analysis of companies worldwide using its Shell Company Indicator. In that paper and on its website, Moody's noted millions of shell corporations in the United States, India, China, and Europe that may hide beneficial ownership by sanctioned individuals or entities, facilitate tax avoidance, and provide cover for the re-export of export-controlled material and items through such companies (Moody's, 2024; Schickler, 2024). Such shell companies could hide foreign involvement in AV development companies in the United States.

While aspects of these concerns exist in the literature reviewed, such concerns are growing, suggesting a need for additional research to proactively counter these threats. The need for legal, regulatory, and policy countermeasures may also grow, and current presidential action and bipartisan congressional interest in such issues suggests that some of these changes may happen in the near term.

Threats to AVs

AVs engender public opposition from various quarters. Much of this opposition centers around safety concerns and takes the form of constructive measures to address those concerns or involves economic concerns related to workforce reductions (Bensinger 2023; Hawkins 2023).

In San Francisco, California, some individuals and opposition groups engaged in more direct action. This took the form of *coning* incidents where individuals and groups placed traffic cones on the hoods of self-driving taxis, which caused the AI to stop and go into standby mode (Griswold, 2023). This practice spread after widespread coverage of such actions on social media appeared in traditional media outlets (Paul, 2023). Some AV companies track such incidents but do not release such data, so the actual scope and impact of this problem remains unknown.

On February 10, 2024, protestors in San Francisco, California, took more direct action—physically attacking an autonomous taxi and setting it on fire—as seen widely in videos and photos shared on social media and picked up by traditional news outlets (Javaid, 2024). Because this event occurred toward the end of the literature review task, the full impact and response to such action remains unknown. Given the degree to which coning attacks spread after going viral on social media, additional direct attacks remain possible elsewhere, including in Texas. If the early attacks against motorists and early automobiles are a guide, such actions may grow and continue for some time until public safety concerns about AVs ease (Norton, 2011).

AVs at Ports and Other Multimodal Freight Facilities

Autonomous vehicles and machinery facilitate the operations and management of ports, mining operations, and other multimodal and production facilities to move and load intermodal containers and transfer freight. The ongoing push for freight automation can increase work efficiency and safety while reducing risk to humans at these facilities (Hope, 2023; Rogers, 2023). One report suggested seaports will deploy over 370,000 autonomous guided vehicles by 2030 (American Journal of Transportation, 2023).

The types and numbers of autonomous machines in operation vary by port or facility. For example, at the Newark Port, managed by the Port Authority of New York and New Jersey, autonomous street sweepers clear roadways in place of cleaning crew employees (Wilson, 2023). In 2021, Union Pacific announced testing of autonomous rail cranes at an intermodal railroad terminal in Joliet, Illinois, designed to increase efficiency and reduce emissions through a decreased reliance on a large fleet of trucks to move containers (Zimmerman, 2021). Over 29,000 inspection robots inspected rail infrastructure worldwide in 2022 (American Journal of Transportation, 2023). In 2023, Volvo announced the removal of safety drivers from AVs utilized at a mine in Velfjord, Norway, which transport carved limestone to a crusher with only limited human interaction (Hope, 2023). The company announced intentions to expand the use of its technology and partnered with a similar mine in Sweden focused on extracting zinc ore (Canadian Mining Journal Staff, 2023; Sawers, 2023).

On February 21, 2024, President Joseph Biden issued an executive order to bolster infrastructure and cybersecurity at the nation’s ports and announced the intent of the administration to onshore manufacturing of critical port infrastructure (Shirley, 2024; Executive Order No. 14,116, 2024). Concerns that led to the announcement involved the use of remotely operated cranes and other technology in American ports acquired from China (Elsberry, 2024; Viswanatha et al., 2023). Importantly, this executive order—and a corresponding Maritime Security Directive order—grants the U.S. Coast Guard express authority to respond to cyberattacks at the nation’s ports and to inspect and control vessels, machinery, and facilities believed to be potential cyber threat vectors (The White House, 2024a).

Automation of ports, freight terminals, rail transportation, and other industrial activities will affect first responders when called to respond to incidents at facilities employing automated freight movement systems. Located away from the public, such facilities typically require a reason for nonemployees to be on site. Those working at such sites will have safety training and experience working around heavy machinery and taking personal precautions to ensure their safety. However, responders familiar with current responses to incidents such as injuries to facility workers; fires in ships, buildings, and vehicles; or securing of crime or terrorist scenes may encounter new and additional risks and challenges when AVs are operating in the vicinity.

Therefore, the future may require new procedures, training, emergency plans, and pre-emergency coordination between facility operators, first responders, and emergency managers as automation increases at ports and other multimodal freight facilities. AVs at such facilities operate differently than AVs on public roadways and usually have some level of centralized control and human interaction. Port and multimodal facilities will need the ability to shut down operations in an emergency to protect workers and responders. Additionally, facilities may need to share such procedures and emergency contact information with responders.

An existing model for such cooperation and information sharing exists in chemical facilities across the United States through the U.S. Environmental Protection Agency's Emergency Planning and Community Right to Know Act Tier II Chemical Reporting Program and the Clean Air Act's Risk Management Program Rule requiring certain high-risk facilities to develop risk management plans, share important response information with local responders, and coordinate their emergency response plans with local emergency management (Trefz et al., 2019). This regulatory model may provide a way forward for automated facilities to interact and coordinate with first responders and emergency management.

III. POLICY AND NEEDS ASSESSMENT

In Task 3, the TTI research team analyzed policies regarding first responder interactions with AVs to develop an assessment of operational, legal, and other mechanisms that would address first responder awareness and safety concerns when interacting with AVs. This work involved the following:

- Stakeholder interviews to understand the level of awareness of AV activities in the state among TxDOT HERO program staff and contractors, as well as other first responders.
- An analysis of laws, regulations, and other policies addressing first responder interactions with AVs.
- Development of a set of operational and policy recommendations that will mitigate first responder awareness and safety concerns when interacting with AVs.

The purpose of this task was to assess Texas policies and needs regarding first responder awareness of AV activities. This chapter describes findings from the TTI research team's stakeholder interviews and subsequent policy analysis and recommendations.

ASSESSMENT APPROACH

For the stakeholder interviews, the research team developed an approach for collecting feedback from subject matter experts from different organizations and stakeholder groups relevant to first responder interactions with AVs. The stakeholders that met with the research team reflected a diverse set of opinions and perspectives about AVs, representing the broad scope and interests of the project. Stakeholder interviews consisted of guided discussions with 17 practitioners representing 10 organizations. The interviewees represented a wide range of viewpoints from those who are regularly engaged in AV deployments and first responder interactions with them to those with limited knowledge of AVs or first responder activities. In this way, the interviews helped the research team deepen their understanding of awareness among first responders of AV operations and safe interactions with them.

For the policy analysis, the research team scanned state regulations, statutes, and case laws in Texas and federal laws, regulations, and legislation to identify relevant provisions and analyze them against issues identified in the stakeholder interviews. The purpose of the policy analysis was to determine whether existing Texas state law or federal law addresses the first responder-AV interaction issues identified in the stakeholder interviews or whether changes are warranted. The review of these laws was also intended to reveal additional issues as well as legal and technical mitigation strategies that may be appropriate for Texas.

The research questions addressed in this task include the following:

- How aware are first responders in Texas (including TxDOT HERO program staff and contractors) of AV activities in the state?
- What best practices and lessons learned from other jurisdictions can be applied to Texas to increase first responder awareness of AVs and mitigate safety risks from first responder interactions with AVs?
- How do federal and Texas laws, regulations, and other policies affect first responder interactions with human-operated vehicles?
- How do federal and Texas laws, regulations, and other policies affect AVs?
- How do federal and Texas laws, regulations, and other policies affect first responder interactions with ADS-operated vehicles, and what best practices and lessons learned from other jurisdictions' policies can be applied to Texas to mitigate safety risks from first responder interactions with AVs?
- How do tort limitations in Texas affect TxDOT's efforts to mitigate safety risks to first responders as they interact with AVs?

- How can TxDOT and local government entities position themselves to mitigate risks to first responders as they interact with AVs?

Work Performed

To begin the task, the research team first identified broad stakeholder categories, including but not limited to Texas first responders, transportation law practitioners, private industry representatives, state transportation agency personnel, state highway patrol agency personnel, and local transportation agency personnel. Next, the team generated a list of proposed interviewees. Initially, 18 individuals from 10 organizations were identified as potential interviewees. After review by the TxDOT Project Monitoring Committee, the final list of interviewees included 17 individuals from 10 organizations.

At the same time, the team developed a standardized interview guide, which included a common set of questions to help ensure a comparable set of outcomes and value statements from the interviews. The interview guide ensured consistency and provided an overall structure to the interviews but allowed flexibility to focus on the practical expertise and experience of the interviewees. As preparation for the interviews, the team developed a PowerPoint slide deck to guide the discussions.

Following the stakeholder interviews, the research team completed their policy analysis by analyzing laws, regulations, and other policies addressing first responder interactions with AVs to provide issue spotting and mitigation recommendations. For this work, the research team scanned existing federal laws and regulations and proposed federal legislation, as well as state regulations, statutes, common law, and other policy documents.

The stakeholder interviews revealed answers to the following two research questions:

- How aware are first responders in Texas (including TxDOT HERO program staff and contractors) of AV activities in the state?
- What best practices and lessons learned from other jurisdictions can be applied to Texas to increase first responder awareness of AVs and mitigate safety risks from first responder interactions with AVs?

Having identified relevant laws, regulations, and policies, the research team sought to answer the remaining five research questions:

- How do federal and Texas laws, regulations, and other policies affect first responder interactions with human-operated vehicles?
- How do federal and Texas laws, regulations, and other policies affect AVs?
- How do federal and Texas laws, regulations, and other policies affect first responder interactions with ADS-operated vehicles, and what best practices and lessons learned from other jurisdictions' policies can be applied to Texas to mitigate safety risks from first responder interactions with AVs?
- How do tort limitations in Texas affect TxDOT's efforts to mitigate safety risks to first responders as they interact with AVs?
- What federal and state policy changes can position TxDOT and local government entities to mitigate risks to first responders as they interact with AVs?

The responses to these seven questions formed the basis of a set of operational and policy recommendations that could mitigate first responder awareness and safety concerns when interacting with AVs.

Stakeholder Interviews

The research team interviewed 17 stakeholders, categorized by their role or organization type as follows:

- First responders from:
  - State Highway Patrols
  - TxDOT HERO program.
- Transportation law practitioners including a:
  - Practicing attorney.
  - Sitting Texas judge.
- Private industry representatives from a:
  - Passenger vehicle AV company.
  - Commercial vehicle AV company.
- Public agency personnel involved in AV testing/first responder interactions from the:
  - Federal government.
  - City of Austin AV Safety Task Force.
  - Arizona state government.
  - California state government.

The project team conducted interviews between November 7, 2023, and December 6, 2023. For each scheduled interview, members of the TTI research team connected with interviewees via an online engagement platform and discussed the topics of the project (as expressed in the interview guide) for approximately 60 minutes. A team member led each scheduled call, while another team member served as a designated notetaker. For some calls, additional project team members joined to observe or participate in the discussion.

The agenda for the interviews generally included the following:

- Introductions.
- A description of the project background (the project overview and literature review findings).
- A discussion of the interview questions.
- Closing remarks.

During the introductions, team members notified interviewees that:

- The interview would be recorded but not transcribed.
- Their responses would not be attributed to them personally in any of the project deliverables.

The interview questions were generally consistent with the following topical concerns of this project:

- Experience with first responder-AV interactions.
- First responder interaction needs.
- First responder interaction risk mitigation strategies.
- Best practices and lessons learned.

STAKEHOLDER INTERVIEW FINDINGS

Main Findings

The stakeholder interviews revealed the awareness levels among first responder regarding AVs and the issues they present, the operational and policy needs of first responders to effectively interact with AVs, and any strategies and best practices developed to ensure safe AV interactions with first responders. Key findings included the following:

- **First responder awareness of AVs**: Those serving in urban areas and states where AVs are being tested and/or deployed and where AV companies have been communicating with state and local first responders were the most familiar and involved in AV-related working groups, task forces, and trade groups. The only exception was TxDOT HERO program contractors who have not been engaged by AV companies or involved in formal discussions regarding AVs.
- **First responder challenges with AVs**: first responder interviews revealed that they are concerned about:
    - Their ability to know when an ADS is engaged and how to take control of an AV during emergencies.
    - The ability of AVs to respond appropriately to first responder vehicle sirens, flashing lights, and hand signals, nonstandard traffic restrictions, and CMV inspection requests.
    - The lack of regulatory authority over AVs in Texas.
    - The lack of rules for the collection and use of AV-generated data.
- **Tracking and reporting incidents involving AVs**: The City of Austin maintains a public-facing, web-based Documented Incident Tracker, which is used to communicate with the public and as a basis for regular engagement between first responders and AV companies. Not many other cities or states have such resources available.
- **First responder operational needs**: The operational resources first responders reported they needed to effectively carry out their safety mission included:
    - Coordinated and standardized training.
    - New or revised standard operating procedures (SOPs) for interacting with AVs in potential emergency and enforcement situations.
    - Statewide guidelines requesting information AV companies should provide to state first responder agencies.
    - A protocol for inspections of automated CMVs.
- **First responder policy needs**: The stakeholder interviews revealed federal and state policy changes that could address first responder challenges with AVs, including federal regulations that codify vehicle safety standards for AVs, first responder interaction and communication protocols for AV companies, and inspection and first responder interaction protocols for AV trucks. Potential changes to state policies noted by interviewees included granting regulatory authority over AVs to state and local government agencies and requiring AV companies to submit LEIPs and train first responders prior to deploying their AVs on public roadways.
- **First responder exposure to liability**: Most interviewees agreed that AVs would not create further exposure to tort liability for first responders. With the exception of TxDOT's HERO program personnel, sovereign and governmental immunity would continue to protect first responders under state law as long as their actions were reasonable or found to be within the standard of care required by laws, regulations, and other policies. Because they are independent contractors of TxDOT, HERO program personnel are not shielded from liability in the same way as first responders who are government employees.
- **Strategies and best practices**: Interviewees recommended that Texas consider incorporating three best practices to mitigate AV-related safety risks to first responders:

- **Establish/maintain formal channels of communication:** Texas should establish formal, regular communications between AV companies and first responders—a practice that has proven crucial to building relationships and developing collaborative solutions to critical safety issues in other states. As part of this effort, Texas could establish a formal means of reporting AV-related incidents via a publicly accessible data tracking tool. Coordination and communication between and within state and local governments is also critical.
- **Request that AV companies submit LEIPs:** Texas should request (not require, in contravention of state law) that AV companies submit LEIPs prior to deployment on public highways—a best practice in Arizona, California, and a growing number of states adopting model AV legislation.
- **Request that AV companies train first responders:** Texas should request that AV companies provide in-person demonstrations, training, and other forms of education to first responders, including TxDOT HERO personnel, regarding their vehicles and how to safely interact with them.

Experience with First Responder-AV Interactions

The first set of interview questions focused on:

- First responders' awareness of AVs.
- Any challenges first responders experienced with AVs in the field when performing their public safety duties.
- Any tracking or reporting activities regarding AV-related incidents.

Awareness of AVs

The level of awareness among first responders varied depending on the presence of AVs in a particular jurisdiction and the level of coordination/communication between AV companies and state and local first responders. To date, passenger AVs have been testing and deploying as robotaxis concentrated on city roads in a small number of cities (e.g., San Francisco, California, and Austin, Texas), while automated CMVs testing occurred with safety drivers on interstates and state highways.

However, the prevalence of AVs will become increasingly widespread in the very near future. Aurora Innovation, Kodiak Robotics, and Gatik expect to remove safety drivers from driverless trucks for deployments on Texas highways by the end of 2024 (Black, 2024). Mercedes-Benz recently launched its Drive Pilot ADS in its sedans in California and Nevada, offering passenger vehicles equipped with SAE Level 3 autonomy to the public (see Figure II-1) where the vehicle can manage most aspects of driving, including monitoring the environment, without human intervention (Mercedes-Benz, 2023).

Stakeholder interviewees were, for the most part, familiar with AVs and aware of the issues they present to first responders. Many were involved in working groups, task forces, and trade groups actively working to address federal, state, and local operational and policy needs related to AVs, including CVSA's ADS Working Group, AVIA, the Texas CAV Task Force, and the AV Safety Task Force in Austin, Texas. Many of the first responder interviewees had not personally interacted with AVs in the field, but had, in most cases, engaged with AV developers and taken part in demonstrations and training conducted by the companies planning to deploy in their states.

Highway patrol interviewees from California and Texas had not worked much with AVs in the field but were very familiar with them from operational and policy perspectives, as part of national and statewide discussions. They noted that the level of awareness among their ranks varied depending on where officers were posted. In both states, all first responder interactions with AVs have occurred in major urban areas where AVs have been testing, so agencies such as the San Francisco and Austin Police and Fire Departments were the most experienced. In Austin, Texas, first responders have organized an AV Safety Task Force to track safety incidents, collect safety incident data, and develop SOPs for interacting with AVs.

The only stakeholder interviewees with minimal knowledge of AVs were the TxDOT HERO personnel. Similar to state police agencies, TxDOT HERO program personnel generally have jurisdiction over interstates and state highways where very limited to no AV activities take place (other than the testing of AV trucks with safety drivers). Unlike state (and local) police agencies, however, TxDOT HERO program contractors were not contacted by AV companies or approached for training opportunities. TxDOT HERO interviewees also noted that AVs were not discussed internally within the HERO program or with the leadership across their programs in Austin, El Paso, and San Antonio, Texas. This revelation is significant given that HERO personnel may arrive on-scene before other first responders because they often encounter incidents, vehicles, and people in need of emergency services before other first responders arrive or receive notification to respond.

As part of their contractual obligations, HERO personnel provide motorist assistance services (e.g., tire changes, fuel, water) and TIM services. They assist law enforcement, fire, rescue, and EMS agencies in maintaining and restoring the public safety of roadways, working in partnership with other first responders. Thus, it was surprising to find that TxDOT HERO program staff reported never encountering an AV and having very little understanding of AVs, characterizing their familiarity as "Very basic… what is reported in the press."

First Responder Challenges with AVs

Challenges that first responders have experienced or foresee experiencing in their interactions with AVs center on the following concerns:

- **The ability of first responders to know when an ADS is engaged**: The interviewees noted that they currently do not know how to distinguish whether an AV has its ADS engaged. Some pointed to the possibility of installing an external indicator (e.g., a colored light) on the outside of the AV. This feature is important to law enforcement officers and roadside assistance personnel when pulling over a vehicle that is in violation of a vehicle or traffic safety law, interacting with it on the roadside, or otherwise approaching the vehicle for any reason. Knowing whether the ADS is engaged informs the first responder of whether the vehicle operator is a human or machine; even if a human is in the vehicle as a passenger, the officer may need to approach the vehicle in a different way than if there were a human driver.

  One interviewee noted that this concern may be unwarranted to the extent that it applies to law enforcement pulling over vehicles. They noted that it is inherently unsafe for law enforcement to pull cars over, so AVs present an opportunity for them to rethink how they enforce certain laws. For example, they may not need to pull AVs over for speeding violations, choosing to cite the vehicles' owners through a form of automated enforcement instead.
- **The ability of AVs to respond to first responders**: Interviewees pointed to the need for AVs to perceive law enforcement, fire, and other emergency vehicle lights and sirens, as well as human traffic direction using arms or batons. When an AV has not been sufficiently programmed to respond to these types of cues, signals, and similar traffic control, it may not respond as a human driver would or should. Indeed, interviewees from the City of Austin reported that AVs tested on city roads struggled with sirens, lights, and human traffic control, especially during special events and emergency situations. City personnel have also observed AVs blocking passage of emergency vehicles and failing to move over to make way for emergency vehicles. Officials also reported instances where AVs did not yield as required to first responder vehicles or respond to police commands from their external speakers.

  These examples might not be unique to AVs, however. Interviewees from the California Highway Patrol noted that the communication challenges presented by AVs today are similar to those involving their interactions with vehicles around schools for the deaf in California. Many of the drivers are students at the school or involved in its activities and cannot hear sirens or verbal orders to pull over. One can anticipate AVs having the same issues. Because AVs must comply with statutory requirements, they will need to be programmed to respond appropriately.

- **The ability of AVs to adjust to restrictions**: Public sector interviewees noted that AVs are not currently well-equipped to learn about and adjust to temporary right-of-way changes, such as those found in work zones and incident management areas. In California and Arizona, AVs have been unable to navigate pinch points, hard closures, and roadblocks imposed by first responders. AVs will not react appropriately if they are not provided adequate real-time data about the traffic restrictions. The interviewees from governmental agencies also voiced their concern over their lack of access to information about whether a fleet's vehicles have been geofenced by the AV operator. This information and the ability to impose geofencing for AV fleets would be useful to first responders to understand where AVs may or may not be located, and in certain situations, keep AVs from areas where they should not be in, including critical infrastructure. Similarly, first responders would benefit from knowing whether AVs have speed limiters installed in them to be assured that they will drive safely on public roadways, especially when they are deployed on interstates and state highways.
- **The ability of AVs to comply with CMV inspection requirements:** Interviewees from state highway patrol agencies noted changes that would be needed to carry out mandated periodic inspections of automated CMVs. Many components of the current inspection regime involving human truck drivers do not apply to ADS-operated trucks. For example, law enforcement officers perform inspections of human-operated CMVs by having the driver push their brakes, beep their horn, and perform other actions. Law enforcement officers may be challenged when inspecting an AV truck unless there is a way for the ADS to communicate with law enforcement the necessary safety-related information about the vehicle, trailer, and ADS itself. Currently, weigh-in-motion and other technologies exist to inspect vehicles while they are moving. The FMCSA is conducting studies to test electronic inspections that provide data snapshots of driver health and vehicle components. In addition, CVSA's ADS Working Group has developed a safety data message set to pre-populate inspection reports. Regardless, many interviewees noted that law enforcement's expectations of ADS-operated CMVs will be the same as for human-driven CMVs.
- **The ability of first responders to take control of AVs:** Interviewees raised the concern that AVs will need to have a means of allowing first responders to take control of the vehicle with associated guidelines defining who grants permission for first responders to take control and under what situations operators should provide this control. The TxDOT HERO interviewees echoed this challenge because they typically approach drivers to ask their permission to relocate and take control over their vehicle if they present a hazard to the public. In the absence of any guidance from AV companies before this situation arises, the HERO personnel will not know who they should ask for permission or control to relocate the vehicle (e.g., to put the vehicle in neutral to tow it away or change a tire).

  Law enforcement, fire, and rescue personnel will also likely need to manually override AVs to carry out their public safety duties. To date, AV companies have offered varying procedures for first responders to take control of their vehicles. Interviewees reported that certain AV robotaxi companies place QR codes on windows of their vehicles for first responders to reach a remote assistant that could assist in emergency situations. Others have 1-800 numbers available for first responders to call. No standard exists across all AVs, however. A problem with incidents being reported to remote assistants is that, generally, remote assistants cannot *teleoperate* the vehicles remotely. Instead, they must dispatch a person to the vehicle or have the vehicle towed, which may take a long time according to some first responder interviewees.

Another problem with remote assistants is that no consistent way exists for them to verify that first responders are, in fact, first responders. The current system is vulnerable to fraud, so it was not surprising to learn from interviewees that during training events, AVs would not let police and fire personnel put the vehicles in manual mode because they could not recognize that they were authorized to do so. Remote assistance approval was needed to engage the manual override function, which could potentially impact the ability of first responders to adequately and timely respond to emergency situations.

- **The lack of regulatory authority over AVs in Texas:** Texas law expressly prohibits political subdivisions and state agencies from "impos[ing] a franchise or other regulation related to the operation of an automated motor vehicle or automated driving system" (7 Tex. Transp. Code § 545.452). This effectively bars any government body from regulating AVs in Texas. Therefore, first responder agencies cannot legally establish a consistent, standardized procedure for interacting with AVs, informing first responders of interaction protocols, training first responders on interaction protocols, and otherwise engaging with first responders on AV interactions.
- **The lack of rules surrounding the collection and use of AV data:** An issue raised by an interviewee that warrants attention is data privacy and the collection and use of AV-generated data. CAVs could, in the near future, send certain types of data to TxDOT and other state agencies for public safety purposes. For example, AVs navigate their environment through external and internal cameras, which produce data that could be surveilled by law enforcement for public safety purposes. This feature raises data privacy and cybersecurity concerns as industry is purportedly going above and beyond any state and local requirements to disclose more data and information than they are required to provide. There may be a need for government agencies who collect or otherwise benefit from receiving this data to determine to what extent first responders and AV companies will preserve the privacy rights of AV owners in the name of enforcing the rules of the road and other public safety matters.

Tracking and Reporting of Incidents Involving AVs

Partly to address the lack of local authority to regulate AVs and partly to understand the scale of traffic safety challenges of AV deployment, the City of Austin in Texas launched a data visualization dashboard to show the types of incidents being reported to the City and where they are located. The City pulls data from several sources, including the public's 3-1-1 service requests, Austin TPW Department reports, and other City departments, to produce a geography-based incident report that shows where AV incidents occur (Figure II-2). These incidents generally fall below the threshold of the NHTSA's *Standing General Order on Crash Reporting for Incidents Involving ADS and Level 2 ADAS*, (issued in June 2021 and amended in April 2023) under which AV manufacturers, developers, and operators must report certain types of crashes within 10 days of an incident.

The City of Austin in Texas uses their dashboard to communicate with the public and as a basis for regular engagement between first responders and AV companies. Once a week, the City sends information about reported incidents to AV companies and discusses them with the companies on a regular basis. In some cases, the City and companies walk hot spots to identify issues and discuss how to improve the technology. For example, through this process, the City and AV companies worked together to create a buffer zone where AVs could not enter during special events and prioritized repainting of KEEP CLEAR markings on roadways that AVs could appropriately detect and respond accordingly.

First Responder Interaction Needs

In terms of needs, first responders recommended operational and policy changes that would facilitate their work when interacting with AVs. Discussions around first responder needs focused on:

- Changes to operational procedures that would be helpful to meet first responder needs.
- Changes to federal and state policies that would be helpful to meet first responder needs.
- AV effects on first responders' exposure to liability.

Operational Needs

Interviewees expressed various needs for operational resources and procedures that are within the scope of powers of state agencies to address challenges that have and may continue to arise from first responder interactions with AVs. These needs included the following:

- **Training***:* Interviewees noted the importance of formal training for first responders, especially for TxDOT HERO personnel. In-person training conducted by AV companies can familiarize first responders with the AVs that will operate on Texas roadways, providing an opportunity for first responders to directly interact with AVs, learn about how AVs respond to first responders and how to manually override the ADS, and ask questions. Interviewees noted that a state agency should coordinate and standardize training, though AV companies may conduct the training. This oversight would allow for consistency in the training materials, training delivery, training recipients, training schedules, and subject matter covered.
- **SOPs**: For the same reasons that training would helpful, interviewees also mentioned the need for SOPs that would clarify the roles of state and local first responders and provide general guidelines for interacting with AVs in potential emergency and enforcement situations. SOPs for HERO, law enforcement, and other public safety personnel likely already exist for first responder interactions with human-operated vehicles. These existing SOPs will need to be reviewed and revised to accommodate interactions with AVs with and without safety drivers. Revisions should include contact information for AV company remote assistants and TMCs. Interviewees recommended that the SOPs be centralized and housed within a single state agency so that local jurisdictions know where to go and who to contact for the information.
- **Statewide guidelines:** Interviewees noted that first responders would benefit from development of new statewide guidelines that describe information AV companies should provide to state first responder agencies. The guidance would be advisory and not mandatory given the state's prohibition on regulating AVs. Interviewees from AV companies noted that they and their competitors are proactively engaging with public partners and willing to provide law enforcement interaction training and resources in the absence of any legal mandate to do so. Thus, the state guidelines could, at a minimum, request that AV companies provide the following information that would help first responders perform their public safety duties:
    - Descriptions of their vehicles and any external indicators that communicate that the ADS is engaged.
    - Contact information for remote assistants and information regarding the remote assistant's ability or inability to teleoperate the vehicles.
    - Contact information for the AV owner, who will receive and respond to requests for information and citations.
    - Procedures for approaching AVs, interacting with remote assistants, and manually overriding the vehicles.

  Interviewees also noted that the statewide guidance could request a certain level of cooperation with municipalities and safety-related data sharing from AV companies. The guidelines would describe the limits of data sharing and level of data aggregation that first responder agencies would find helpful. It would also provide the purposes for which first responder agencies will use the data, including insights into whether the vehicles are safe enough to operate on public roadways in the state.

The guidelines could also serve as a means of providing helpful information to AV companies, including names, phone numbers, and other information of points-of-contact at state and local law enforcement, local fire and rescue, the HERO program, and other first responder entities. Like the SOPs, interviewees recommended that the guidelines be centralized and housed within a single state agency so that AV companies know where to go and who to contact for the information.

- **Protocol for AV Truck Inspections***:* In the absence of a federal standard for periodic inspections of CMVs, interviewees expressed the need for the State to adopt CVSA's Enhanced CMV Inspection Program for Autonomous Trucks. Introduced in 2022, this program involves CVSA-trained motor carrier personnel conducting inspections on ADS-equipped CMVs from their fleets at the point-of-origin before dispatch, as well as in-transit at a dictated interval throughout the trip. Along the vehicle's route, the ADS is required to communicate to law enforcement while in-motion that the ADS is functioning and operating within its ODD. The AV trucks will then bypass weigh/inspection sites with roadside inspections limited to situations where there is an imminent hazard or as part of a post-crash investigation. As part of the program, all AV trucks are required to be able to respond to law enforcement should an officer attempt to pull over the vehicle.

  Texas' adoption of this protocol may be urgent; AV trucking companies are planning to deploy driverless operations in 2024 or 2025. Therefore, interviewees suggested that the State renew its commitment to follow CVSA standards for all safety processes and have private motor carrier personnel associated with the AV trucking companies undergo the program's training course and become certified to conduct the inspections.

  As a part of this effort, interviewees noted that FMCSA and Texas are already working with AV trucking companies to test inspection procedures for AV trucks. This coordination is helping the public and private partners to refine the safety datasets shared with law enforcement and the communications from law enforcement back to the AV trucks. The ongoing and fluid nature of this effort demonstrates that the protocol for AV truck inspections is evolving over time, which underscores the need to adopt a flexible approach to taking on any new inspection regime.

Policy Needs

Interviewees expressed various needs for legal and policy changes that will require administrative and legislative action. These policy needs will help address challenges that have and may continue to arise from first responder interactions with AVs, including the following:

- **Federal regulations:** Interviewees expressed the need for codification of national standards related to AVs. As a precursor to federal rulemakings, interviewees suggested that standards for AVs, including trucks, be drafted by industry organizations such as CVSA and AAMVA. Interviewees suggested that NHTSA's FMVSSs could be modified to address unique features of AVs and provide consistency across all AVs that first responders will interact with in the United States. Modifications could include standardization of the following:
  - An external indictor to communicate to those outside the vehicle that the ADS is engaged.
  - A compartment that first responders could access to retrieve necessary information (e.g., insurance, registration) during emergencies, traffic stops, or CMV inspections.
  - A manual override function.
  - A vehicle component (e.g., call box) that can connect first responders with remote assistant operations centers.

  Public and private sector interviewees agreed that federal regulations should be promulgated to standardize first responder interaction and communication protocols across the nation.

This would provide consistency and predictability for AV companies and first responders, eliminating the current state-by-state patchwork of content, delivery, and submission requirements for training; LEIPs; and data sharing.

- **FMCSA regulations:** In addition to NHTSA rule changes, interviewees noted that FMCSA regulations may require amendments to address first responder interaction needs with AV trucks, especially relating to inspections. FMCSA regulations could be revised to:
  - Mandate enforcement of FMCSA regulations through the CVSA Enhanced CMV Inspection Program for Autonomous Trucks.
  - Require submission of LEIPs, which FMCSA could collect and distribute to states and localities or alternatively authorize state public safety agencies to standardize and require LEIPs.
  - Clarify the conditions under which AV trucks can bypass weigh/inspection stations and the safety dataset that would need to be shared before, during, and after transit.
  - Ensure ADSs in trucks handle weather events appropriately and uniformly across the nation by prohibiting dispatches or routing to safe parking locations based on weather intelligence technologies or public advisories.
- **State law:** Interviewees noted that effective first responder preparation for and interaction with AVs would be best supported by changes to state policy positions on AVs. The most drastic measure the state could make would be to grant regulatory authority over AVs to state and local government agencies— no regulatory authority is currently enumerated in state statute. If rulemaking authority were to be granted to local governments—they currently exercise authority over micromobility devices (e.g., shared e-scooters and bicycles)—they could define the number of vehicles, the allowable areas of operation, and safety data sharing protocols. The state rulemaking authority could set baseline standards that provide consistency across the state and limit drastic changes between jurisdictions.

  Some interviewees suggested that if the state's AV law cannot feasibly be amended to provide regulatory authority to state or local authorities, other provisions of state statute could be used to provide such authority. For example, state laws governing the licensing of drivers could be changed to require issuance of driver's licenses to AV company fleets so that the AVs could be regulated as a driver is currently regulated. Existing state laws governing TNCs could also be amended to authorize the regulation of AVs providing TNC services (i.e., robotaxis).

  A less impactful and more practical/feasible measure would be to amend the state's AV law to require LEIPs as a condition of deployment. Interviewees noted that the model state AV bill from AVIA, which represents private AV interests, requires that AV companies and operators submit a LEIP before operating on the public roads of a given state (AVIA, n.d.). The model bill states that the LEIP should provide information on how to communicate with remote assistants, how to safely remove AVs from the roadway, how to recognize whether the ADS is engaged, and what hazards and public safety risks are associated with the operation of the AV. In addition to a LEIP requirement, some interviewees, including those representing private sector AV companies, also recommended that the state enact legislation that mandates training for first responders on safe AV interactions.

Exposure to Liability

Most interviewees agreed that AVs would not create any new form of exposure to tort liability for first responders. Most interviewees speculated that the immunity from liability that first responders currently enjoy under state laws would shield them as long as their actions were reasonable or found to be within the standard of care required by their governing laws, regulations, and other policies (e.g., SOPs). They felt confident that if they damaged an AV in an effort to clear a road, address injuries, or prioritize preservation of human life, they would not be found liable under existing law.

Similarly, interviewees reported no perceived need to rethink liability for ADSs and AVs. Under existing law, ADSs must meet the same reasonable person standard as human drivers. Thus, AVs are just as liable for traffic violations and civil lawsuits as human drivers. One unsettled legal question that interviewees noted was who to cite for a traffic violation committed by an AV. Most answered that if there is no human driver, or if the vehicle is being controlled by the ADS at the time of an incident, then either the registered owner or the carrier would be cited. However, some interviewees noted that existing laws imposing liability on the driver would need to be revised to include AV owners and operators within the definition of a driver.

Interviewees representing the HERO program highlighted the need to address their exposure to liability from interactions with human- and ADS-operated vehicles. They noted that because they are independent contractors of TxDOT, HERO personnel to not have the same shield from as other first responders who are government employees. They suggested to their counterparts at TxDOT that HERO contractors receive approval to ask motorists they are assisting to sign liability waivers before initiating any roadside assistance. Virginia authorizes this practice currently, but it is not currently authorized in Texas.

First Responder Strategies and Best Practices

The last set of questions during the stakeholder interviews asked for best practices and lessons learned regarding first responder interactions with AVs that could apply to Texas to increase first responder awareness of AVs and address first responder safety risks from AVs. The interviewees provided the following strategies and best practices for Texas to consider:

- **Establish and maintain formal channels of communication:** The most commonly cited strategies by private sector and public agency interviewees was to establish an interface and communications between government and AV companies. Formalized, regular communication between AV companies and state and local first responders proved crucial in building relationships and developing collaborative solutions to unforeseen critical safety issues as they arise. AV company interviewees reported that they seek to be helpful resources for first responders and perform proactive, voluntary outreach to government agencies. This outreach has taken the form of dedicated staff and resources for first responders, including videos and live demonstrations, which have helped to eliminate any misconceptions first responders may otherwise have. Local government interviewees welcomed this approach, reporting that multiple AV companies have opened lines of communication with them since launching operations within their cities.

  State and local government interviewees reported that regular meetings have proven helpful to first responders as they seek to reduce risks to people and property from AVs. Some interviewees recommended that Texas establish a formal means of public reporting of incidents involving AVs and providing information about such incidents via publicly accessible data tracking and visualization tools (e.g., dashboards, maps). Tracking incidents in this way can form the basis of formalized, regular discussions with AV companies that produce solutions. The City of Austin in Texas conducts monthly meetings with AV companies to examine incidents from their Documented Incident Tracker and develop collaborative solutions to prevent similar incidents. California officials have regular discussions with AV developers to discuss how law enforcement can communicate with AVs, how to tell whether the ADS is engaged, and how to handle ticketing and driving under the influence enforcement. The Arizona State Department of Transportation and public safety partners meet on a quarterly basis with AV companies to discuss incidents that fall below the threshold for NHTSA reporting. In the past, they have discussed the mitigation of undesirable AV actions (e.g., blocking emergency vehicles and not pulling over when directed) and the creation of an interaction strategy for communication to keep AVs out of incident areas.

Coordination and communication between and within state and local governments is also critical. The City of Austin in Texas established an AV Safety Task Force, which includes participation from all public safety agencies in Austin, to prepare and train for incidents, collect data, standardize documentation, and facilitate communication with AV companies. The task force acts as a single point-of-contact to communicate and share incident data with AV companies. The California Highway Patrol is developing information bulletins for agencies and officers across the state that describe how they should interact with AVs.

- **Request that AV companies submit LEIPs:** Having AV companies submit formalized interaction protocols (i.e., LEIPs) prior to deployment on public highways was another universally favored strategy recommended by most of the interviewees, regardless of whether a jurisdiction required them. This requirement part of model AV legislation supported by the AV industry. Although the contents of LEIPs vary by company, they generally address most significant questions that first responders have including where to find vehicle documentation and contact information for follow-up investigations; where the vehicles operate; and what power sources the vehicles rely on, where power source components are located, and where any no-cut zones are located. The Arizona DPS developed a Law Enforcement Interaction Protocol that dictates what to include in an AV LEIP, including procedures for manually overriding the vehicle, contact information for the remote assistants, and the ability of remote assistants to teleoperate the vehicle. In states that require LEIPs, AV companies submit their LEIP to a specific state agency. Following agency review, the AV company must revise the LEIP based on the feedback provided by the agency. In Arizona's case, LEIPs are reviewed by both the DOT and DPS. The review involves meetings between the DOT, DPS, and the AV company to go over LEIP requirements. In California, the DMV and Highway Patrol conduct LEIP workshops with local first responders to ensure that local law enforcement personnel are aware of the contents of LEIPs submitted to the DMV as a condition of an AV company's permit to operate in the state.
- **Request that AV companies train first responders:** Another common strategy that Texas could formalize is having AV companies provide demonstrations, training, and other forms of education on their vehicles and how to safely interact with them. Private AV developer interviewees noted the importance of being proactive and reaching out to offer training to first responders who typically do not have the time and urgency to seek the information for themselves. Most AV companies are already delivering in-person training that provides an opportunity for first responders to physically interact with their vehicles. They noted that even though they make videos available to first responders, in-person training is more effective at mitigating first responder concerns regarding how to communicate with AVs and how the vehicles respond to flashing lights, sirens, and human traffic control. In-person training is also an effective means of educating first responders about the ADS technology, elements of the LEIP, resource document locations, and disengagement procedures for the ADS.

  First responder interviewees reported the need for their agencies to prepare similar training for their own personnel. They foresee that, at some point in the near-term, AV interaction training will become standardized for law enforcement officers as a condition of certification at police academies.

POLICY ANALYSIS FINDINGS

TTI's policy analysis covered federal statutes, legislation, and regulations, as well as state statutory and common laws, regulations, and other policy documents addressing first responder interactions with AVs. The review addressed the following five questions:

- How do federal and Texas laws and regulations affect first responder interactions with human-operated vehicles?
- How do federal and Texas laws and regulations affect AVs?

- How do federal and Texas laws and regulations affect first responder interactions with ADS-operated vehicles, and what best practices and lessons learned from other jurisdictions' policies can be applied to Texas to mitigate safety risks from first responder interactions with AVs?
- How do tort limitations in Texas affect TxDOT's efforts to mitigate safety risks to first responders as they interact with AVs?
- How can TxDOT and local government entities position themselves to mitigate risks to first responders as they interact with AVs?

This section details the findings from this policy analysis. The following summarizes key findings from the review of federal and state policies:

- **How do federal laws and regulations affect first responder interactions with human-operated vehicles?** Federal policies set national safety standards for motor vehicles and delegate enforcement authority to NHTSA, FMCSA, and individual states. NHTSA's FMVSSs provide national standards for automobile fuel economy, technologies, equipment, and components (e.g., lighting, marking, braking, tires, seating, crash protection, seat belts, child restraints, and fuel systems). NHTSA has sole authority to enforce the FMVSSs; federal law does not allow delegation of this authority to the states. NHTSA also grants funding for training first responders and to improve law enforcement services targeting highway safety goals. FMCSA's FMCSRs set minimum safety standards for CMVs, including inspections. Federal regulations provide authority for both state and federal officials to enforce the provisions.
- **How do Texas laws and regulations affect first responder interactions with human-operated vehicles?** State policies authorize Texas DPS—through the Texas Highway Patrol and local authorities—to enforce laws related to vehicle and traffic safety, including those affecting CMVs. State laws and regulations also enumerate first responder requirements for interacting with motor vehicles and drivers, including stopping violators, directing traffic, and removing abandoned vehicles. In the same way, state laws regulate motor vehicle operator interactions with first responders in situations where they must pull over, move over, or otherwise yield the right-of-way to first responders.
- **How do federal laws and regulations affect AVs?** Despite attempts at regulatory and legislative action, the federal government has yet to codify national standards regarding AVs. AV-specific legislation has been introduced in Congress but has yet to be enacted. NHTSA and FMCSA have initiated their rulemaking processes to include standards for AVs but have yet to adopt finalized updates to the FMVSSs and FMCSRs. Until Congress passes legislation, and NHSTA and FMCSR finalize their rulemakings, the governance of AVs falls under the legal authority of individual states.
- **How do Texas laws and regulations affect AVs?** In the absence of federal rules governing AVs, states, including Texas, have enacted legislation or issued executive orders to authorize AV activity on state roadways. Texas law allows AVs to operate without a human operator in the state and prohibits political subdivisions and state agencies from regulating AVs. Another provision of Texas law authorizes the Texas Department of Licensing and Regulation (TDLR) to regulate the operation of TNCs under a permitting scheme.
- **How do federal and Texas laws and regulations affect first responder interactions with ADS-operated vehicles, and what best practices and lessons learned from other jurisdictions' policies can be applied to Texas to mitigate safety risks from first responder interactions with AVs?** Federal and Texas laws and regulations address certain elements of AV technologies, but do not address first responder interactions with AVs. However, other states and industry associations adopted laws and policies that address first responder interactions with AVs that Texas could enact. For example, Arizona, Oklahoma, and Mississippi's AV laws—enacted in 2021, 2022, and 2023, respectively—include similar provisions requiring AV companies to submit LEIPs before operating AVs on public roadways and providing authority to certain

state agencies to implement and enforce the law but not impose any additional regulations on AVs and CVSA—through its Enhanced CMV Inspection Program for Autonomous Trucks—is applying existing inspection standards to the unique needs, requirements, and challenges of ADS-equipped trucks.

- **How do tort limitations in Texas affect TxDOT's efforts to mitigate safety risks to first responders as they interact with AVs?** Under Texas statutes and common law, state agencies and local jurisdictions are shielded from tort liability, which can be waived if a constitutional or statutory waiver exists. Texas statutes generally do not extend this immunity to independent contractors, including TxDOT HERO personnel providing roadside assistance. However, first responders—defined by state law as government employees—are generally immune to claims for civil damages as a result of performing services within the scope of their duties. State agencies in Texas also benefit from state laws that cap damages on liability where immunity has been waived and establish proportionate responsibility that allows a reduction in a plaintiff's recovery if the plaintiff was partially to blame for their injury.
- **How can TxDOT and local government entities position themselves to mitigate risks to first responders as they interact with AVs?** Federal and state operational and policy changes could address safety risks to first responders interacting with AVs. Texas first responders would likely benefit from a national standard requiring AV and ADS manufacturers to meet conditions currently provided in Texas and other state laws, including requirements that AVs:
    - Comply with applicable state motor vehicle and traffic safety laws.
    - Be equipped with a recording device and a federally compliant ADS.
    - Achieve a minimal risk condition that reduces the risk of crashes if the ADS fails.
    - Bear the AV manufacturer's certification of compliance with the FMVSSs.

    Federal rules could also be promulgated to require AV companies to submit LEIPs and train first responders, as well as adopt CVSA's Enhanced CMV Inspection Program for Autonomous Trucks. Texas first responders would also benefit from changes to Texas laws that mirror other state AV laws by:
    - Authorizing TxDOT and Texas DPS to implement and enforce the law.
    - Adding an LEIP submission requirement.
    - Clarifying that autonomous CMVs are subject to state CMV safety laws.
    - Limiting liability for independent contractors involved in roadside assistance and other first responder duties.
    - Applying the TNC law to AVs operating as robotaxis.

Federal and Texas Law/Regulation Effects on First Responder Interactions with Human-Operated Vehicles

Federal Laws

Federal laws set safety standards for motor vehicles (state laws generally cover vehicle registration, driver licensing, traffic laws and enforcement, and motor vehicle insurance and liability regimes). As such, federal law is very limited regarding first responder interactions with motor vehicles.

Federal Motor Vehicle Safety Rules

In general, FMVSSs—promulgated by the USDOT through NHTSA—preempt any similar standard prescribed by a state. State motor vehicle safety standards are only enforceable if they are identical to or stricter than federal standards (49 USC § 30103). NHTSA's FMVSSs are codified in the form of regulations that implement the laws of Congress. These regulations—codified in 49 CFR Part 571—are intended to fulfill NHTSA's mission to prevent and reduce vehicle crashes. The FMVSSs provide national standards related to automobile fuel economy, technologies, equipment, and components such as lighting, marking, braking, tires, seating, crash protection, seat belts, child restraints, and fuel systems, among other things.

In addition to issuing and enforcing the FMVSSs, the role of USDOT (through NHTSA) is to provide federal grants to states, which are required under federal law to each have a highway safety program that is approved by the USDOT Secretary and "designed to reduce traffic accidents and the resulting deaths, injuries, and property damage" (49 USC § 401–402). Federal highway safety funds are granted to states to conduct their approved highway safety programs. States can use these funds for a variety of purposes, such as developing and implementing programs to reduce injuries and deaths resulting from excess speeding and driving under the influence; encouraging the proper use of occupant protection devices (e.g., seatbelts and child restraint systems); and preventing accidents involving motorcycles, pedestrians, bicycles, and school buses. These grant funds can also be used to train first responders and improve law enforcement services targeting a variety of highway safety goals, including preventing crashes and addressing impaired driving, occupant protection, and driving in excess of posted speed limits (49 USC § 402). Through approval of state highway safety programs for grants, federal law can shape first responder interactions with vehicles.

Federal Motor Carrier Safety Rules

Under federal law and regulation, NHTSA has authority to enforce the FMVSSs and does not delegate this authority to states. USDOT (through FMCSA) does, however, delegate enforcement powers of the FMCSRs to states that receive federal Motor Carrier Safety Assistance Program (MCSAP) funding. Specifically, federal law authorizes USDOT to delegate to such states "those duties and powers related to enforcement (including conducting investigations) … that the Secretary considers appropriate" (49 USC § 31133).

The federal government's authority to regulate CMVs derives from its duty to regulate interstate commerce under the U.S. Constitution. Similar to highway safety programs under NHTSA's authority, FMCSA administers the MCSAP, which provides formula grants that fund state activities intended to reduce the number and severity of CMV crashes. To receive MCSAP funds, states must submit CMV safety plans that implement state programs covering inspections, data collection, and reporting carried out by a designated state agency (49 USC § 31102).

Under FMCSA's authority to regulate interstate commerce, the FMCSRs are codified in 49 Code of Federal Regulations (CFR) Parts 350–399. The regulations set minimum safety standards for CMVs, including administration of the MCSAP; motor carrier registration; the maintenance, equipping, loading, and operating of commercial vehicles; commercial driver's licenses; and inspections. In some of these cases, FMCSA is responsible for enforcing safety requirements. More often, however, federal regulations provide authority for both state and federal officials to enforce the provisions.

One example of state agencies enforcing federal motor carrier safety rules is the inspection of CMVs. All CMVs are required to pass an inspection of all safety equipment required under the FMCSRs. Inspections can be conducted by authorized federal or state enforcement officials (49 USC § 31142[a]). Under federal law, states are allowed to impose and enforce more stringent standards for use in their own periodic CMV roadside inspection programs (49 USC § 31142[c]). Further, federal law allows state enforcement officials to make random inspections of CMVs (49 USC § 31142[d]).

These statutes are carried out in 49 CFR Part 396 where the FMCSRs require CMVs engaging in interstate commerce to be inspected at least once per year based on federal inspection standards or a state inspection program determined by FMCSA to be comparable to, or as effective as, federal standards (49 CFR § 396.17 and 396.23). Accordingly, if FMCSA determines a state's periodic inspection program is comparable to, or as effective as, the requirements of 49 CFR Part 396, motor carriers must ensure that all of their CMVs required by that state to be inspected through the state's inspection program are so inspected. FHWA has determined that Texas' periodic inspection program is comparable to, or as effective as, the federal periodic inspection requirements (81 Federal Register 14195).

Another example of state agencies enforcing federal motor carrier safety rules is the determination of unfitness. Under federal law, states who receive MCSAP funds can determine that an owner or operator of a CMV that is principally located in the state and engages in intrastate commerce is unfit under federal safety fitness standards and thereby prohibit them from operating the vehicle in the state (49 USC § 31144[d]). In such circumstances, FMCSA must prohibit the owner or operator from operating the vehicle in interstate commerce until the state determines that they are fit.

State Laws

While the Texas Transportation Code provides certain vehicle safety standards, the laws also include provisions that note their compliance with federal safety standards. For example, state standards for lighting, reflective devices, and associated equipment on a motor vehicle are consistent with or stricter than the FMVSSs. In some cases, state standards are in compliance with the current FMVSSs (or the standards in effect at the time the vehicle was manufactured); in other cases, state standards are prohibited (7 Tex. Transp. Code § 547.3215). Similarly, under state law, the FMCSRs prevail over a conflicting provision of state law applicable to a CMV operated in interstate commerce. However, state CMV laws prevail over conflicting provisions of the FMCSRs applicable to CMVs engaged in intrastate commerce (7 Tex. Transp. Code § 644.002).

Federal law expressly does not authorize USDOT or its modal administrations to prescribe traffic safety regulations or preempt state traffic regulations (49 USC § 31147). As such, states generally have oversight over traffic safety laws (rules of the road) and their enforcement. In Texas, the Texas Transportation Code (state law) and the Texas Administrative Code (state regulations) establish rules regulating traffic safety and CMVs.

Authority to Enforce Traffic Safety Laws

Under state law, Texas DPS (through the Texas Highway Patrol and local authorities) is authorized to enforce laws related to traffic safety. Specifically, 7 Tex. Transp. Code Subtitle C provides the authority to enforce traffic safety laws to Texas DPS—acting directly or through its authorized officers and agents and local authorities, including counties, municipalities, or other local entities authorized to enact traffic laws under state and local law (7 Tex. Transp. Code § 541.002).

Under state regulations, Texas DPS' purview to enforce traffic safety rules is clearly provided through the agency's mission and guiding policies. Texas DPS' mission includes supervision of traffic on rural highways (37 Tex. Admin. Code § 1.2). Among DPS' guiding policies is "to assume primary responsibility for traffic supervision on the rural highways of this state" (37 Tex. Admin. Code § 1.11[f]).

State regulations also provide the functional departmental programs, major service classes of the programs, and major activities under Texas DPS. One of the three functional departmental programs under Texas DPS is police law enforcement, which includes the highway patrol service among its eight service classes (37 Tex. Admin. Code § 1.3). The Highway Patrol Service falls under the Texas Highway Patrol Division. The Highway Patrol Service's major activities include police traffic supervision on rural highways and general police work primarily on rural highways (37 Tex. Admin. Code § 1.4[a]).

Local authorities are not allowed to enact or enforce traffic safety laws that conflict with state law but can regulate traffic in a manner that is consistent with state law (7 Tex. Transp. Code § 542.201). As such, local law enforcement may regulate traffic and enforce state and local traffic safety laws on roads within their jurisdiction (7 Tex. Transp. Code § 542.202). Per state regulations, local law enforcement are encouraged to conduct all police traffic supervision activities on all interstate highways within their jurisdiction such that "DPS officers will not be routinely assigned traffic supervision duties on these sections of the interstate systems." Even so, Texas DPS officers are authorized to "handle major dangerous violations they observe while traveling such sections and may take routine enforcement action" (37 Tex. Admin. Code § 3.52).

Authority to Enforce CMV Laws

Title 7 (Vehicles and Traffic), Subtitle F (Commercial Motor Vehicles) of the Texas Transportation Code delegates authority to enforce CMV safety laws solely to Texas DPS (7 Tex. Transp. Code § 644.001). Under state regulations, Texas DPS' purview to enforce CMV safety rules is clearly provided through the agency's mission and guiding policies. Texas DPS' mission includes supervision and regulation of commercial and for-hire traffic (37 Tex. Admin. Code § 1.2). Texas DPS' guiding policies include responsibility for traffic supervision on rural highways, including the regulation of commercial traffic (37 Tex. Admin. Code § 1.11[f]).

Major activities of the Commercial Vehicle Enforcement Service, which also falls under the Texas Highway Patrol Division, include supervision of CMV traffic (including assisting CMV owners and operators on technical matters, supervising motor carrier operations, and enforcing traffic laws applicable to CMVs) and traffic and criminal law enforcement on rural highways (37 Tex. Admin. Code § 1.4[b]).

State regulations specify that Texas DPS is responsible for enforcing registration requirements of CMVs in accordance with state law (7 Tex. Transp. Code Chapter 502) and policies and reciprocal agreements promulgated by TxDOT (37 Tex. Admin. Code § 4.31). All CMVs registered in Texas are required to pass an annual inspection of all safety equipment required by the FMCSRs, as well as regular inspections laid out in state statute (7 Tex. Transp. Code § 548; 37 Tex. Admin. Code § 4.36). In carrying out its duties, Texas DPS is authorized to stop, weigh, and cause any excess loads to be reduced to comply with state vehicle size and weight statutes (7 Tex. Transp. Code § 621–623; 37 Tex. Admin. Code § 4.51).

First Responder Requirements for Interacting with Motor Vehicles and Motor Vehicle Operators

Texas DPS traffic law enforcement officers are required to stop traffic law violators they observe and take enforcement actions against them, including issuing warnings and citations and performing custody arrests (37 Tex. Admin. Code § 3.21). They are allowed to conduct condition inspections of the drivers and vehicle equipment to assure compliance with safety and licensing requirements (37 Tex. Admin. Code § 3.26). When directing traffic, Texas DPS officers have discretion to indicate to drivers and pedestrians what to do or not to do and make emergency rules for the flow of traffic "when the usual regulations prove inadequate or when special regulations have not been made to meet unusual or unexpected traffic conditions." In doing so, they may direct traffic with hand signals and special equipment (e.g., whistle, baton, flashlight) (37 Tex. Admin. Code § 3.41).

State or local personnel operating an authorized emergency vehicle (i.e., fire department or police vehicles, public or private ambulances operated by Department of State Health Services licensees, and EMS vehicles) are permitted under state law to "park or stand, irrespective of any other provision of state traffic safety law" (7 Tex. Transp. Code § 546.001). They may also cautiously run through a red or stop signal or stop sign, exceed maximum speed limits, and disregard regulations governing the direction of movement or turning only when responding to emergency calls and fire alarms, pursuing actual or suspected violators, directing or diverting traffic for public safety reasons, or conducting a police escort (7 Tex. Transp. Code §§ 546.001 and 546.002). Operators of authorized emergency vehicles may violate state traffic safety laws in these ways as long as they use audible or visual signals, except if they are a police officer responding to an emergency call, avoiding the risk of collisions or prolonged pursuit, complying with state regulations, or pursuing a suspected violator. If police officers decide not to operate emergency lights or a siren in this way, they are advised under state regulations to "give consideration to the safety of others" (37 Tex. Admin. Code § 1.191[b]). They do not relinquish their duty of care to operate their vehicle "with appropriate regard for the safety of all persons; or the consequences of reckless disregard for the safety of others" (7 Tex. Transp. Code § 546.005).

Under state law, TxDOT is authorized to remove personal property (i.e., damaged or disabled motor vehicles, cargo, and hazardous materials and substances) from the right-of-way or roadway of the state highway system without the consent of the owner or carrier of the property if TxDOT personnel determines the property blocks the roadway or endangers public safety (7 Tex. Transp. Code §§ 472.011 and 472.012). In such cases, TxDOT officials and employees are not liable for damage to the personal property resulting from the removal or disposal of the property (unless the removal or disposal is done recklessly or in a grossly negligent manner) or failure to remove or dispose of the property (7 Tex. Transp. Code § 472.014). To carry out the removal of personal property from the right-of-way or state highway system, TxDOT is authorized to execute contracts with private businesses (7 Tex. Transp. Code § 472.015). State regulations detail the process for removal, storage, and disposition of abandoned vehicles. Texas DPS works with other police agencies to handle and dispose of all abandoned motor vehicles found or reported within their geographic jurisdiction. If no other police agency with jurisdiction over the area where the vehicle is found accepts responsibility, Texas DPS will process the vehicle (37 Tex. Admin. Code § 3.55).

Motor Vehicle Operator Requirements for Interacting with First Responders

Under existing state traffic safety laws, operators are bound by rules that govern how they interact with authorized emergency vehicles (7 Tex. Transp. Code § 541.201). When such vehicles approach using audible and/or visual signals, operators of motor vehicles are required to yield the right-of-way, immediately drive as close as possible to the curb, and stop and remain standing until the authorized emergency vehicle has passed (7 Tex. Transp. Code § 545.156).

The state's Move Over law requires motor vehicle operators to take certain safety measures when passing specific types of vehicles, including authorized emergency vehicles using visual signals, stationary tow trucks, TxDOT or TxDOT contractor maintenance or construction vehicles using visual signals, utility service vehicles, municipal solid waste vehicles, and toll operator vehicles. When approaching these vehicles on a highway with two or more lanes in the direction of the vehicle, motor vehicle operators must vacate the lane closest to the vehicle and slow to a speed not to exceed 20 mph less than the posted speed limit when the posted speed limit is 25 mph or more or 5 mph when the posted speed limit is less than 25 mph (7 Tex. Transp. Code § 545.157).

Motor vehicle operators are not allowed to follow any closer than 500 feet of a fire apparatus responding to a fire alarm or an ambulance that is flashing red lights. They also cannot drive into or park in a block where a fire apparatus has stopped to answer a fire alarm or where an ambulance has been summoned for an emergency call in such a way as to interfere with the ambulance's ingress and egress (7 Tex. Transp. Code § 545.407). Similarly, it is an offense for anyone to use their body, car, or a barricade to knowingly impede or otherwise interfere with a peace officer's investigation of unlawful conduct or reckless driving (7 Tex. Transp. Code § 545.4205).

Motor vehicle operators who are given a visual or audible signal by a police vehicle to pull over and stop but willfully flee or attempt to elude the officer are considered under state law to have committed an offense. The police officer's visual or audible signal can be given by hand, voice, emergency light, or siren. The officer must be uniformed with their badge prominently displayed and their vehicle must bear the insignia of their law enforcement agency (7 Tex. Transp. Code § 545.421). In the same way, it is an offense to willfully fail or refuse to comply with a lawful order or direction from a police officer, school crossing guard, or escort flagger for oversize or overweight vehicles (7 Tex. Transp. Code § 542.501).

Federal and Texas Law/Regulation Effects on AVs

Federal Laws

In 2016, the federal government increased its focus on the development and integration of AVs into the nation's transportation system. USDOT began issuing iterative policy guidance applicable to all AV use cases and regulatory agencies, including NHTSA, FMCSA, and FHWA and began seeking input on policies associated with the deployment of AVs. The U.S. Congress also saw legislative action on this topic. This section provides summaries of these regulatory actions and AV-specific bills.

American Vision for Safer Transportation through Advancement of Revolutionary Technologies Act and Safely Ensuring Lives Future Deployment and Research in Vehicle Evolution Act

In 2017, the U.S. Senate introduced SB 1885, the American Vision for Safer Transportation through Advancement of Revolutionary Technologies (AV START) Act, and the U.S. House of Representatives introduced HB 3388, the Safely Ensuring Lives Future Deployment and Research in Vehicle Evolution (SELF DRIVE) Act. The House bill passed out of the Energy and Commerce Committee; however, the Senate bill died before receiving a committee vote. The SELF DRIVE Act was reintroduced in the prior Congress (117th [2021–2022]) as HB 3711, but the legislation did not move any further than it had in 2017.

These two pieces of federal legislation have been the only AV-specific legislation introduced in the U.S. Congress to date. Both bills cover similar topics and, in many cases, use identical text. One critical topic the bills addressed was federal adoption of the SAE J3016 Levels of Automation taxonomy (Figure II-1), which are the accepted industry standard. Other critical topics covered in both bills included:

- The establishment of federal preemption over standards regulating the design, construction, or performance of highly automated vehicles, which the legislation defined as vehicles under 10,000 pounds operating with SAE Level 3- 5 automation systems.
- Requirements to streamline and define the federal exemption process for AVs.
- Relevance of human drivers to various existing federal safety and vehicle design standards, including passenger safety requirements, should the internal configurations for passengers in vehicles be modified.
- Parameters for a federal highly automated vehicle (HAV)— a vehicle equipped with SAE Level 3–5 ADS—on-road testing program.
- HAV safety evaluation reports submitted by vehicle manufacturers, inclusive of cybersecurity practices.
- Creation of a motor vehicle privacy database that includes information collected from individuals associated with the use and operation of CAVs and privacy policies.
- The establishment of an advisory committee and working groups to include:
    - A HAV technical committee comprising industry stakeholders to inform future agency actions.
    - A consumer education working group focused on helping consumers delineate between ADAS and ADS vehicles.
    - A data access advisory committee for the purpose of convening stakeholders to advise Congress on data management practices.
- Research initiatives into the potential effects on traffic wrought by the integration of ADS-equipped vehicles.

The most important aspect of both pieces of legislation is that they did not include AVs over 10,000 pounds. However, since 2017, it has become clear that automated trucks and other goods movement vehicles hold much more near-term promise than passenger vehicles, so it is anticipated that future federal AV legislation will include vehicles over 10,000 pounds.

Infrastructure Investment and Jobs Act

In 2021, the U.S. Congress enacted Public Law 117-58, the Infrastructure Investment and Jobs Act (IIJA or the Bipartisan Infrastructure Bill), which included the following provisions authorizing AV research and grant programs:

- **Section 11504, Study of Impacts on Roads from Self-Driving Vehicles**: This provision authorized a study on the existing and future impacts of self-driving vehicles to transportation infrastructure, mobility, the environment, and safety, including impacts on:
  - The interstate system.
  - Urban roads.
  - Rural roads.
  - Corridors with heavy traffic congestion.
  - Transportation systems optimization.
  - Any other areas or issues relevant to FHWA operations.
- **Section 13005, Emerging Technology Research Pilot Program***:* This provision created a new pilot program to conduct research and development in areas such as reducing the impact of AV driving systems and ADSs on pavement and infrastructure performance and improving transportation infrastructure design in anticipation of increased usage of ADSs and ADASs.
- **Section 13006, Research and Technology Development and Deployment**: This provision created a Center of Excellence on New Mobility and Automated Vehicles to collect, conduct, and fund research on the impacts of new mobility and AVs on land use, urban design, transportation, real estate, equity, and municipal budgets.
- **Section 25005, Strengthening Mobility and Revolutionizing Transportation Grant Program**: This provision authorized the creation of a new grant program at $100 million annually for demonstration projects focused on advanced smart city or community technologies and systems to improve transportation efficiency and safety. Grant funds may be used for intelligent, sensor-based infrastructure; systems integration; and smart technology traffic signals.

These and other IIJA provisions will expire on September 30, 2026, unless Congress acts to extend them beyond that date.

Other Federal Legislative Action

Recently, renewed interest and momentum on federal AV legislation has emerged in both chambers of Congress, including hearings that have included the themes of safety, workforce, and local coordination. However, no meaningful legislative action has been enacted to date.

In early 2022, House lawmakers launched a new Congressional Autonomous Vehicle Caucus, indicating what could be a promising outlook for future federal legislative action. Representatives Debbie Dingell (Democrat-Michigan-12) and Bob Latta (Republican-Ohio-05)—known industry stalwarts—are the Caucus co-leads. In February 2022, the House held its first dedicated hearing on AVs in over two years. Witnesses included organized labor, AV industry representatives, and state and local leaders, among others. In September 2023, the House held a hearing on The Future of Automated Commercial Motor Vehicles: Impacts on Society, the Supply Chain, and U.S. Economic Leadership with testimony from private industry, the trucking industry, and safety advocates.

Substantial barriers still exist for future federal legislative action, however. Such barriers include the following:

- **Organized labor:** Labor unions such as the American Federation of Labor and Congress of Industrial Organizations and the International Brotherhood of Teamsters have not coalesced on what they want to see in federal AV legislation. As a result, their primary Congressional allies have held up movement.

- **Change in agency leadership:** In January 2025, a new USDOT Secretary was nominated and confirmed. Administrators for NHTSA and FMCSA have been nominated but not confirmed as of March 2025. Congressional leaders understand that if a law is passed, the relevant agencies must be ready to implement the legislation. Such implementation is not likely to happen in the immediate future due to these staffing changes, along with other changes in the federal government, including reductions in force and policy reversals.

Federal Regulations

NHTSA's FMVSSs preempt any state or local standard that do not meet federal requirements and supersede any inconsistent state standards. Because the FMVSSs have not been adapted to address AVs, it has not yet been adjudicated whether state provisions on AVs in the Texas Transportation Code conflict or support federal AV authority.

NHTSA has initiated its rulemaking process to include standards for AVs, releasing new design standards for autonomous passenger vehicles and drafting a *Framework for Automated Driving System Safety*. These items have been released for public review and comment. The USDOT (through NHTSA) has also contributed to the discussion about a federal role in governing AVs and ADS, issuing guidance documents with suggestions for government and industry to follow in the development and regulation of AVs. As promising as this seems for a harmonized national legal landscape in which AVs can operate, until Congress passes legislation at the federal level and NHSTA updates the FMVSSs, the governance of AVs remains the responsibility of individual states.

Table III-1 and Table III-2 provide an overview of rulemaking and non-rulemaking regulatory actions, respectively, by federal agencies within USDOT focused on AVs as of February 2024. Such agency actions provided an important opportunity to anticipate potential federal regulations, identify concerns from industry, and stay abreast of topics of interest.

State Laws

Each year since Florida's legislative action in 2012, various U.S. states have considered and enacted AV legislation or issued executive orders. Texas is among those states that have acted—either by legislation or executive order—to authorize AV activity on state roadways.

In 2017, during the 85th Legislative Session, the Texas Legislature passed two AV bills: SB 2205 and HB 1791. SB 2205 amended the Texas Transportation Code to:

- Define an ADS as hardware and software installed in a vehicle that can collectively perform "all aspects of the entire dynamic driving task for the vehicle on a sustained basis," as well as "any fallback maneuvers necessary to respond to a failure of the system" without human intervention or supervision.
- Define an *automated motor vehicle* as a vehicle with an ADS installed in it (7 Tex. Transp. Code § 545.451).
- Place responsibility on the owner of an AV for compliance with traffic and motor vehicle laws whether or not they are physically in the vehicle.
- Allow licensing of ADSs to operate the vehicle in the state.
- Allow AVs to operate without a human operator in the state (7 Tex. Transp. Code § 545.453).
- Prohibit AVs from operating if they are incapable of operating in compliance with state traffic and motor vehicle laws, not equipped with manufacturer-installed recording devices and federally compliant ADS, not registered and titled in the State, or insured (7 Tex. Transp. Code § 545.454).
- Require AVs to comply with existing state law regarding accidents and reporting of accidents (7 Tex. Transp. Code § 545.455).
- Permit AV owners to identify them as such to the state (7 Tex. Transp. Code § 545.456).

Table III-1. Overview of Federal Rulemaking Actions (as of February 2024).

Title	Issuing Agency	Rule Status	Description	Relevance	Last Updated
Vehicle size and weight	FHWA	NPRM-March 2024	This rulemaking would amend FHWA's regulations in 23 CFR 657–658 governing vehicles subject to 23 United States Code (USC) 127 and 49 USC 31111–31112.	ADS sensors extend beyond the maximum allowable width limit and may impact state inspection requirements and procedures.	Fall 2023 Unified Agenda
Work zones	FHWA	NPRM-November 2023	This rulemaking would amend the regulations in 23 CFR part 630, subparts J (Work Zone Safety and Mobility) and K (Temporary Traffic Control Devices).	This rulemaking will determine how ADS developers certify safe vehicular interactions with work zones.	Fall 2023 Unified Agenda
MUTCD	FHWA	Final rule-Effective January 18, 2024	This rulemaking updated the MUTCD to reflect advances in technologies and operational practices that are not currently allowed in the MUTCD.	Consideration of roadway design, markings, and best practices for compliance affect potential liability.	February 2024 Significant Rulemaking Report v. 4
Motor carrier operation of ADS-equipped CMVs	FMCSA	NPRM-March 2024	This proposed rulemaking would allow FMCSA to amend the FMCSRs to ensure the safe introduction of ADS-equipped CMVs onto the nation's roadways. Proposed changes affect rules related to CMV operations, inspection, repair, and maintenance regulations.	This rulemaking would provide an agency with the most comprehensive—and preemptive—action on ADS-equipped CMVs to date.	February 2024 Significant Rulemaking Report v. 4
Electronic logging device (ELD) revisions	FMCSA	NPRM-October 2024	This proposed rulemaking would allow FMCSA to seek information to determine what changes to ELD regulations would be warranted.	Current ELD enforcement duties are performed by state law enforcement officers.	Fall 2023 Unified Agenda

Title	Issuing Agency	Rule Status	Description	Relevance	Last Updated
Unique electronic identification of CMVs	FMCSA	ANPRM-September 2022; Undetermined next action	This advanced notice allowed FMCSA to request public comment on potential amendments to the FMCSR that requires every CMV operating in interstate commerce to be equipped with an electronic device capable of communicating a unique identification number when queried by a roadside system.	This rulemaking could also serve to identify SAE Level 4 CMVs operating on the roads.	Fall 2023 Unified Agenda
Updating the petition process for FMVSSs	NHTSA	Terminated-May 30, 2022	This action allowed NHTSA to request public comment on proposed updates for the processing of petitions (49 CFR Part 552–553) for FMVSSs would improve the process for reviewing innovative safety technologies.	This rulemaking conveyed the continuing relevance of NHTSA's existing regulations, which define a process for the receipt, review, and processing of both the petitions for rulemaking and petitions for reconsideration.	Spring 2022 Unified Agenda
Occupant protection for vehicles with ADS	NHTSA	Final rule-Effective September 26, 2022	This rulemaking addressed the crashworthiness regulations that may be necessary to facilitate the certification of new vehicle designs equipped without driver controls. The final rule made clear that—despite their innovative designs—vehicles with ADS technology must continue to provide the same high levels of occupant protection that current passenger vehicles provide.	Representing one of the first final federal rules related to AVs, this rulemaking updated the FMVSSs specifically for ADS-equipped passenger vehicles.	Spring 2022 Unified Agenda
Uniform procedures for state highway safety grant programs	NHTSA	Final rule-Effective March 8, 2023	This rulemaking amended 23 CFR Part 1300 to implement the IIJA. NHTSA provides formula grants to states for the Highway Safety and National Priority Safety Programs and Racial Profiling Data Collection Grants, which the IIJA revised.	This rulemaking explains statutory elements for the triennial highway safety plan, the criteria and annual application requirements for grants under the National Priority Safety Program, and post-award administrative requirements.	Spring 2023 Unified Agenda

Title	Issuing Agency	Rule Status	Description	Relevance	Last Updated
FMVSS 150-Vehicle to vehicle (V2V) communication	NHTSA	Withdrawn-November 2023	This rulemaking would have required that all light vehicles be capable of V2V communication by use of onboard dedicated short-range radio communication (DSRC) devices.	This rulemaking signals the administration's shift away from V2V communication through DSRC to broadcast messages about a vehicle's speed, heading, brake status, and other information to other vehicles.	February 2024 Significant Rulemaking Report v. 4
Facilitating new ADS vehicle designs for crash avoidance testing	NHTSA	Currently analyzing ANPRM comments; expected to conclude October 2024	This advanced notice allowed for public comment on crash avoidance test procedures to facilitate the safe introduction and certification of new vehicle designs equipped with ADS.	This rulemaking could potentially impact FMVSSs and requirements for ADS vehicles.	February 2024 Significant Rulemaking Report v. 4
Considerations for telltales, indicators, and warnings in vehicles equipped with ADS	NHTSA	ANPRM-October 2024	This advanced notice allowed for public comment on amending the FMVSSs to address the applicability and appropriateness of safety messaging (telltales, indicators, and warnings) in new vehicle designs without conventional driver controls.	This rulemaking could potentially impact FMVSSs and requirements for ADS vehicles.	February 2024 Significant Rulemaking Report v. 4
Alternative options for rearview mirrors	NHTSA	Currently analyzing ANPRM comments; expected to conclude August 2024	This advanced notice allowed for public comment on the safety standard for rear visibility to facilitate new designs regarding the introduction and certification of cameras replacing rearview mirrors.	This rulemaking would determination whether cameras are sufficient replacements or augmenting tools for traditional mirrors.	Fall 2023 Unified Agenda

Title	Issuing Agency	Rule Status	Description	Relevance	Last Updated
Minimum performance standards for lane departure warning and lane-keeping assist systems	NHTSA	NPRM-October 2024	Pursuant to a statutory mandate in the IIJA, the proposed rulemaking would establish an FMVSS requiring that all passenger motor vehicles manufactured for sale in the United States on or after the compliance date be equipped with a lane departure warning system that warns the driver to maintain the lane of travel and a lane-keeping assist system that corrects the course of travel if the driver fails to do so.	This rulemaking signals the development of an FMVSS for SAE Level 1–2 ADAS.	Fall 2023 Unified Agenda
Framework for ADS safety	NHTSA	Currently analyzing ANPRM comments; expected to conclude May 2024	This advanced notice allowed for public comment on the development of a framework for ADS safety.	This rulemaking is extremely relevant to state DOTs because it will provide a framework to objectively define, assess, and manage the safety of ADS performance.	February 2024 Significant Rulemaking Report v. 4
Updating event data recorders (EDR) standard for time capture	NHTSA	Final rule-March 2024	In accordance with the 2015 Fixing America's Surface Transportation Act, this rulemaking amended 49 CFR Part 563 to update the current pre-crash recording duration for motor vehicles equipped with EDRs. For motor vehicles equipped with an EDR, the previous regulation required a 5-second pre-crash recording period at a frequency rate of 2 cycles/second (Hz).	This rulemaking is extremely relevant for all ADS vehicles and enforcement personnel.	Fall 2023 Unified Agenda
Passenger-less delivery vehicles equipped With ADS	NHTSA	2018 ANPRM deleted at agency request in 2021	This advanced notice (published in the Federal Register on January 18, 2018) allowed for public comment on existing regulatory barriers that may block the introduction and certification of ADS-equipped vehicles.	While action has been temporarily halted, this rulemaking is important for state DOTs because AVs do not fit neatly into existing motor vehicle laws.	Spring 2021 Unified Agenda

Title	Issuing Agency	Rule Status	Description	Relevance	Last Updated
Pilot program for collaborative research on motor vehicles with high or full driving automation	NHTSA	Withdrawn-2024	NHTSA withdrew this rulemaking. Based on further agency analysis, the proposals discussed in the ANPRM may be considered in a NHTSA rulemaking titled, "Expansion of Temporary Exemption Program to Domestic Manufacturers for Research, Demonstrations, and Other Purposes."	This rulemaking indicates changing federal agency priorities related to AVs. Additionally, appropriate terminology for ADS vehicles has evolved, and regulatory actions would no longer use the phrase *high or full automation*. It is critical that future government action on AVs use accurate language.	February 2024 Significant Rulemaking Report v. 4
Exemption and demonstration framework for ADS	NHTSA	NPRM-November 2023	This proposed rulemaking would support development of a framework for the review and assessment of ADS-equipped vehicles to evaluate operations or requests for exemptions.	This rulemaking will inform NHTSA's approach to future AV rulemaking and oversight.	Fall 2023 Unified Agenda
Expansion of temporary exemption program to domestic manufacturers for research, demonstration, and other purposes	NHTSA	NPRM-January 2024	This proposed rulemaking would allow entities to request exemptions to operate nonconforming vehicles on public roads for purposes of research, investigations, demonstrations, training, competitive racing events, show, or display, but not sale or lease. It would also establish new submission and reporting requirements for vehicles to be exempted under the new regulation, mirroring those applicable to exempted imported vehicles.	The potential for novel vehicle types to operate on public roadways may challenge state transportation and law enforcement agencies.	Fall 2023 Unified Agenda
Assessment of FMVSS test procedures	NHTSA	Currently analyzing ANPRM comments; expected to conclude June 2024	This advanced notice allowed for public comment on FMVSS test procedures that may not account for today's new vehicle designs, including EVs.	This rulemaking will inform NHTSA's approach to AV testing.	Fall 2023 Unified Agenda

Title	Issuing Agency	Rule Status	Description	Relevance	Last Updated
ADS-equipped vehicle safety, transparency, and evaluation program	NHTSA	NPRM- December 2024	This proposed rulemaking would support development of a voluntary framework for the evaluation and oversight of motor vehicles equipped with ADS. The ADS-equipped Vehicle Safety, Transparency, and Evaluation Program would establish a national program for ADS-equipped vehicles that operate or may operate on public roads in the United States under NHTSA's oversight with the goal of improving public transparency related to the safety of certain ADS-equipped vehicles, while allowing for responsible development of this technology	This rulemaking will provide additional data to assist NHTSA in future rulemaking regarding AVs and ADS.	December 2024

Table III-2. Overview of Federal Nonrulemaking Regulatory Actions (as of February 2024).

Title	Description	Relevance	Date(s) of Interest
GM-Receipt of petition for temporary exemption from various requirements of the FMVSSs for an ADS-equipped vehicle	On February 17, 2022, GM submitted a petition for exemption for its Cruise Origin vehicle, which GM states is a multipurpose passenger vehicle equipped with SAE Level 4 ADS. This document notifies the public that NHTSA has received from GM a petition for a temporary exemption from portions of six FMVSSs. GM requested a two-year exemption, during which it sought to be allowed to manufacture not more than 2,500 exempted vehicles for each 12-month period covered by the exemption.	This action was important given the withdrawal of Cruise robotaxis from U.S. streets due to safety issues. Once back in operation, the potential exists for novel GM vehicles operating on public roadways and impacting enforcement personnel.	Published in the Federal Register in July 2022 and August 2022
Ford Motor Company-Receipt of petition for temporary exemption from various requirements of the FMVSSs for an ADS-equipped vehicle (Withdrawn)	Ford withdrew its July 2021 exemption petition under 49 CFR Part 555 for a vehicle equipped with SAE Level 4 ADS that can be operated in either a human-driven mode (manual mode) or in an ADS-driven mode (AV mode). Ford sought the exemption from portions of seven FMVSSs to allow for the controlled deployment and usage of the vehicle on tested, proven roadways during appropriate weather conditions. Ford requested a two-year exemption, during which it sought to be allowed to manufacture not more than 2,500 exempted vehicles for each 12-month period covered by the exemption.	This action would have been important given the potential for novel Ford vehicles to operate on public roadways, and the impact of those vehicles on enforcement personnel. The reason for withdrawal was not specified.	Published in the Federal Register on March 31, 2023
NHTSA agency information collection activities-Human interaction with ADS	NHTSA sought public comments about its proposed collection of information supporting research addressing safety-related aspects of drivers' interactions with ADS.	This research will support NHTSA in understanding the potential safety challenges associated with human-ADS interactions, particularly in the context of mixed traffic interactions where some vehicles have ADSs and others do not.	Published in the Federal Register on December 12, 2023; comments are due on February 12, 2024

Title	Description	Relevance	Date(s) of Interest
NHTSA agency information collection activities–FMVSS considerations for vehicles with ADS: Seating preference study	NHTSA announced that an Information Collection Request will be submitted to the Office of Management and Budget for review and approval. This new information collection effort will gather both objective and subjective data regarding occupant/passenger seat preference in ADS-DV via experiments.	This study will provide NHTSA information about the seating preferences of occupants in vehicles that do not require a human driver in the left front seat.	Published in the Federal Register on March 20, 2023
NHTSA second amended standing general order on crash reporting	NHTSA issued a standing general order requiring identified manufacturers and operators to report to the agency certain crashes involving vehicles equipped with an ADS or SAE Level 2 ADAS.	This information will support safety evaluations of ADS on public roads. Information will include public safety data classified by the reporting entity. Although the data will omit important context factors, this effort will still reflect the most CAV safety information that has ever been collected and made publicly available. State DOTs should track how this information is shared and how it may be used for safety enforcement by NHTSA.	First published in July 2021 and updated on May 15, 2023; the first data dump occurred in June 2022, with expected data dumps every month; all data will be publicly available on the NHTSA site
Nuro, Inc.-Grant of temporary exemption for a low-speed vehicle with an ADS	On Feb 6, 2020, NHTSA announced the first-ever temporary exemption from specific FMVSSs for a driverless vehicle; the exemption was awarded to Nuro, so the company could operate its purpose-built delivery vehicle on public roads.	NHTSA's response to the GM and Ford petitions listed above will further indicate USDOT's willingness to move forward on federal AV regulations and grant exemptions for AVs with passengers instead of just goods.	Announced in February 2020; continued exemption validity is uncertain
Einride-Exemption	Einride received approval from NHTSA to test its autonomous, electric truck prototypes on public roads. The Pod will still be monitored by a remote operator, who can assume control if needed, but it will otherwise be operating in an automated manner on public roads.	This exemption was likely motivated by the EV aspect. Additionally, Einride has a unique perspective on workforce, viewing a remote operator as inherent to operations. That viewpoint likely provided yet another greenlight for federal exemption approval.	Announced on June 23, 2022

Title	Description	Relevance	Date(s) of Interest
HOLON U.S., Inc.-Receipt of petition for temporary exemption from various requirements of the FMVSSs for an ADS-equipped vehicle	On August 28, 2024, HOLON submitted a petition for exemption for its HOLON bus, which HOLON states is an SAE Level 4 ADS-dedicated vehicle. Specifically, HOLON petitioned NHTSA for a temporary exemption from portions of seven FMVSSs. HOLON requested a two-year exemption, during which it sought to be allowed to manufacture not more than 2,500 exempted vehicles for each 12-month period covered by the exemption.	Uniquely, HOLON is seeking to construct and deploy a fleet of ADS-equipped SAE Level 4 buses designed to hold up to 15 passengers without the usual human operator driving component.	Announced on November 18, 2024

The second bill, HB 1791, passed in 2017, allowing the use of connected braking systems for platooning of connected vehicles on Texas roadways. Connected braking systems allow for the braking of one vehicle to be electronically coordinated with the braking system of a following vehicle. Platooning occurs when "an operator of a vehicle equipped with a connected braking system that is following another vehicle equipped with that system may be assisted by the system to maintain an assured clear distance or sufficient space" (7 Tex. Transp. Code § 545.062[d]).

In 2021, during the 87th Legislative Session, the Texas Legislature passed HB 3026. The bill amended the Texas Transportation Code to exempt automated motor vehicles from:

- State motor vehicle equipment laws and regulations that support human operation of vehicles or are not relevant to ADS.
- Required vehicle safety inspections with respect to any equipment, as long as they are not a trailer, semitrailer, pole trailer, or mobile home, and equipped with ADSs designed to be operated exclusively by the ADS for all trips (7 Tex. Transp. Code § 547.618).

The bill also expressly limited regulation of AVs to state statutes and prohibited political subdivisions and State agencies from "impos[ing] a franchise or other regulation related to the operation of an automated motor vehicle or automated driving system" (Tex. Transp. Code § 545.452). This effectively bars any government body from regulating AVs in Texas.

Whether these provisions conflict with or support federal AV authority has not yet been adjudicated. Thus far, federal ADS safety standards have not been promulgated, so under Tex. Transp. Code § 545.454, AVs are allowed to operate in Texas so long as they are capable of operating in compliance with state traffic and motor vehicle laws, equipped with manufacturer-installed recording devices, registered and titled in the state, and insured. In addition, under Tex. Transp. Code § 547.618, AVs are assumed to have passed state safety inspections. This may potentially come in conflict with federal regulations in the future, so it is an issue to monitor.

Another issue that warrants monitoring is the procedure for reporting accidents. Under Texas law, protocols around crashes involving AVs must conform with existing procedures under Chapter 550 of Texas. Transportation Code. However, NHTSA's Standing General Order Update, issued in June 2021 and amended in April 2023, creates a three-year reporting obligation for named manufacturers, developers, and operators of Level 2 ADAS and Levels 3 through 5 ADS in which covered crashes must be reported within 10 days of the incident. Thus, owners of AVs in Texas must comply with two parallel requirements for accident reporting.

While they do not directly affect AVs, State statutes regarding TNCs should be looked at because, as the stakeholder interviews revealed, they could be amended to provide a way for the State to regulate certain types of AVs. To the extent that AVs are used as "robotaxis" and can be classified as TNC vehicles, they will be subject to the law, provided in the Texas Occupations Code (Tex. Occ. Code), Title 14 (Regulation of Motor Vehicles and Transportation), Subtitle C (Regulation of Transportation Services). The statute grants authority to the Texas Department of Licensing and Regulation (TDLR) to regulate the operation of TNCs, which are defined as a "corporation, partnership, sole proprietorship, or other entity that, for compensation, enables a passenger to prearrange with a driver, exclusively through the entity's digital network, a digitally prearranged ride" (Tex. Occ. Code § 2402.001(5)). Local governments are prohibited from regulating TNCs in the State but can adopt and enforce traffic rules that apply to TNC and non-TNC drivers (Tex. Occ. Code § 2402.003).

Unlike the State statute governing AVs, the TNC statute requires TNCs to acquire a permit from TDLR before operating in the State. Tex. Occ. Code §2402.051. TNCs are subject to specific requirements related to their drivers and vehicles. They must implement an "intoxicating substance policy that prohibits a driver who is logged in to the company's digital network from any amount of intoxication." confirm that their drivers are at least 18 years old and have a valid driver's license and proof of registration, conduct background checks on their drivers, and review their driving records (Tex. Occ. Code §§ 2402.106 and 2402.107). They must also prohibit individuals with certain criminal records from driving for them (Tex. Occ. Code § 2402.107). TNCs are also required by law to provide training to each of their drivers on human trafficking awareness and prevention (Tex. Occ. Code §2402.1075). Under the statute, TNC vehicles must conform to existing State vehicle safety laws (Tex. Occ. Code § 2402.111). Further, the statute specifies record retention and submission requirements and authorizes TNCs to share data with municipalities (Tex. Occ. Code §§ 2402.151 and 2402.154). These provisions are interesting because the business model for AV companies such as Waymo and Cruise has involved the use of their vehicles for TNC purposes. So, while they may not be regulated by any governmental agency in Texas in terms of operating AVs, they may be regulated by TDLR as TNCs.

How do federal and Texas Law Affect First Responder interactions with ADS-operated Vehicles, and what Best Practices From Other Jurisdictions' Policies can be Applied To Texas To Mitigate Safety Risks From First Responder Interactions with AVs?

While federal legislation and the 2017 and 2021 Texas bills addressed certain elements of AV technologies, they did not address all policy questions that these innovative technologies present. This includes First Responder interactions with AVs. One may look to other States and industry associations for laws and policies that address First Responder interactions with AVs and could be applied to Texas.

New York's AV Law

New York's AV law was enacted in 2017, allowing demonstrations and tests of AVs on State roadways. The law authorized the New York State Commissioner of Motor Vehicles to approve the demonstrations and tests, which must be supervised by the New York State Police. The law required that AV demonstrations and tests "take place in a manner and form prescribed by" the New York State Commissioner of Motor Vehicles, giving the New York State Department of Motor Vehicles authority to regulate AVs.

The following year, New York became the first State to enact legislation addressing First Responder interactions with AVs. In 2018, the State Legislature enacted A 9508, which amended the State's 2017 AV bill to expand regulatory authority of AV demonstrations and tests to the New York State Police. In addition, the bill required a "law enforcement interaction plan" as part of the demonstration and test application. Under the bill, which now exists as State statute, each AV company must include in their LEIP "information for law enforcement and first responders regarding how to interact with [AVs] in emergency and traffic enforcement situations."

New Hampshire's AV Law

In 2019, the New Hampshire State Legislature enacted SB 216, which directed the State's Department of Safety's Division of Motor Vehicles to establish a pilot program to test AVs on public roads within the state. To test AVs on New Hampshire roads, AV companies are required to provide notice to the Department of Safety's Division of Motor Vehicles, which has authority under the law to suspend or refuse an AV company's participation in the pilot program. The law, however, bars any state or local entity from imposing "a tax, fee, or other requirement on the operation" of the pilot program, ADS-equipped vehicles, or ADS generally if the tax, fee, or other requirement "relates specifically to the operation of ADS-equipped vehicles."

To participate in the AV pilot, an AV company's notice to the Division of Motor Vehicles must include two items of information. The first is an acknowledgment that their AVs are capable of achieving minimal risk condition (defined as "a reasonably safe state to which an [ADS] brings an ADS-equipped vehicle upon experiencing a performance-relevant failure of the vehicle's [ADS] … such as bringing the vehicle to a complete stop and activating the hazard lamps") if the ADS malfunctions and renders the system unable to perform as intended.

The second requirement of the AV testing entity's notice is a copy of their ERG. The guide must include instructions to "law enforcement, fire, and emergency medical personnel on safe interaction with the vehicle in emergency and traffic enforcement situations." The Department of Safety's Division of Motor Vehicles must distribute the ERG to all law enforcement, fire, and emergency response personnel with geographic jurisdiction over the testing area.

SB 216 also establishes an AV Advisory Commission and details its duties and responsibilities. Among the commission's duties and responsibilities is a requirement to develop a training curriculum for law enforcement and first responders.

Arizona's AV Law

In 2021, the Arizona State Legislature enacted AV legislation (HB 2813) that authorizes the Arizona Department of Transportation (ADOT) to suspend, revoke, or cancel the registration of an AV or otherwise restrict an AV's operations for safety reasons. The bill prohibits counties, cities, and towns from imposing taxes, fees, for-hire vehicle requirements, or other requirements on ADS/AVs or AV operators, allowing ADOT and the Arizona Department of Public Safety (ADPS) to implement or enforce the state's AV laws, provided that "neither agency may prescribe procedures or rules that are unreasonable or unduly burdensome."

HB 2813 allows AVs, including AV trucks, to operate with a human operator "who is able to resume part or all of the dynamic driving task or respond to a request to intervene." The law also allows AVs to operate without a human safety driver if two conditions are met. First, the person who wishes to operate the AV without a driver must submit a written statement to ADOT acknowledging that the AV is equipped with federally-compliant ADS; will achieve a minimal risk condition if the ADS fails to perform the entire dynamic driving task; is capable of complying with all applicable state traffic and motor vehicle safety laws; and meets all state title, registration, licensing, and insurance requirements. Importantly, no one can operate a driverless AV in Arizona until they submit a LEIP to ADOT and ADPS. Failure to provide the written statement or LEIP can result in a cease-and-desist letter prohibiting the operation of the AV on public roadways in the state.

The LEIP must be consistent with all elements of the *Law Enforcement Protocol for Fully Autonomous Vehicles,* published by ADPS in 2018. Required by HB 2813, the AV protocol must provide guidelines for providing information to law enforcement agencies and other first responders regarding how to interact with AVs in emergency and traffic enforcement situations, including how to provide contact information for insurance and citation purposes and other information needed to ensure the safe operation of AVs in the state.

Oklahoma's AV Law

In 2022, Oklahoma enacted their AV bill, SB 1541, which—like the Arizona law—authorizes the State's DOT and DPS (ODPS) to promulgate regulations to implement the law. Otherwise, the state's AV statute contains all rules governing AVs in the state, expressly preempting local authority to prohibit, restrict, or regulate AVs in the state and superseding any existing local law or ordinance of that prohibits, restricts, or regulates the testing or operation of AVs.

SB 1541 requires those who wish to operate an AV on public roads in Oklahoma to submit to ODPS a LEIP that must contain, at minimum, information on how to communicate with a fleet support specialist any time the AV is in operation, how to safely remove the AV from the roadway, how to recognize whether the AV is in autonomous mode, and how to safely tow the vehicle, as well as any hazardous conditions or public safety risks associated with the operation of the AV. ODPS is authorized under the law to issue regulations to clarify the contents of LEIPs.

Mississippi's AV Law

The most recent enactment of an AV bill that addresses first responder interactions with AVs is from 2023 in Mississippi. HB 1003 is similar to the Arizona and Oklahoma AV laws, requiring that anyone who wishes to operate a driverless AV submit a LEIP to the State's DPS. The LEIP must describe how to communicate with a fleet support specialist any time the AV is in operation, how to safely remove the AV from the roadway, how to recognize whether the AV is in autonomous mode, and how to safely tow the vehicle, as well as any hazardous conditions or public safety risks associated with the operation of the AV. Unlike the Oklahoma law, the Mississippi law requires that the LEIP include "other elements determined to be necessary by the Department of Public Safety and made publicly available on the Department of Public Safety's website." Like Arizona's AV law, failure to provide the LEIP can result in a cease-and-desist letter prohibiting the operation of the AV on public roadways in the state. Interestingly, the law's LEIP requirement sunsets on July 1, 2026.

Like the Arizona and Oklahoma AV laws, Mississippi's AV statute alone governs AVs in the state and only specified state agencies (here, the DPS and Department of Revenue) are authorized to implement and enforce the AV law. The Mississippi law is also similar to the Arizona and Oklahoma AV statutes in that it bars any state agency, political subdivision, municipality, or local entity from prohibiting AVs or enacting or enforcing "rules or ordinances that would impose taxes, fees, or other requirements, including performance standards, specific to the operation of" AVs in addition to the requirements included in existing state law.

New Jersey's AV Legislation

In the current session (2024–2025), the New Jersey State Legislature is considering several AV-related bills, including a bill to permit testing and use of AVs on state roadways (A 1589). While New Jersey has not yet authorized AVs to test or deploy on its roadways, the state enacted legislation in 2020 to establish a New Jersey Advanced Autonomous Vehicle Task Force to "to conduct a study of advanced [AVs] and to make recommendations on laws, rules, and regulations that this state may enact or adopt to safely integrate advanced [AVs] on the state's highways, streets, and roads."

In prior sessions, the State Legislature has considered but not passed a bill (A 2495) that would, like the New York AV law, establish a training program to prepare law enforcement and first responders to interact with AVs. Under the bill, the Attorney General, in consultation with the Commissioner of Transportation, would "develop or approve a training course and curriculum for law enforcement officers regarding how to safely interact with [AVs] in emergency and traffic enforcement situations." The training course and curriculum would be reviewed and modified at least every five years. All law enforcement agencies in the state would be required to complete the training.

Kentucky's AV Legislation

In its current session, the Kentucky State Legislature is considering a bill similar to the Arizona, Oklahoma, and Mississippi AV laws, requiring that anyone who wishes to operate a driverless AV submit a LEIP to the State's Transportation Cabinet and Department of Kentucky State Police. The LEIP must describe how to communicate with a fleet support specialist any time the AV is in operation, how to safely remove the AV from the roadway, how to recognize whether the AV is in autonomous mode, and how to safely tow the vehicle, as well as any hazardous conditions or public safety risks associated with the operation of the AV.

Under this bill, AVs and ADSs are governed exclusively by the legislation with the Transportation Cabinet acting as the sole and exclusive state agency that can implement it. The Transportation Cabinet is provided authority to promulgate administrative regulations to implement the bill's procedural provisions but cannot impose any additional requirements. The bill also bars any state agency from prohibiting the operation of AVs or ADSs or otherwise enacting or maintaining policies that impose taxes, fees, or other requirements regarding AV operations.

CVSA Enhanced CMV Inspection Program for Autonomous Trucks

In anticipation of federal and state laws affecting first responder interactions with ADS-operated CMVs, the CVSA developed an Enhanced CMV Inspection Program for Autonomous Trucks in 2022. Most state law enforcement agencies, including those in Texas, have adopted the North American Standard Inspection Program—a set of CMV inspection procedures and criteria created by CVSA. Under the North American Standard Inspection Program, human CMV drivers conduct a pre-trip inspection prior to starting a trip and a post-trip inspection at the end of the trip. Along their route, the driver may be required by law enforcement to drive through a weigh/inspection station and/or be stopped at the roadside and subjected to a CVSA North American Standard Inspection, both of which rely on assistance from the human driver.

The Enhanced CMV Inspection Program for Autonomous Trucks adapts the North American Standard Inspection Program to the unique needs, requirements, and challenges of ADS-equipped trucks, which do not easily conform to roadside and weigh/inspection station environments. It is being implemented through an enhanced inspection standard and procedure and a 40-hour training course and exam for motor carrier personnel who will be conducting the inspections.

The Enhanced CMV Inspection Program for Autonomous Trucks involves a no-defect, point-of-origin inspection program for ADS-equipped CMVs. Rather than the driver conducting a pre-trip inspection, CVSA-trained motor carrier personnel conduct the Enhanced CMV Inspection Procedure on ADS-equipped CMVs from their fleets at the point-of-origin before dispatch, as well as in-transit inspections at dictated intervals throughout the trip. Along the vehicle's route, the ADS is required to communicate to law enforcement while in-motion that it passed the origin/destination inspection and its ADS is functioning and operating within its ODD. The AV trucks will then bypass fixed weigh/inspection sites with roadside inspections by law enforcement officials limited to situations where there is an imminent hazard or as part of a post-crash investigation. As part of the program, all AV trucks are required to be able to respond to law enforcement should an officer attempt to pull over the vehicle. Any truck or trailer or CMV combination that fails the Enhanced CMV Inspection Procedure at the point of dispatch must be repaired (CVSA, 2022).

Texas Tort Limitation Effects on TxDOT's Efforts to Mitigate Safety Risks to First Responders as They Interact with AVs

Under state statutes and common law, Texas state agencies like TxDOT and local jurisdictions are generally immune from tort liability. State agencies enjoy sovereign immunity while political subdivisions enjoy governmental immunity, which can be waived if a constitutional or statutory waiver exists (Reata Const. Corp. v. City of Dallas, 197 S.W.3d 371, 374 [Tex. 2006]; University of Texas Southwestern Medical Center v. Rhoades, 605 S.W.3d 853 [Tex. 2020]). Current Texas state statutes in Title 5, Chapter 101 of the Texas Civil Practice and Remedies Code—known as the Texas Tort Claims Act (TTCA)—provides such a waiver, enumerating the instances and conditions of, and limitations on, a governmental unit's tort liability for property damage, personal injury, and death.

Generally, no risk of liability to State agencies and municipalities exists for the act, omission, or negligence of an employee who—acting within their scope of employment—causes property damage, personal injury, or death. Sovereign or governmental immunity is waived by municipalities and state agencies where the Texas State Legislature has—through enacted legislation—waived immunity in clear and unambiguous language (Sampson v. University of Texas at Austin, 500 S.W.3d 380, 385 [Tex. 2016]; Texas Government Code [Tex. Gov't. Code] § 311.034). Under the TTCA, damages may be recovered from governmental units in Texas for:

> (1) property damage, personal injury, and death proximately caused by the wrongful act or omission or the negligence of an employee acting within his scope of employment if:

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(A) the property damage, personal injury, or death arises from the
operation or use of a motor- driven vehicle or motor-driven equipment;
and
(B) the employee would be personally liable to the claimant according
to Texas law; and
(2) personal injury and death so caused by a condition or use of
tangible personal or real property if the governmental unit would, were
it a private person, be liable to the claimant according to Texas law
(Tex. Civ. Prac. Code § 101.021).
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Thus, the TTCA expressly waives immunity for certain negligent acts by governmental employees in three areas when statutory requirements are met:

- Operation or use of publicly owned automobiles.
- Injuries arising out of a condition or use of tangible personal property.
- Premises defects (Sampson v. Univ. of Tex. at Aus., 500 S.W.3d 380, 385 [Tex. 2016]).

Of these three negligent acts that waive sovereign immunity, only one applies to the analysis conducted for this project—the operation or use of a motor-driven vehicle. The TTCA waives sovereign immunity for property damage, personal injury, or deaths that are proximately caused by "the wrongful act or omission or the negligence" of government employees involved in the operation or use of a motor-driven vehicle while they are acting within their scope of employment (Tex. Civ. Prac. Code § 101.021[1]). So, extending this to AVs operated by state government employees serving as first responders, sovereign immunity is waived when someone is struck and killed by a government-owned AV that is properly operated by the government employee acting within the scope of their employment. However, for immunity to be waived, the injury or death must be proximately caused by the government employee's own operation or use of the vehicle or equipment—not the injured person's or some third party's operation or use of it (Leleaux v. Hamshire-Fannett Independent School District, 835 S.W.2d 49 [Tex. 1992]). For liability to attach to an injury, damage, or death, the government employee's use of the vehicle must have actually caused the injury. No waiver of liability exists for a claim based on the failure to provide protection or the nonuse of publicly owned vehicles or equipment (Dallas Area Rapid Transit v. Whitley, 104 S.W.3d 540 [Tex. 2003]; City of El Paso v. Hernandez, 16 S.W.3d 409 [Tex. App.—El Paso 2000, no pet.]). In this way, Texas tort limitation affects TxDOT's efforts to mitigate safety risks to first responders the same whether they interact with AVs or vehicles without ADS. First responders who are also government employees operating AVs are as shielded from liability as they currently are operating non-ADS vehicles.

Independent Contractors and First Responders

Texas statutes generally do not extend sovereign immunity to independent contractors, including TxDOT contractors providing roadside assistance through the HERO program. The TTCA defines an employee as "a person, including an officer or agent, who is in the paid service of a governmental unit by competent authority" but excludes "an independent contractor, an agent or employee of an independent contractor, or a person who performs tasks the details of which the governmental unit does not have the legal right to control" (Texas Dept. of Transp. v. Able, 35 S.W.3d 608 [Tex. 2000]; St. Joseph Hosp. v. Wolff, 94 S.W.3d 513 [Tex. 2002]). As such, governmental units cannot plead sovereign immunity for damage, injury, or death proximately caused by wrongful acts, omissions, or negligence of their independent contractors.

On the other hand, Texas statutes extend immunity to first responders providing roadside assistance services in good faith. The law applies to first responders, defined as "a law enforcement, fire protection, or emergency medical services employee or volunteer," including peace officers, fire protection personnel, volunteer firefighters, and certified EMS personnel that provide roadside assistance, which is defined as "assistance to the owner, operator, or passenger of a motor vehicle with an incident related to the operation of the motor vehicle, including jump-starting or replacing a motor vehicle battery, lockout assistance, replacing a flat tire, and roadside vehicle breakdown assistance" (Tex. Civ. Prac. Code § 78A.001). This definition does not include independent contractors providing roadside assistance services. The law only protects first responders providing roadside assistance from liability for damages to vehicles "affected by the incident for which the roadside assistance is provided that is caused by an act or omission that occurs during the performance of the act of roadside assistance unless the act or omission constitutes gross negligence, recklessness, or intentional misconduct" (Tex. Civ. Prac. Code § 78A.002). Independent contractors providing the same services, like TxDOT HERO personnel, are open to liability against such claims.

Independent HERO contractors, however, may benefit from a statutory limitation of liability if they are a person who "by force or otherwise, enters a motor vehicle for the purpose of removing a vulnerable individual from the vehicle." In this case, they would be immune from civil liability for damages resulting from the entry or removal as long as they take specific precautions. First, they must determine that the vehicle is locked or there is no reasonable method for the vulnerable individual to exit it without assistance. They must also have a "good faith and reasonable belief, based on known circumstances, that entry into the motor vehicle is necessary to avoid imminent harm to the individual" and, before entering the vehicle, notify law enforcement or call 911. They must then use no more force to enter the vehicle and remove the individual than is necessary and remain with the individual in a safe location in reasonable proximity to the vehicle until a law enforcement officer or other first responder arrives (Tex. Civ. Prac. Code § 92A.002).

Whether they are providing roadside assistance or other services, first responders—defined by state law as government employees—are generally treated favorably under the law against claims for civil damages as a result of performing services within the scope of their duties. Immunity from tort liability extends to first responder actions "while responding to an emergency call or reacting to an emergency situation if the action is in compliance with the laws and ordinances applicable to emergency action, or in the absence of such a law or ordinance, if the action is not taken with conscious indifference or reckless disregard for the safety of others." Immunity even extends if a first responder fails to provide police or fire protection and applies to any method of providing police or fire protection (Tex. Civ. Prac. Code § 101.055).

First responders providing emergency care are only liable for civil damages resulting from performance of services during the emergency if their actions are willfully or wantonly negligent. If they operate an authorized emergency vehicle, they are still bound to a duty to operate the vehicle "with appropriate regard for the safety of all persons; or the consequences of reckless disregard for the safety of others" (7 Tex. Transp. Code § 546.005). They may be sued for civil damages if the emergency care is administered "for or in expectation of remuneration" or by anyone at the scene of an emergency "because he or a person he represents as an agent was soliciting business or seeking to perform a service for remuneration." They could also be found liable if their "negligent act or omission was a producing cause of the emergency for which care is being administered" (Tex. Civ. Prac. Code § 74.151).

Caps on Damages and Proportionate Responsibility

Texas state agencies are advantaged by caps on damages provided by the TTCA. State statutes set maximum damage limits on liability for actions brought under the TTCA against a governmental unit involving governmental functions where sovereign immunity has been waived. The caps are applied to the total of monetary damages and prejudgment interest with limits on liability for:

- **State government**: Monetary damages of $250,000 for each person, $500,000 for each single occurrence of bodily injury or death, and $100,000 for each single occurrence of injury to or destruction of property).

- **Units of local government**: Monetary damages of $100,000 for each person, $300,000 for each single occurrence of bodily injury or death, and $100,000 for each single occurrence of injury to or destruction of property).
- **Municipalities**: Monetary damages of $250,000 for each person, $500,000 for each single occurrence of bodily injury or death, and $100,000 for each single occurrence of injury to or destruction of property) (Tex. Civ. Prac. Code § 101.023).

Another protection against tort liability is Texas law establishing it as a proportionate responsibility state. Similar to comparative negligence, which allows a reduction in a plaintiff's recovery if the plaintiff was partially to blame for their injury, proportionate responsibility bars a plaintiff's recovery of damages if their percentage of responsibility is greater than 50 percent (Tex. Civ. Prac. Code § 33.001). If the plaintiff's percentage of responsibility is not greater than 50 percent, the court must reduce the amount of damages by a percentage equal to the claimant's percentage of responsibility. This amount is further reduced to the extent that other parties are involved in the cause of action (Tex. Civ. Prac. Code § 33.012).

Municipal and County Liability for Preempted Regulations

In 2023, the Texas State Legislature enacted HB 2127, which amends Title 5 of the Texas Civil Practice and Remedies Code to confer upon individuals, corporations, and other legal and commercial entities standing to sue municipalities and counties for *actual* or *threatened* injuries sustained by a local law that conflicts with specific state law. Currently, those laws pertain to the Texas Agriculture, Business and Commerce, Finance, Insurance, Labor, Local Government, Natural Resources, Occupations, and Property codes; the Transportation Code does not apply. As such, the new law would only compromise first responder immunity from liability if they were to enforce municipal or county laws that conflicted with state laws regulating agriculture, financial institutions and services, insurance, labor and workers' rights, animal businesses, natural resources and businesses extracting natural resources, licensing and trades, and real property.

The only transportation-related provisions that present a risk of waiving governmental immunity are those contained in the Occupations Code that regulate motor vehicle sale or leasing; vehicle salvage dealers; vehicle storage facilities; motor vehicle repairs; motor vehicle towing and booting; auto parts recycling; motor fuel metering and quality; EV charging stations and supplies; stevedores; boat manufacturing, distribution, and sale; transportation service providers; and TNCs. However, these types of regulations are not typically enforced by first responders. Because current state law prohibits any governmental entity— state or local—from regulating AV operations and ADSs in the state, first responders are already at risk of liability if they enforce a preempted local law or regulation, should any be enacted.

Opportunities for TxDOT and Local Government Entities to Position Themselves to Mitigate Risks to First Responders as They Interact with AVs

Federal and state policy changes have the potential to address safety risks to first responders when interacting with AVs.

Changes to Federal Policy

Federal legislation and rulemaking will affect first responder interactions with AVs to the extent that they currently influence first responder interactions with human-operated motor vehicles. While necessary to standardize AV safety features and components across the nation, revisions to NHTSA's FMVSSs to accommodate ADS-operated vehicles are not vital for preparing Texas first responders to safely interact with AVs. However, Texas first responders would likely benefit from a national standard requiring AV and ADS manufacturers to meet certain conditions before deploying on a public roadway. These conditions could include those currently provided in Texas law where AVs must comply with applicable state motor vehicle and traffic safety laws and be equipped with a recording device and an ADS that is compliant with federal law and the FMVSSs.

Additional conditions could be incorporated into federal rules to include those provided in other, more recently enacted state AV laws in Arizona, Oklahoma, and Mississippi, including requirements that AVs:

- Achieve a minimal risk condition (i.e., a condition that reduces the risk of a crash when a given trip cannot or should not be completed) if the ADS fails and is unable to perform the dynamic driving task (i.e., real-time operational and tactical functions that are required to operate a vehicle in traffic).
- Bear the AV manufacturer's certification that indicates that—at the time of manufacture—the AV was in compliance with all applicable FMVSSs (and if not, has been exempted by NHTSA).

In addition, federal regulations could be amended to standardize the contents of an AV manufacturer's LEIP, as well as its distribution and accessibility. Federal rules could follow the lead of state laws in Arizona, Oklahoma, and Mississippi that require submission of LEIPs prior to an AV's deployment on public roadways. Rather than requiring that the LEIP be submitted to a state's public safety agency and/or transportation agency, the federal rule could require that LEIPs be submitted to NHTSA, FMCSA, and/or FHWA, which could distribute them to states or make them publicly accessible. The federal rule could provide a minimum standard for LEIPs that requires provision of the following information similar to the Oklahoma and Mississippi AV laws:

- How to communicate with a fleet support specialist who is available during the times the vehicle is in operation.
- How to recognize whether the AV is in autonomous mode.
- How to safely remove the AV from the roadway, including how to safely tow the vehicle.
- Any additional information the manufacturer deems necessary regarding the hazardous conditions or public safety risks associated with the operation of the AV.

The federal rule could give states discretion to include other required elements of a LEIP and also require that the manufacturers provide training resources for first responders. Alternatively, federal grant programs, such as those administered by NHTSA, which currently fund first responder training, could specify that grant funds could be used to develop and deliver training targeted to first responder interactions with AVs.

To standardize the approach to safety with autonomous CMVs, FMCSA may need to modify the FMCSRs to adopt CVSA's Enhanced CMV Inspection Program for Autonomous Trucks and allow use of federal MCSAP funds for training state public safety officials on the program and implementing the program in the state. The regulations must recognize the unique needs, requirements, and challenges of ADS-equipped trucks by detailing the data and information to be collected, the frequency and points at which data and information will be collected (e.g., pre-trip, enroute), the role of weigh/inspection stations, and the ADS-equipped trucks' response to law enforcement.

Changes to State Policy

Without changes to state laws and regulations, first responders in Texas, especially contractors serving as TxDOT HERO personnel providing roadside assistance, will find it difficult or impossible to safely interact with AVs. As noted in this report, all government bodies are barred by law from regulating AVs in Texas. The law currently does not address first responder interactions with AVs, so if a first responder encounters a disabled AV or an AV in violation of a vehicle or traffic safety law on a Texas roadway, their safety is completely dependent on their awareness and understanding of AVs and the available information provided by AV manufacturers and operators. In addition, when rendering services to remove a disabled AV from traffic or otherwise assist an AV, TxDOT HERO personnel are exposed to tort liability for damages to those vehicles.

To remedy these vulnerabilities, Texas laws would need to be revised (regulations would not be necessary because no AV regulations current exist in the Texas Administrative Code and existing law prohibits any state or local agency from promulgating any AV regulations). The Arizona, Oklahoma, Mississippi, and Kentucky's existing or proposed AV laws provide the most appropriate models for policymakers to consider because they are most similar to Texas' AV law. These laws are more similar to Texas' statutory framework than others (e.g., California expressly authorizes the DMV to regulate AVs through a permitting scheme) and provide more recent language related to first responder interactions to consider.

Like Texas' AV statute, Arizona, Oklahoma, Mississippi, and Kentucky's existing or proposed AV bills limit regulation of AV operations and ADSs in the state to the law itself and expressly prohibit local governments from prohibiting or otherwise regulating AVs and ADSs. Texas' AV law goes further by prohibiting state agencies from regulating AVs. Texas first responders would benefit, however, if it followed the model provided under the Arizona, Oklahoma, Mississippi, and Kentucky AV legislation, which authorize specific state agencies to implement and enforce the law. Specifically, Texas law could be amended to clarify TxDOT and Texas DPS authority to implement and enforce the law through standard procedures and rules that cannot be unreasonable or unduly burdensome. This change could be accomplished by amending 7 Tex. Transp. Code § 545.452 as follows (added language is in **<u>bold underline</u>** font):

> Sec. 545.452. EXCLUSIVE REGULATION OF THE OPERATION OF AUTOMATED MOTOR VEHICLES AND AUTOMATED DRIVING SYSTEMS. (a) Unless otherwise provided by this subchapter, the operation of automated motor vehicles, including any commercial use, and automated driving systems are governed exclusively by:
> (1) this subchapter; and
> (2) Section 547.618.
> **<u>The Texas Department of Transportation and the Department of Public Safety are the only state agencies that may implement or enforce this subchapter, except that neither agency may prescribe procedures or rules that are unreasonable or unduly burdensome.</u>**
> (b) A political subdivision of this state or a state agency may not impose a franchise or other regulation related to the operation of an automated motor vehicle or automated driving system.

To better mitigate safety risks to first responders as they interact with AVs than under current law, policy makers in Texas may also consider adding a LEIP requirement to 7 Tex. Transp. Code § 545.454. Potential legislation could include a LEIP provision as follows (added language is in **<u>bold underline</u>** font):

> Sec. 545.454. AUTOMATED MOTOR VEHICLE OPERATION. (a) An automated motor vehicle may operate in this state with the automated driving system engaged, regardless of whether a human operator is physically present in the vehicle.
> (b) An automated motor vehicle may not operate on a highway in this state with the automated driving system engaged unless the vehicle is:
> (1) capable of operating in compliance with applicable traffic and motor vehicle laws of this state, subject to this subchapter;
> (2) equipped with a recording device, as defined by Section 547.615(a), installed by the manufacturer of the automated motor vehicle or automated driving system;
> (3) equipped with an automated driving system in compliance with applicable federal law and federal motor vehicle safety standards;
> (4) registered and titled in accordance with the laws of this state; and

(5) covered by motor vehicle liability coverage or self-insurance in an amount equal to the amount of coverage that is required under the laws of this state.

(c) **Prior to operating an automated motor vehicle in this state without a human driver, the manufacturer or owner of the automated motor vehicle shall submit a law enforcement interaction plan to the Department of Public Safety that describes:**

(1) How to communicate with a fleet support specialist who is available during the times the vehicle is in operation;

(2) How to safely remove the automated motor vehicle from the roadway and steps to safely tow the vehicle;

(3) How to recognize whether the automated motor vehicle is in autonomous mode; and

(4) Any additional information the manufacturer or owner deems necessary regarding hazardous conditions or public safety risks associated with the operation of the automated motor vehicle.

(d) If a manufacturer or owner fails to submit a law enforcement interaction plan prescribed by subsection (c) of this section, the Department of Public Safety may immediately issue a cease-and-desist letter prohibiting the operation of the automated motor vehicle on public roads of this state until the manufacturer or owner submits the law enforcement interaction plan.

Because existing law sufficiently provides for Texas DPS authority to enforce vehicle and traffic safety laws, first responder requirements for interacting with vehicles (including abandoned vehicles), and vehicle operator requirements for interacting with first responders, statutory changes may not be necessary to address these subject areas. However, other state statutes may need to be revised as follows to mitigate risks to first responders from AV interactions:

- **CMVs:** A provision may need to be added to 7 Tex. Transp. Code Subtitle C Subchapter J to clarify that autonomous CMVs are subject to state CMV safety laws contained in 7 Tex. Transp. Code Subtitle F, including inspections. The Arizona, Oklahoma, and Mississippi AV laws all specify that AVs that are also CMVs may operate pursuant to the provisions of state commercial vehicle safety laws that "govern the operation of CMVs, except that any provision that by its nature reasonably applies only to a human driver does not apply to such a vehicle operating with the automated driving system engaged."
- **Independent contractor liability:** The simplest legislative means of limiting liability for its independent contractors involved in roadside assistance and other first responder duties (e.g., TxDOT HERO personnel) would be to amend Tex. Civ. Prac. Code § 101.001(2), which defines an employee for purposes of the TTCA. The amendment would strike the phrase "but does not include an independent contractor, an agent or employee of an independent contractor, or a person who performs tasks the details of which the governmental unit does not have the legal right to control." This, however, may be too broad and counter to public policy as it extends immunity from liability to acts of all contractors. Alternatively, Tex. Civ. Prac. Code § 101.055 could be amended to add another governmental function that is excluded from any waiver of immunity. It could provide that the TTCA does not apply to claims arising from the actions of a governmental employee or an independent contractor in connection with providing roadside assistance or other traffic safety services (e.g., directing traffic) on state highways.
- **TNCs:** The current state statute regulating TNCs may need to be revisited because the business model for AV companies like Waymo and Cruise has involved the use of their vehicles for TNC purposes. First, the definition of a TNC under Tex. Occ. Code § 2402.001(5) would need to be revised to account for the fact that digitally prearranged rides could be provided by a driver or an ADS. Currently, the law limits the definition to rides arranged with a

driver. Second, the law may have to be amended to exempt AVs used as robotaxis from the requirements in Tex. Occ. Code §§ 2402.106 and 2402.107 governing driver qualifications and fitness. Third, the training requirement in Tex. Occ. Code §2402.1075 could be expanded to require AV companies operating as TNCs to provide training to first responders on safe interactions with their vehicles. Similarly, the provisions in Tex. Occ. Code §§ 2402.151 and 2402.154 could be revised to require that such companies submit LEIPs and safety-related data to state officials as part of the records and information they must collect and submit to TDLR.

Data Policy Considerations

During this policy analysis and needs assessment, several issues related to the data that AVs generate and rely upon arose when considering first responder interactions with AVs. The following issues are tangential to the policy analysis but may be worth consideration:

- Cybersecurity.
- Data privacy.
- Data protection.

Cybersecurity

The Task 2 literature review highlighted a more worrisome threat related to the collection and storage of AV data (e.g., data generated by digital mapping of public roadways)—data exfiltration from company servers by foreign nations for intelligence purposes. Foreign intelligence services could collect significant amounts of AV-generated data and information without exposing themselves to detection, arrest, or detention by controlling the vehicles from overseas or exfiltrate information from U.S.-based systems. In this way, AVs can be used to gather intelligence or perform surveillance without attracting attention (e.g., violating prohibitions on photography and data collection at military installations under the Internal Security Act of 1950). In addition, foreign-owned, American-based AV companies could acquire information or technology in the U.S. that they intend to export through third-party countries destined for export-controlled or sanctioned countries or companies.

Legal, regulatory, and policy measures to counteract these cybersecurity threats have not been developed but will grow in necessity with federal and state interest in such issues. Evidence of federal interest in cybersecurity issues can be found in legislation considered during the recent 118th congressional session (2023–2024) and best practices published by NHTSA.

On February 28, 2024, the White House issued an executive order intended to protect sensitive personal data of Americans from exploitation by countries of concern. The executive order authorizes the U.S. Attorney General to prevent the large-scale transfer of Americans' personal data to countries of concern and provides safeguards around other activities that can give those countries access to Americans' sensitive data. The executive order specifically requires the U.S. Department of Justice to issue regulations and work with the U.S. Department of Homeland Security to set high security standards. It also urges Congress to pass comprehensive privacy legislation (The White House, 2024a).

Comprehensive privacy legislation was introduced in June 2023 as HR 4108 and SB 1974, Protecting Americans' Data from Foreign Surveillance Act of 2023. The bills were introduced with the understanding that "technological trends have made sensitive personal data an especially valuable input to activities that foreign adversaries" have taken to threaten national security and privacy and, thus, it is "essential to the safety of the United States and the people of the United States to ensure that the United States Government makes every effort to prevent sensitive personal data from falling into the hands of malign foreign actors."

The bills would amend the Export Control Reform Act of 2018 to require export controls for certain personal data of U.S. nationals and individuals in the United States. Specifically, they require the identification of categories of personal data that could be exploited by foreign governments or adversaries and harm national security, as well as establishment of a threshold for determining when the export, reexport, or in-country transfer of personal data to or in a restricted country could harm national security. The threshold would be used to impose controls on the export, reexport, or in-country transfer of identified personal data that exceeds the threshold. One such form of export control would be the requirement to possess a license for the export, reexport, or in-country transfer of identified personal data that exceeds the threshold.

Given the number of industries and markets it would affect, the likelihood of passage of these bills in their current form is slim. The bills have not moved any further than introduction in the House and Senate and have not been heard by committees of jurisdiction (the House Committee on Foreign Affairs and Senate Committee on Committee on Banking, Housing, and Urban Affairs). However, the bills' introduction indicates that Congress is taking seriously cybersecurity concerns.

Prior to the introduction of the Protecting Americans' Data from Foreign Surveillance Act of 2023 in 2020, NHTSA released a draft update to their "nonbinding and voluntary guidance to the automotive industry for improving motor vehicle cybersecurity." The document, *Cybersecurity Best Practices for the Safety of Modern Vehicles*, does not have the force of law or regulations, but provides guidance to vehicle and equipment manufacturers to review. In the guidance, NHTSA acknowledges that vehicles are "cyber-physical systems and cybersecurity vulnerabilities could impact safety." NHTSA has therefore determined that vehicle cybersecurity is an organizational priority. NHTSA encourages the automotive industry to prioritize vehicle cybersecurity in the same way and to determine whether and to what extent they can apply the identified best practices to their unique systems.

The document provides voluntary best practices that provide a solid foundation for developing a risk-based approach to cybersecurity challenges. NHTSA takes a layered approach to vehicle cybersecurity, assuming some vehicle systems may be compromised and promoting practices and solutions that are expected to result in strengthening vehicles' electronic architectures to protect against potential attacks and ensure vehicle systems respond appropriately and safely when an attack is successful. This approach can reduce the probability of an attack's success and mitigate the harm of unauthorized vehicle system access.

The guidance recommends that the automotive industry follow the National Institute of Standards and Technology's Cybersecurity Framework, which is structured around the five principal functions of identify, protect, detect, respond, and recover. Their approach to vehicle cybersecurity should:

- Eliminate sources of risks to safety-critical vehicle control systems.
- Timely detect and rapidly respond to potential vehicle cybersecurity incidents.
- Design methods and processes to facilitate rapid recovery from incidents.
- Institutionalize methods for accelerated adoption of lessons learned (e.g., vulnerability sharing) across the industry through effective information sharing.

In the guidance, NHTSA encourages the auto industry to consider cybersecurity through the full lifecycle of the vehicle—from conception to design to manufacture to sale to use to maintenance to resale and finally to decommissioning. According to the agency, industry should follow a "robust product development process based on a systems-engineering approach with the goal of designing systems free of unreasonable safety risks, including those from potential cybersecurity threats and vulnerabilities" (NHTSA, 2020).

Although nonbinding and voluntary, NHTSA would likely use the principles in this guidance to evaluate cybersecurity issues in the event of a defect investigation (Grigorian and Englund, 2021). Further, the guidance could potentially form the basis for vehicle data security rules (for vehicles with an ADS or ADAS).

Evidence of state-level interest in cybersecurity issues can be found in recent executive-level and legislative actions. In 2021, the 87th Texas State Legislature enacted SB 2116, the Lone Star Infrastructure Protection Act, which prohibits "contracts or other agreements with certain foreign-owned companies in connection with critical infrastructure in this state." The bill added Chapter 113 to the Texas Business and Commerce Code (Tex. Bus. Com. Code) to prohibit a business entity from entering into an agreement relating to critical infrastructure in the state with another company if the agreement grants the company direct or remote access to or control of critical infrastructure; and the business entity knows that the company's owner or majority shareholder is a citizen, company, or governmental entity of or headquartered in China, Iran, North Korea, Russia, or another designated country (Tex. Bus. Com. Code § 113.002).

In December 2022, Governor Greg Abbott issued a directive requiring all state agencies to ban the video-sharing application, TikTok, from all state-owned and state-issued devices and networks over the Chinese Communist Party's ability to use the application for surveilling Texans. Governor Abbott also directed Texas DPS and the Texas Department of Information Resources to develop a plan providing state agencies guidance on managing personal devices they use to conduct state business. The *Model Security Plan for Prohibited Technologies* was published in January 2023, providing that all state agencies and institutions of higher education, including their employees, contractors, interns, or any users of state-owned networks, are responsible for the implementation of the plan. The plan outlines five objectives for each agency:

- Ban and prevent the download or use of prohibited technologies on any state-issued device.
- Prohibit employees and contractors from conducting state business on prohibited technology-enabled personal devices.
- Identify sensitive locations, meetings, or personnel within an agency that could be exposed to prohibited technology-enabled personal devices and prohibit technology-enabled personal devices from entering or being used in these sensitive areas.
- Implement network-based restrictions to prevent the use of prohibited technologies on agency networks by any device.
- Coordinate the incorporation of other technology providers as necessary, including any apps, services, hardware, or software that pose a threat to the State's sensitive information and critical infrastructure into this plan (Texas Department of Information Resources, 2023).

Data Privacy

As revealed in the Task 2 literature review, a concern of law enforcement officers is the potential vulnerability of AVs due to their reliance upon interconnected software and interlinks with wider computer systems, which could expose AVs to malicious actors. It might be possible, in the future, for CAVs to send certain types of data to TxDOT and other state agencies for public safety purposes. For example, TxDOT-owned and operated and TxDOT independent contractor vehicle fleets (e.g., for roadway construction, maintenance, roadside assistance) may become automated and/or connected and transmit data related to construction projects, maintenance activities, work zone configurations, and disabled or abandoned vehicles. In addition, pavement condition data could be transmitted to TxDOT by privately-owned and operated AVs for purposes of maintenance and repair, as well as traffic operations (e.g., vehicular speed, braking, and other performance data) to monitor, mitigate, and respond to congestion and road conditions. A breach in the transmission of data from these AVs could result in the loss or destruction of personal property, a crash resulting in personal injury or death, the disablement and theft of AVs to render them inaccessible or inoperable, and disruptions to the flow of people and goods. Importantly, to the extent that data transmitted by AVs to TxDOT and other state agencies, as well as their contractors, is associated with an owner's personal data (e.g., personal information provided to law enforcement and roadside assistance personnel). It could also result in the disclosure of personally identifying information of the car's owner.

Federal and state legislative efforts have attempted to address this data privacy issue in recent years. In July 2022, the U.S. House of Representatives considered HR 8152, the American Data Privacy and Protection Act, which would establish requirements for how companies handle personal data and information that identifies or is reasonably linkable to an individual. Specifically, the bill would require companies to limit the collection, processing, and transfer of personal data to purposes that are reasonably necessary to provide a requested product or service and to other specified circumstances. It also establishes consumer data protections by prohibiting companies from transferring individuals' personal data without their affirmative express consent and giving consumers the right to access, correct, and delete their personal data.

Carveouts exist within the text, but with regard to AV developers and service providers, the bill would affect data ingestion. They would not be able to use a gather-everything-possible approach to the data that ADS-equipped vehicles collect and rely upon. Rather, they would have to limit or alter the data that are generated from external sensors on AVs.

HR 8152, the American Data Privacy and Protection Act, received a markup in the House Committee on Energy and Commerce but did not move any further through the legislative process. A Senate companion bill was not introduced. Given the number of industries and markets it would affect, the likelihood of passage of these bills in current form is slim. However, it signals that Congress is taking consumer data privacy concerns into consideration.

In Texas, the State Legislature has codified data management and disclosure limitations to protect private information that state agencies and their data vendors must follow. In 2021, the Texas State Legislature enacted SB 15 and HB 3471, the Texas Consumer Privacy Act Phase I, which amends the Texas Transportation Code to "restrict[] disclosure of personal information to essential government agencies and forbids personal information from redisclosure or resale to private entities such as marketing and technology companies." Specifically, the law provides that government agencies:

- Only disclose personal information (i.e., information identifying a person, including photos, social security number, date of birth, driver identification number, name, address, email address, and medical or disability information) to those who are the subject of the information or with their consent or for specific uses (7 Tex. Transp. Code §§ 730.006 and 730.007).
- Never sell personal information to anyone not authorized to receive it, exposing sellers of personal information to an unauthorized recipient to civil liability (7 Tex. Transp. Code §§ 730.0122 and 730.0123).
- In contracts with authorized third parties for personal information, include provisions covering cybersecurity, compliance, and reporting requirements (7 Tex. Transp. Code § 730.014).

In 2021, the Texas State Legislature also enacted SB 475 to establish state agency data management requirements and procedures. The bill requires state agencies, including TxDOT, to include a provision requiring vendors to meet the agency's security controls and provide evidence that they meet the security controls in contracts with vendors authorized to access, transmit, use, or store data for the agency (Tex. Gov't. Code § 2054.138). The law also prohibits acquiring, retaining, and disseminating "information that alone or in conjunction with other information identifies an individual or the individual's location" without the individual's written or electronic consent, unless required or permitted by federal or state law or for law enforcement purposes. This new provision requires state agencies to obtain the written or electronic consent of an individual before acquiring, retaining, or disseminating information that identifies the individual or their location through the use of global positioning system (GPS) technology, individual contact tracing, or technology designed to obtain biometric identifiers such as a retina or iris scan, fingerprint, voiceprint, or record of hand or face geometry (Tex. Gov't. Code § 2062.002). This provision is notable because, under the law, it is the agency's obligation— not the obligation of the agency's vendor, collaborator, or third party—to obtain the consent from individuals before collecting the data.

Data Protection

To the extent that a state agency collects and uses AV-generated data will be governed in part by the State's Public Information Act (PIA). Codified in Chapter 552 of the Texas Government Code, the Texas PIA obligates the government to make public information reasonably available to those who request it but allows for exceptions and confidentiality under certain circumstances. State agencies are subject to this law, which is constructed liberally based on the express policy that "each person is entitled, unless otherwise expressly provided by law, at all times to complete information about the affairs of government and the official acts of public officials and employees" (Tex. Gov't. Code § 552.001).

State agencies in Texas are required—upon a request for public information—to promptly produce the information for inspection, duplication, or both, where public information is defined as any information that, "under a law or ordinance or in connection with the transaction of official business," is "written, produced, collected, assembled, or maintained" by or for a governmental unit where the governmental body owns the information or has a right of access to it (Tex. Gov't. Code § 552.002[a]). The legal definition of public information pertains to "electronic communication created, transmitted, received, or maintained on any device if the communication is in connection with the transaction of official business" (Tex. Gov't. Code § 552.002[a-2]). Whether electronic or not, public information can take the form of a "book, paper, letter, document, e-mail, Internet posting, text message, instant message, other electronic communication, printout, photograph, film, tape, microfiche, microfilm, photostat, sound recording, map, and drawing and a voice, data, or video representation held in computer memory" (Tex. Gov't. Code § 552.002[c]).

The Texas PIA specifies the following types of public information that are subject to disclosure:

- Completed reports, audits, evaluations, or investigations made of, for, or by a governmental body.
- Account, voucher, or contract information related to the receipt or expenditure of funds by a government body.
- Working papers, research material, and information used to estimate the need for or expenditure of public funds or taxes by a governmental body.
- Policy statements that have been adopted or issued by an agency.
- Information deemed open to the public under an agency's policies (Tex. Gov't. Code § 552.022).

Contracting information is deemed public under the law and is subject to disclosure with many contract terms not protected by the Texas PIA's general protections for certain information (Tex. Gov't. Code § 552.0222). These protections provided by the Texas PIA generally exempt what are considered *trade secrets* and *proprietary information* from disclosure.

Trade secrets include "[B]usiness, scientific, technical, economic, or engineering information, and any formula, design, prototype, pattern, plan, compilation, program device, program, code, device, method, technique, process, procedure, financial data, or list of actual or potential customers or suppliers, whether tangible or intangible and whether or however stored, compiled, or memorialized physically, electronically, graphically, photographically, or in writing." Information that qualifies as trade secrets are those that possess "independent economic value, actual or potential, from not being generally known to, and not being readily ascertainable through proper means by, another person who can obtain economic value from the disclosure or use of the information" (Tex. Gov't. Code § 552.110).

Proprietary information is information that vendors and contractors submit to governmental bodies in bids, proposals, or qualifications that meet the following two criteria:

(1) They “reveal an individual approach to: (A) work; (B) organizational structure; (C) staffing; (D) internal operations; (E) processes; or (F) … pricing information that will be used in future solicitation or bid documents.”
(2) They advantage a competitor (Tex. Gov’t. Code § 552.1101).

Other exceptions to the Texas PIA that protect information from disclosure include:

- Information deemed confidential by law, including those made confidential under the Texas Rules of Civil Procedure and Rules of Evidence (Tex. Gov’t. Code § 552.101; In re the City of Georgetown, 53 S.W.3d 328 [Tex. 2001]).
- Motor vehicle inspection records (Tex. Gov’t. Code § 552.129).
- Motor vehicle records such as driver's licenses or permits, motor vehicle titles or registrations, and personal identification documents issued by any state or local agency (Tex. Gov’t. Code § 552.130).
- Government information related to computer network security, including vulnerability reports and assessments (Tex. Gov’t. Code § 552.139).
- Information that, if disclosed, would create a substantial threat of physical harm (Texas Department of Public Safety v. Cox Texas Newspapers, L.P., 343 S.W.3d 112 [Tex. 2011]).
- Agency communications or parts of agency communications that are deliberative relating to agency policymaking (City of Garland v. Dallas Morning News, 22 S.W.3d 351 [Tex. 2000]).

Under the Texas PIA, electronic data are considered public information and, therefore, are subject to disclosure when it takes the form of electronic communications, maps, and data representation held in computer memory. However, the data may be exempt from disclosure if it can quality as trade secrets or include information that is already exempted under the Texas PIA. The Texas PIA is unclear, however, as to whether data stored in the cloud and other types of data and datasets that may potentially be used by CAVs will be subject to disclosure. For example, location data and vehicle data—even if anonymized—could be layered with other datasets, resulting in the re-identification of someone’s personal data (which does not fall within existing exceptions under the Texas PIA). Regardless of whether data are collected directly by governmental units or purchased from third-party data owners, the processes for acquiring and processing that data would benefit from review and development of a framework and set of protocols for managing and protecting data (Jones Day, 2023).

IV. AV SUMMIT

AV SUMMIT DESCRIPTION

The goal of the Task 4 AV Summit was to bring together key stakeholders from the automated vehicle industry; local, state, and federal agencies; first responders; and other organizations to develop information required for subsequent tasks.

The project team hosted the two-day summit at the Center for Infrastructure Renewal at the RELLIS campus in Bryan, Texas, on April 30 and May 1, 2024. The TTI/TEEX project team identified key stakeholders across a wide spectrum of organizations and invited over 85 individuals to the summit. Among these individuals, 57 invitees representing 36 organizations registered and attended the two-day summit (see Table IV-1).

Table IV-1. Summary of AV Summit Attendees.

Organization Type	Number of Organizations	Number of Participants
Law Enforcement[1]	6	10
Fire/EMS[1]	4	5
Towing/Emergency Assistance	2	2
AV Industry	11	17
Federal Government	3	3
TxDOT	1	8
Out-of-State DOTs	1	1
Local Government	1	3
Policy/Insurance	2	2
Private Research	3	3
TTI/TAMU[2]	2	4
Total	36	57

[1]Includes out of state participants
[2]Participants not part of the project team

Speakers

TTI Director Gregory Winfree delivered opening remarks to kick off the AV Summit on Day 1 (see Figure IV-1). The following five keynote speakers also delivered remarks during the summit:

- Darcyne Foldenauer, director of AVSC (part of the SAE Industry Technology Consortia), described AVSC's efforts related to first responder interactions with AVs.
- Brett Fabbri, head of law enforcement policy for Kodiak Robotics, discussed his company's efforts to assist first responders when interacting with their AVs and the CVSA Enhanced CMV Inspection Program for Autonomous Trucks.
- Mike Lukuc, manager of FMCSA's Automated CMV Evaluation Program, and Gwyn Kash, policy analyst at the Volpe National Transportation Center Division of Technology, Innovation, and Policy, delivered remarks on FMCSA's perspective related to first responder interactions with CMVs and an ongoing effort at Volpe to develop guidelines and policy recommendations for first responder interactions with automated CMVs.
- Lieutenant William White, Austin Police Department and police representative to the City of Austin's AV Safety Task Force, delivered remarks discussing law enforcement interactions with AVs in Austin, Texas, and the work of the AV Safety Task Force.

Figure IV-2 depicts four of the five keynote speakers in attendance.

Figure IV-1. TTI Director Gregory Winfree Delivered Opening Remarks at the AV Summit on April 30, 2024 (Photo: Jim Lyle, TTI).

Figure IV-2. Keynote Speakers (from Left to Right) Lieutenant William White, Gwyn Kash, Brett Fabbri, and Darcyne Foldenauer Listen during Opening Remarks from TTI Director Gregory Winfree (Photo: Jim Lyle, TTI).

Schedule of Events

Day 1 events were as follows:

- 8:00 a.m.–8:20 a.m.—Arrival and check-in with continental breakfast.
- 8:20 a.m.–9:15 a.m.—Introductory remarks by Gregory Winfree, TTI Director; Zeke Reyna, TxDOT Project Monitoring Committee Chair; Bradley Trefz, TTI Principal Investigator; and Ray Ivie, TEEX Principal Investigator.
- 9:15 a.m.–11:45 a.m.—Keynote speaker remarks by Darcyne Foldenauer, AVSC; Brett Fabbri, Kodiak Robotics; Mike Lukuc, FMCSA; and Gwyn Kash, Volpe Center.
- 11:45 a.m.–12:00 p.m.—Breakout session group assignments.
- 12:00 p.m.–1:00 p.m.—Catered lunch.
- 1:00 p.m.–4:00 p.m.—Group breakout sessions.
- 4:00 p.m.–5:00 p.m.—Concluding remarks and review of Day 1 activities.
- 5:00 p.m.–7:00 p.m.—Evening social event.

Day 2 events were as follows:

- 8:00 a.m.–8:10 a.m.—Arrival and check-in with continental breakfast.
- 8:10 a.m.–8:30 a.m.—Day 1 summation and review.
- 8:30 a.m.–9:00 a.m.—Keynote speaker remarks by Lieutenant William White, Austin Police Department and City of Austin's AV Safety Task Force.
- 9:00 a.m.–12:00 p.m.—Breakout sessions.
- 12:00 p.m.–1:00 p.m.—Catered lunch.
- 1:00 p.m.–3:00 p.m.—Large group meeting/discussion.
- 3:00 p.m.–4:00 p.m.—Summit review and next steps/concluding remarks.
- 4:00 p.m.–5:00 p.m.—RELLIS campus tour for interested parties.

Breakout Groups

Two breakout group assignments were written on the back of each attendee's name badge, denoted by a letter (A, B, C, or D). TTI/TEEX researchers assigned individuals to breakout groups to ensure similar representation across all groups of various stakeholder organizations (e.g., police, fire, EMS, industry, local and federal government). During the Day 1 breakout sessions, attendees participated in two breakout group discussions. During the Day 2 breakout sessions, approximately half of each group swapped members with the group in their cohort and then participated in two additional breakout sessions. This ensured that group dynamics across the two days of the summit remained diverse, although when swapping groups, most individuals took the place of an individual from a similar organization (e.g., industry for industry, police for police). Table IV-2 through Table IV-5 detail the breakout group topics and moderators for each session on Day 1 and Day 2.

Table IV-2. Breakout Group Topics and Moderators for Day 1, 1:00 p.m.–2:15 p.m.

Topic	Group	Room	TTI/TEEX Moderators
1—Law Enforcement Interactions	A	1109	Tracy Zhou and Itzel Guzman, TTI; Scott McCollum, TEEX
2—TIM and Construction Zones	B	1108	Minh Le and John Speed, TTI; Mike Avolio, TEEX
3—CMVs and CMV Enforcement	C	1107	Jeff Warner and Jack Merritt, TTI; Ray Ivie, TEEX
4—Policy, Regulation, Liability, Crash Investigation, and Data Sharing	D	1105	Billy Hwang and Gretchen Stoeltje, TTI

Table IV-3. Breakout Group Topics and Moderators for Day 1, 2:30 p.m.–3:45 p.m.

Topic	Group	Room	TTI/TEEX Moderators
1—Law Enforcement Interactions	B	1109	Tracy Zhou and Itzel Guzman, TTI; Scott McCollum, TEEX
2—TIM and Construction Zones	A	1108	Minh Le and John Speed, TTI; Mike Avolio, TEEX
3—CMVs and CMV Enforcement	D	1107	Jeff Warner and Jack Merritt, TTI; Ray Ivie, TEEX
4—Policy, Regulation, Liability, Crash Investigation, and Data Sharing	C	1105	Billy Hwang and Gretchen Stoeltje, TTI

Table IV-4. Breakout Group Topics and Moderators for Day 2, 9:00 a.m.–10:15 a.m.

Topic	Group	Room	TTI/TEEX Moderators
1—Law Enforcement Interactions	C	1109	Tracy Zhou and Itzel Guzman, TTI; Scott McCollum, TEEX
2—TIM and Construction Zones	D	1108	Minh Le and John Speed, TTI; Mike Avolio, TEEX
3—CMVs and CMV Enforcement	A	1107	Jeff Warner and Jack Merritt, TTI; Ray Ivie, TEEX
4—Policy, Regulation, Liability, Crash Investigation, and Data Sharing	B	1105	Billy Hwang and Gretchen Stoeltje, TTI

Table IV-5. Breakout Group Topics and Moderators for Day 2, 10:30 a.m.–11:45 a.m.

Topic	Group	Room	TTI/TEEX Moderators
1—Law Enforcement Interactions	D	1109	Tracy Zhou and Itzel Guzman, TTI; Scott McCollum, TEEX
2—TIM and Construction Zones	C	1108	Minh Le and John Speed, TTI; Mike Avolio, TEEX
3—CMVs and CMV Enforcement	B	1107	Jeff Warner and Jack Merritt, TTI; Ray Ivie, TEEX
4—Policy, Regulation, Liability, Crash Investigation, and Data Sharing	A	1105	Billy Hwang and Gretchen Stoeltje, TTI

TTI and TEEX moderators began breakout group discussions by presenting example scenarios developed by TTI/TEEX researchers during the literature and policy reviews (Tasks 2 and 3 of this project) to spark discussion. Group participants were then asked to provide best practices for addressing such scenarios. From there, moderators allowed discussions between participants to develop additional scenarios and best practices or divert to other related topics offered as important considerations. Moderators recorded each session and kept notes of the discussions that were later used to produce a summary of results from the AV Summit (detailed later in this chapter). Figure IV-3 shows an example of a demonstration vehicle presented to the breakout groups.

Following the last breakout group sessions on Day 2 of the AV Summit, attendees reassembled for a large group discussion and summit review that identified several overarching themes and broader points, as well as items not mentioned during breakout group discussions. Moderators again recorded this discussion for inclusion in a summary of results.

Figure IV-3. Cruise and Waymo Provided Vehicle Demonstrations during the AV Summit Breakout Group Sessions (Photo: Jim Lyle, TTI).

AV SUMMIT RESULTS

Common Points of Discussion

The following common points were discussed across breakout groups and in the larger group:

- The need for two-way information-sharing portals that:
  - Communicates roadway and TMC information to AV companies from first responders and vice versa.
  - Allows for the exchange of information regarding issues and solutions between industry and first responders.
- Issues surrounding human-directed traffic and AVs (standard hand and arm signals for human-directed traffic in Texas (defined in 37 Tex. Admin. Code § 3.41) may not be adequate and are not universally utilized.
- First responder identification of AVs, difficulty obtaining contact numbers for vehicle operators, and wait times for remote operators or emergency contacts.
- Standardization of training and procedures for industry and first responders (rather than each company and jurisdiction developing their own materials separately).
- First responder ability to determine a vehicle's autonomy status (e.g., indicator lights) and their ability to manually override/disable autonomy.

Figure IV-4 shows attendees during a presentation. Participants expressed a strong desire for follow-up summits, meetings, and/or working groups to continue communication and discussions.

Figure IV-4. Summit Attendees Listen during Keynote Speaker Presentations (Photo: Jim Lyle, TTI).

Breakout Session Discussions

Breakout group topics included the following:

- Law enforcement interactions.
- TIM and construction zones.
- CMVs and CMV enforcement.
- Policy, regulation, liability, crash investigation, and data sharing.

All attendees participated in each breakout group over the two days of the AV Summit, ensuring that every stakeholder had the opportunity to express their views across all areas examined.

Law Enforcement Interactions

Tracy Zhou and Itzel Guzman from TTI, along with Scott McCollum from TEEX, moderated the discussions regarding law enforcement interactions. In each of the four sessions, a short presentation outlined the type of information to be recorded, explained the SAE International levels of autonomy (see Figure II-1), and provided questions to consider while discussing best practices for first responders interacting with AVs. This breakout topic focused on the day-to-day AV interactions that law enforcement officers and other first responders encounter while performing their duties. During the law enforcement interactions discussions over the four sessions, several scenarios and common themes were identified.

During the final breakout session, participants noted that this was the first time anyone had explained the differences between the SAE International levels of autonomy and the operating levels of vehicles in Texas. Several participants previously believed that all major AV companies attending the AV Summit operated vehicles at full autonomy. Each group highlighted the importance of basic AV awareness, but the final group revealed that even experienced first responders might have a limited understanding of AVs and their levels of autonomy. Some first responders requested a technical paper explaining the driving automation levels and detailing the vehicle autonomy levels in their jurisdictions, while others preferred a concise video and pamphlet with visual elements to explain basic AV awareness, the levels of driving automation, and key interaction considerations. Participants also suggested launching campaigns to raise AV awareness and knowledge among the general public. This awareness could reduce the misuse of ADAS vehicles operating at SAE Level 2 or Level 2+, potentially increasing public safety and reducing first responder interventions.

Law enforcement officers emphasized the need for agency-wide training to increase AV understanding and standardize signaling and interaction protocols. This training could include new academy curricula, continued education credits, or mandatory yearly sessions. The desired training should cover AV awareness, AV recognition, SAE International levels of driving automation, interaction protocols, and manual AV disabling techniques. Participants suggested that a combination of online courses, training videos, and hands-on opportunities form the most effective methods for law enforcement officers and other first responders to obtain proper training. They also raised concerns about funding, particularly for hands-on training not hosted locally. Moreover, participants discussed creating an information-sharing portal where first responders could access interaction plans and extrication guides from the AV industry and provide feedback based on field experience. This portal could also enable secure communication between first responders and the AV industry during routine interactions and emergencies.

Multiple sessions addressed communication between first responders and AV operators/developers, as well as microlevel communication with remote operation and safety teams. First responders expressed a desire for a standardized method to identify that an AV understands their commands. This determination could involve a specific flashing light on the AV or an external monitor/speaker indicating that the vehicle understands and will comply. A common issue is that some AVs struggle to understand and react to hand and arm signals. Some participants suggested that first responders could standardize hand and arm signals to allow developers to train AVs more effectively, while first responders want assurance that their signals will produce the desired response.

Following the AV Summit, the research team identified that Title 37, Rule § 3.41 of the Texas Administrative Code (Legal Authority for Police Officers to Direct Traffic) details the standards for directing traffic in Texas. However, first responder agencies likely overlook it because they do not regularly direct traffic or do not use the standardized signals. This emphasizes the necessity for standardized AV training among first responders, to include a review of 37 Tex. Admin. Code § 3.41. However, this code lacks signals for certain situations and may require expansion and further standardization to be compatible with AV algorithms.

Additionally, Chapter 6, Temporary Traffic Control, of the MUTCD provides standards for the direction of traffic during temporary deviations from normal highway operations (FHWA, 2023a). This chapter includes information on providing hand signals, flagging, and the use of flashlights or other illuminated objects *with a red glow* to inform highway vehicle operators of the emergency responders' intended instructions.

Some first responders suggested using a two-way microphone for communication with AVs. They want remote operators to hear instructions and provide acknowledgement, including an explanation of how the AV will comply, delivered by the remote operator via speaker. Some AV companies stated that they currently use only a one-way microphone for remote operators to hear instructions and move the AVs accordingly, especially with delivery robots. Participants also noted that automated CMVs will primarily operate in highway environments, which may be too loud for two-way communication microphones.

Additionally, some first responders requested a single emergency hotline for any AV. Responders reported difficulty reaching operators. Time is critical in emergencies, so long wait times to reach a remote operator can be detrimental. Participants suggested creating a regulated ratio of AVs on the road to remote operators in a company's command center to ensure adequate staffing.

AV Summit participants also discussed linking a license plate on an AV to its respective company's operation center. This linkage would allow a law enforcement officer to run the plate in their vehicle computer system and receive information that identifies the vehicle as an AV, provides nonemergency and emergency hotline numbers, and includes a QR code for accessing interaction plan guides or an information-sharing portal for emergency response guidance and extrication guides. First responders discussed alternative ways of identifying the AV and its information, such as printing AV in bold text or a QR code on the exterior of the vehicle. However, some participants from the AV industry expressed concerns that such markings could lead to aberrant driving behavior around the AV.

TIM and Construction Zones

Minh Le and John Speed from TTI moderated the TIM and construction zones discussions (see Figure IV-5). The focus of these discussions was to identify concerns and ideas from first responders encountering AVs in situations requiring TIM, including work zones.

The discussions generally began with the introduction of hypothetical crash scenarios. For example, one scenario considered how responders would manage a crash involving an AV on a two-lane rural highway. Another scenario considered what would happen if an unexpected object fell onto a freeway immediately in front of an AV. A third scenario considered how an AV would respond if there was a car fire on the freeway shoulder and visibility was severely limited. Participants contributed to the discussion using their own experiences and concerns about unknown parameters and provided input based on their perspectives. Unsurprisingly, some of the participants' input was equally applicable to TIM situations that did not involve AVs.

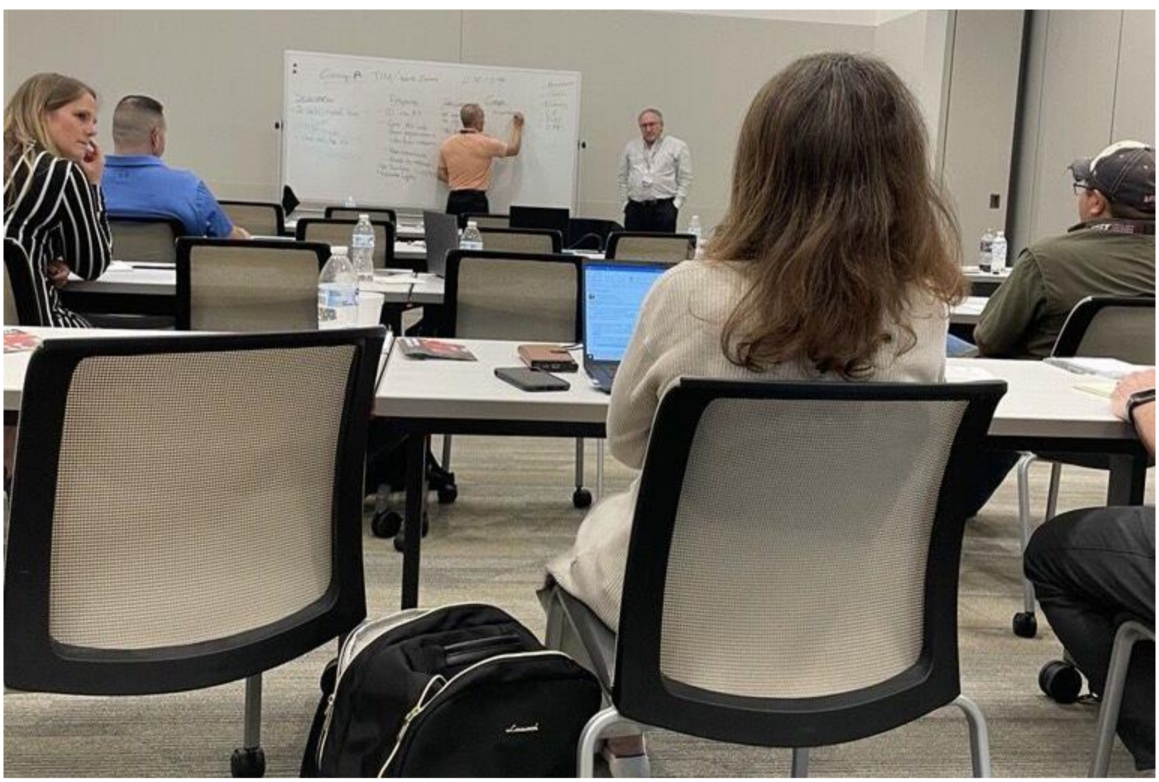

Figure IV-5. Minh Le and John Speed from TTI Moderate the TIM and Construction Zones Discussions (Photo: Jim Lyle, TTI).

Several common concerns about meeting the needs of on-site field responders emerged from discussions in each of the four sessions. First responders expressed the need to:

- **Identify whether a vehicle was an AV:** Discussions between AV industry and first responder participants recognized that current AV manufacturers and fleet operators do provide significant visual clues that a vehicle is an AV. Still, first responders were apprehensive about training their staff members on how to recognize and interact with fleet AVs. First responders were even more concerned about how to recognize and interact with nonfleet AVs as technology expands (i.e., private AVs). Discussions also considered whether some kind of emblem should be required on the vehicle.
- **Identify the operational status of an AV:** Once a vehicle is determined to be an AV, first responders need a way to quickly and confidently determine whether an AV has been rendered immobile and is safe to approach. A need exists regarding the ability of first responders to determine the status of autonomy (e.g., indicator lights, audio queues, etc.). Some discussions occurred about possible backup power supplies that may kick in and allow for sudden vehicle movement.
- **Define crash response:** Crashes, by definition, damage vehicles and AV controls. Responders emphasized the need for AVs to have manual override capabilities in case the AV cannot understand field conditions, cannot receive communications from the remote-control center, or responders need to move the vehicle to manage a situation safely. Some discussion occurred about related legal issues, such as whether the responder must have a commercial driver's license to operate the freight AV and who would assume liability of the load/cargo if it were damaged and/or if it caused damage when it spilled on the roadway.
- **Prepare for unexpected responses to abnormal situations:** Minimal risk maneuvers in response to abnormal situations involving an AV can vary by operator/company. For example, some AV companies may have an AV pull over and wait for remote assistance or a crew to pick it up when it encounters difficulty, whereas another developer may have an AV traverse the roadway or execute a pull-over maneuver, as long as it is safe to do so. Other companies may have the vehicle stop in the roadway or execute a pull-over maneuver and request remote assistance, while still others may allow the AV to try to figure the situation out—a scenario that previously resulted in AVs attempting to traverse active response scenes or continue to encroach when officers instructed the vehicle to stop. SAE Level 2 systems may assume the driver will take control, but that presumes the driver is paying attention and realizes they need to take over. This variation in response results in first responders not knowing what to expect from any particular AV in any given situation.

In addition to the common concerns for field responders, other consensus input included observations on the following topics:

- **Communication:** Continual, open communication between first responders and industry is productive and should be maintained and expanded. A higher level of trust can be built between AV operators and first responders, resulting in quicker response times and faster problem recognition and resolution for both groups.
- **Increased coordination for special events, work zones, and temporary road closures or detours:** Improvements are needed from the onset when communicating about special events that affect traffic flow (such as temporary work zones or crashes) to AV companies to allow preplanning or rapid adjustment to their operations.
- **Education:** First responders are interested in learning more about AV technology, including how vehicles use tools such as lidar and video and the current limitations of technology.
- **Applications and information-sharing tools:** Discussions in some sessions identified gaps and possible tools for future improvements addressing crashes requiring TIM, such as developing a federal repository with relevant AV information and specifications for each vehicle make/model. On-site first responders could access this information via a mobile application

- **Inclusion of courtesy patrol operators and staff in AV training programs:** Programs such as TxDOT's HERO, Tow and Go, and municipal/county courtesy patrols could become valuable in providing knowledgeable partners in TIM situations involving AVs. To date, they were largely left out of the training and coordination between first responders and AV operators.
- **Possible establishment of a statewide centralized TMC:** Many of the participants felt that a centralized system would be able to provide more uniform data directly to first responders that would streamline the response in TIM situations. Several participants felt that TxDOT would be the logical implementation agency for a statewide TMC.
- **Development of fact sheets for each AV make and model:** First responders need critical information and simple diagrams showing extraction cut lines in emergencies.
- **Misunderstandings about enforcement and liability:** Responders and industry participants discussed how the lack of a clear regulatory picture, enforcement powers, and liability for violations, crashes, and other circumstances creates a situation that limits enforcement, could endanger the public, and exposes responsible AV operators to additional public scrutiny when something goes wrong or an irresponsible operator engages in risky actions.
- **Trust building:** Responders and AV developers expressed a lack of trust between the two communities, potentially hampering coordination, and safety improvements. Participants recommended efforts like the AV Summit to increase education and build trust.
- **Crash data:** Participants recognized that it will be difficult to determine the level of autonomy engaged at the time of a crash, aside from relying on driver or passenger accounts. This issue will require more training for investigators and may require some design specifications or mandated indicators or systems that provide officers investigating crashes with a means to determine both the vehicle's level of autonomy of its engagement status during the crash.

CMVs and CMV Enforcement

Breakout session discussions regarding CMVs and CMV enforcement addressed the unique needs of first responders interacting with automated CMVs and other large autonomous vehicles not intended for personal transportation or taxi services. Participants also discussed the development and deployment of small commercial delivery robots.

Participants emphasized the importance of implementing advanced security measures to enhance the safety and efficiency of interactions between first responders and automated CMVs. Participants recommended using advanced authentication methods to verify the identity of officers during inspections and other interactions. Beyond traditional onboard cameras, these methods could include standardized hotline phone numbers, secure identification cards, and digital authentication protocols. Such measures would ensure that only authorized personnel could access critical vehicle systems and information, thereby preventing unauthorized access. Additionally, participants stressed the need for secure remote disabling and locking features that authorities or remote operating teams could activate in the event of unauthorized access or hijacking attempts. These features would enable authorities to contact autonomous CMV operators and remotely immobilize a vehicle, ensuring the safety of the vehicle and its surroundings.

In all four group discussions, participants repeatedly emphasized the development and implementation of procedures or systems to enable first responders and CMV enforcement officers to communicate abrupt commands to vehicles during inspections and pull-over scenarios. One participant highlighted the unique challenges of CMV enforcement procedures, noting that commercial drivers often make stops in nonstandard locations, such as fields or clearings off the main highway. These unconventional stopping points complicate the inspection process, especially for autonomous CMVs relying on SAE Level 4 automation, which usually requires mapping for routes. Consequently, these vehicles may not recognize or navigate in unmapped areas. Similarly, CMV enforcement officers might require a vehicle to drive to/stop on a weigh scale during inspections. In such instances, autonomous CMVs must quickly comprehend and react to the officer's commands.

The discussions also highlighted the CVSA Enhanced CMV Inspection Program for Autonomous Trucks that includes a self-inspection protocol. This program authorizes CVSA-certified inspectors to examine and prescreen automated CMVs at their point of origin and communicate the results to inspection officers, allowing the vehicle to bypass routine roadside inspection sites where other CMVs must stop. Currently, only a small number of autonomous CMV operators utilize this enhanced inspection protocol, which allows them to bypass state CMV inspection stations enroute. However, as automated CMVs become more prevalent, the need for a robust auditing process to oversee self-inspections will become increasingly critical. Regular audits will be essential to identify discrepancies and address issues related to self-inspection practices, potentially uncovering criminal activities such as trafficking which officers may identify at inspection stations under current operations but struggle to detect under a self-inspection regime. Additionally, authorities may still require automated CMVs to stop for other inspections or when observing deficiencies while the vehicle is enroute, such as agricultural product checks when entering certain states or at international borders and customs points or a mechanical problem observed by an officer while the vehicle is moving.

Policy, Regulation, Liability, Crash Investigation, and Data Sharing

The breakout session discussions regarding policy, regulation, liability, crash investigation, and data sharing focused primarily on how public policies must address the need for first responders to be aware of and mitigate safety risks from AV interactions. The discussions coalesced around a unanimous desire for a uniform regulatory scheme, ideally at the federal level, but also within and among states. Surprisingly, participants from industry and responder communities all agreed that AVs should be regulated in regard to first responder interactions and safety. A regulatory framework in Texas, as well as at the federal level, would level the playing field and remove some of the guesswork involved in first responder interactions.

Participants noted that regulations at the federal level would facilitate vehicle standardization for efficient first responder access into AVs and a standardized safety testing and rating system. At the state level, voluntary compliance is working for now, but mandatory state requirements may become necessary at some point as the AV market matures. While all participating industry and first responders expressed a willingness to collaborate, this willingness may depend on context-specific factors or individual preferences, which might not exist in all circumstances. Thus, the current voluntary approach may require more enforceable action in the future.

Participants from the private sector welcomed the prospect of legal harmonization among all states so that the laws of each ODD are predictable and reliable, creating a regulatory environment that applies equally to all original equipment manufacturers (OEMs) deploying in a state. In the absence of a federal regulatory scheme, which would be preferable, state regulations that provide rules for all would be similarly helpful.

First responder participants acknowledged that industry is being very forthcoming in taking the initiative to reach out with training and communication planning but is also aware that the first responder community does not have the capacity to train endlessly for every developer deploying in their area. Therefore, some regulatory and legal standards would help the first responder community be prepared for larger-scale deployments across brands.

Session participants identified the following key policy priorities for Texas:

- **Governance**: A need exists for a governance structure over AVs in Texas. Participants called for a clear policy decision regarding who within state government should have authority to implement and enforce AV laws in the state. Presently, no state agency or local authority is authorized under state law to regulate or otherwise encumber the AV industry in Texas. A clear governing entity is needed to act as a point of contact for all OEMs and municipalities who are learning to integrate AVs into their mobility ecosystems. Participants further noted that integration of an AV governing body into the state's regulatory framework would benefit from dedicated funds to effectively meet the safety needs of first responders and the public.

- **FRIPs/LEIPs:** New policy is needed that requires OEMs to submit FRIPs/LEIPs before deploying or testing in Texas. These plans would inform first responders on how to safely interact with AVs. Currently, there is no federal standard for the content and level of detail of FRIPs/LEIPs, so they may vary across states. Texas may want to look to the FRIP/LEIP requirements codified in state laws in Arizona and the model AV legislation for industry (represented by AVIA) for reference. If state law were to require FRIPs/LEIPs, a governing body would need to be authorized to review, approve, and house them.
- **Training:** Session participants recommended that for the first responder community to be best prepared for further AV deployments, regular in-person demonstrations and training facilitated by OEMs should continue and be required prior to deployment. This training would help first responders become familiar with and aware of mitigating safety risks from AVs.
- **Geofencing**: First responders need a way to prevent AVs from entering certain areas (e.g., work zones, fire stations, special events, emergency events). Geofencing is one of the most effective tools currently used in some cities to keep AVs out of areas where first responders are working. However, the process is inefficient in its current form—a municipality sends an email to a developer about the incident or event and, in response, the AV company sets the geofences. Improvements to this process could include methods for a municipality or governing agency to create the geofences for faster, safer assurance that AVs will not enter an emergency scene. As one first responder noted, "We need policymakers to say, 'incident drops, you need to drop an exclusion zone of this distance,' and then it has to stay that way for X amount of time and then you can have the [right-of-]way." Geofencing would require giving that entity legal authority and technical access to communicate with the vehicles and set the geofences.
- **Information portal**: Having a common location where information from OEMs about each AV deployed in a community would streamline the process of learning about a vehicle and finding documents needed to respond to an AV incident. Thus, participants noted the need for creating and maintaining a portal/repository of first responder resources (e.g., LEIPs and other information from industry).
- **Data lake**: Participants recommended that Texas create and maintain a *data lake* that local and state agencies could drop information related to incidents and emergencies into so that industry could avoid operating in affected areas. A minimal level of data sharing would be necessary for an effective and useful shared receptable of data to which incident data could be contributed in real time and AVs could respond to by geofencing around the incidents. These data lakes could serve other data-sharing purposes as long as guardrails are set around the data type and use. Data lakes could be employed for faster geofencing of vehicles for planned and unplanned incidents.
- **Standardization**: All participants expressed a desire for national standardization of key vehicle safety features, especially those related to a first responder's ability to control or communicate with the AV during both emergency and nonemergency situations to override and safely move vehicles. One developer noted, "Military bots are a good example of this in terms of standards and interoperability; one tool allows you to interact with any of the different systems." A first responder noted that "we need a golden key to tap into your cars," asking whether industry participants would be open to the concept. They agreed and noted that "this is something that could be driven at the federal level." Another necessary vehicle safety feature is an autonomy status indicator so that first responders know immediately and from a safe distance that the ADS is engaged, and the vehicle is driving itself.

AVIA's model legislation could be a resource for Texas to consider for the next legislative session because it includes a requirement that AV companies submit a LEIP prior to testing or deploying on public roads. It also designates an agency or multiple agencies to implement and enforce the AV law and serve as a single point of contact for industry.

Large Group Discussion

At the conclusion of the Day 2 breakout sessions, participants reconvened for a larger group discussion. While many of the points iterated during this discussion echoed those of the breakout sessions, the following overarching themes emerged:

- The need for two-way information-sharing portals that:
  - Communicate roadway and TMC information to AV companies from first responders and vice versa.
  - Allow for the exchange of information regarding issues and solutions between industry and first responders.
- Issues surrounding human-directed traffic involving AVs (standard hand and arm signals for human-directed traffic in Texas (defined in 37 Tex. Admin. Code § 3.41) may not be adequate and are not universally utilized.
- First responder identification of AVs, difficulty obtaining contact numbers for vehicle operators, and wait times for remote operators or emergency contacts.
- Standardization of training and procedures for industry and first responders (rather than each company and jurisdiction developing their own materials separately).
- First responder ability to determine a vehicle's autonomy status (e.g., indicator lights) and their ability to manually override/disable autonomy.

Participants expressed a strong desire for follow-up summits, meetings, and/or working groups to continue communication and discussions.

AV Summit Review and Concluding Remarks

Following the large group discussion, the TTI and TEEX principal investigators and the TxDOT Project Monitoring Committee chair delivered closing remarks and walked participants through a brief after-action review of the previous two days, reviewing breakout session and large group discussion highlights and thanking participants for their attendance (see Figure IV-6). After the AV Summit concluded, 15–20 interested participants voluntarily toured the RELLIS campus and test track.

Figure IV-6. Ray Ivie, TEEX Principal Investigator, and Bradley Trefz, TTI Principal Investigator, Lead the AV Summit Review and Large Group Discussion on Day 2 (Photo: Jim Lyle, TTI).

IMPLICATIONS FOR THIS PROJECT

While the goals of the AV Summit (conducted April 30 and May 1, 2024) largely served to meet the needs of this project, an additional benefit of the AV Summit was the creation of an extensive contact list that TxDOT and project team researchers can leverage for future efforts and the development of collaborative working relationships and contacts between participants that will significantly impact both AV developer practices and those of first responders, regulatory agencies, and local and state government. The conversations and the AV Summit overall had a positive, although immeasurable, impact on the safety of road users and first responders during AV interactions. In this regard, the AV Summit exceeded its goals.

Overall, researchers received positive feedback from participants regarding the AV Summit (see Appendix B for exit survey results). AV Summit participants worked collaboratively toward common goals, and the resulting discussions led to extensive exchanges of information benefiting all parties.

The TTI principal investigator subsequently provided an overview of the summit and its results to the Texas CAV Task Force during its full meeting, which was held on May 14, 2024 (see Figure IV-7). The importance of continued discussions as part of a formalized, regular meeting group was one of the key takeaways expressed by AV Summit participants during the final large group discussion and was included in the presentation to the Texas CAV Task Force as a potential strategy for increased collaboration.

Figure IV-7. Bradley Trefz, TTI Principal Investigator, Presents an AV Summit Overview to Members of the Texas CAV Task Force on May 14, 2024 (Photo: Jeff Warner, TTI).

V. CATALOG OF SCENARIOS AND BEST PRACTICES

CATALOGING APPROACH

The goal for Task 5 was to use the information gathered in Tasks 2, 3, and 4, particularly information from stakeholder interviews and discussions, to create a catalog of first responder AV interaction scenarios and best practices in response to those scenarios. This effort resulted in detailed descriptions of use case scenarios for first responder interactions with AVs, as well as best practices for routine and emergency situations.

Initial Challenges to this Effort

Differing Viewpoints

One of the issues discovered by the project team during this project was that AV developers and first responders think about first responder-AV interaction scenarios differently. For AV developers, a first responder-AV interaction scenario is a problem to address through changes to their vehicle control system. For first responders, such scenarios are situations they encounter—both routine and nonroutine—in the course of their duties.

This difference in viewpoint between the two parties can color discussions about scenarios. For example, the same scenario involving an emergency vehicle enroute to an emergency is considered a *rolling code* for first responders who expect that their lights and sirens will be recognized and elicit the correct response from vehicle operators and a trigger for a pull over/stop maneuver by AV developers. For a first responder, an AV that fails to recognize and respond as they expect it to when they approach is a threat to responder life and health. Additionally, both parties may have different priorities. For example, first responders may be primarily concerned about scenarios where an AV is a danger or threat to life. Conversely, AV developers may be primarily concerned about collision avoidance or losing cargo.

Each party's response to a particular situation (scenario) when identified as a problem also differs. Developers may modify their algorithms, while first responders may need to modify their procedures or equipment to ensure recognition.

Lack of Regulatory Frameworks and Limited Data

A common complaint discussed in this project's literature review (Task 2) and during the AV Summit (Task 4) was the limited regulation and safety rules at federal and state levels for AVs. In Texas, AVs must obey the rules of the road as any other driver, but the way in which these vehicles may react to abnormal situations is different than the way in which a human might react.

As discussed in the literature review, differences between human mistakes and machine mistakes create novel situations that current regulatory schemes may not account for. Given the lack of both regulation and case law, fault and liability from incidents remain open questions.

Who to cite, how to cite, and what to report in crash reports were all outstanding questions as this task and the overall project ended. Further, limited crash data and studies looking at AV incidents involving first responders meant that researchers could only rely on the data and previous incidents so far when developing the scenarios. As new situations occur, developers make changes to their algorithms to ensure that they do not reoccur. In doing so, they may create new problems requiring more change. Project team members had to extrapolate and think creatively about scenarios and best practices given that this is the first known attempt to catalog and develop such information on a comprehensive basis.

Novelty of Scenario and Best Practice Development Approach

Where possible, the project team attempted to develop frontline first responder scenarios and best practices that incorporated as much information as possible at the time of this report's publication. Many of these best practices are novel; in some cases, the best practices remained elusive.

When developing scenarios, the project team focused on squad car/fire truck level scenarios—information that a law enforcement officer or firefighter needs to know when interacting with an AV in the course of their duties. To that end, this approach deviated significantly from previous research that either focused on the AV developers perspective (i.e., scenarios to design against) or that simply recognized a need for such guidance without offering any specific direction.

Dynamic Landscapes

Both AV companies and first responder agencies are in a state of constant innovation and adaptation around AV deployment, meaning that issues, scenarios, and best practices will change over time as both the vehicles change, and responders develop new procedures and policies to address issues. As such all findings in this task are tentative and subject to change.

The project team attempted to use established procedures wherever possible, incorporating any AV-specific steps into those existing procedures as a best practice. Scenarios were drawn from the AV Summit discussions, the published literature, and the project team's experience and knowledge. The project team attempted to distill and categorize a limited set of scenarios and develop best practice procedures using basic step-by-step approaches. Some best practices refer to AV company-specific guidance. Likewise, for many scenarios, contacting the AV operator is a primary step for interacting with the AV. As such, the project team included known operator contact information in the *Texas First Responder Guide for Interactions with Automated Vehicles.*

The development of scenarios and best practices was an initial step to provide guidance to frontline first responders based on discussions, previous and ongoing research, and feedback from stakeholders. All scenarios and best practices developed in this task will require validation and further examination over time utilizing crash data, stakeholder interviews, and validation tests performed by responders in realistic scenarios with operational AVs.

Work Performed

Using information gathered from the AV Summit, industry, and other sources, the project team developed frontline first responder scenarios and best practices to respond to those scenarios, addressing responder safety during incidents, including those involving electric or hybrid vehicle battery fires or where electric shock hazards posed threats to responders during extrication.

The project team also reviewed developed scenarios and best practices for consistency with first responder standards and practices with key stakeholders. Wherever possible, the project team relied on established policies and procedures that were either AV specific or for non-AV scenarios. In the latter case, the project team attempted to incorporate AV-specific information into the established procedures, pointing to AV developer specific guidance or contact information where necessary. Much of this information was gathered in Task 6, which considered existing AV developer guidance.

The project team incorporated feedback on the developed scenarios and best practices obtained from several key stakeholders, project team members, and TEEX partners to ensure accuracy and completeness. TxDOT also reviewed this information internally and with outside stakeholders and recommended changes to citation and other procedures incorporated into the final scenarios.

The project team focused this task exclusively on frontline first responders. Previous tasks considered higher-level coordination and communication issues for responders and AV developers, such as geofencing around fire stations or school zones. These high-level issues are addressed separately in this report and more briefly as part of the first responder AV interaction guide.

CATALOGING RESULTS

Scenario Types

The project team categorized the developed scenarios by:

- **Scenario type**: Scenario type considers when a first responder might encounter the situation during their duties, whether routinely (e.g., during a traffic stop) or during abnormal events (e.g., responding to a fire involving an AV powered by a lithium-ion battery).
- **Responder type**: Responder type considers which type of first responder is most likely to handle the scenario.

This category assignment was not exhaustive, and multiple types of first responders may respond to the same scenario depending on the nature of the event. Additionally, traffic management, public works, and even school officials can and do direct traffic, and will all likely encounter future instances in which they will need to provide instructions to AVs with or without a human present.

The scenario type subcategories included the following:

- Law enforcement officer (LEO) routine interaction (e.g., traffic stop).
- Secondary interactions (e.g., AV encountering a response).
- CMV interaction (e.g., inspection and enforcement).
- Crash response and investigation.
- Law enforcement officer nonroutine interaction (e.g., vehicle pursuit, emergency disablement).
- Traffic/parking management and enforcement.

The responder type subcategories used to determine the primary responding agency or personnel included the following:

- Firefighting.
- Law enforcement.
- Crash investigation.
- Courtesy patrols, towing, and traffic management.
- Flaggers/traffic direction (e.g., law enforcement officer, public works, construction crews, school crossing guards).
- Combined response involving multiple responding agencies.

Known Unresolved Issues

Citations

The question of how to cite an SAE Level 4–5 vehicle for violations of the traffic code remains unanswered. While the scenarios in this report include steps for issuing citations, no established practice currently exists and interpretations and procedures may vary by jurisdiction. With emphasis added in bold font, 7 Tex. Transp. Code § 545.454(b)(1) states the following:

> Sec. 545.453. OPERATOR OF AUTOMATED MOTOR VEHICLE
> (a) When an automated driving system installed on a motor vehicle is engaged:
> (1) **the owner of the automated driving system is considered the operator of the automated motor vehicle solely for the purpose of assessing compliance with applicable traffic or**

motor vehicle laws, regardless of whether the person is physically present in the vehicle while the vehicle is operating; and

(2) the automated driving system is considered to be licensed to operate the vehicle.

(b) Notwithstanding any other law, a licensed human operator is not required to operate a motor vehicle if an automated driving system installed on the vehicle is engaged.

Under 7 Tex. Transp. Code § 541.001(2), the owner is "a person who has a property interest in or title to a vehicle." This law also requires AVs to operate in compliance with the traffic laws as follows:

Sec. 545.454. AUTOMATED MOTOR VEHICLE OPERATION
(a) An automated motor vehicle may operate in this state with the automated driving system engaged, regardless of whether a human operator is physically present in the vehicle.
(b) An automated motor vehicle may not operate on a highway in this state with the automated driving system engaged unless the vehicle is:
(1) capable of operating in compliance with applicable traffic and motor vehicle laws of this state, subject to this subchapter;
(2) equipped with a recording device, as defined by Section 547.615(a), installed by the manufacturer of the automated motor vehicle or automated driving system;
(3) equipped with an automated driving system in compliance with applicable federal law and federal motor vehicle safety standards;
(4) registered and titled in accordance with the laws of this state; and
(5) covered by motor vehicle liability coverage or self-insurance in an amount equal to the amount of coverage that is required under the laws of this state.

Most traffic violations in Texas are Class C misdemeanors under 7 Tex. Transp. Code Subtitle C. When a law enforcement officer conducts a traffic stop for a misdemeanor violation of the traffic laws, they effectively place the individual driving the vehicle under temporary arrest and the citation that individual signs is a promise to appear before the court at a later date or pay a fine of up to $500—the only penalty allowed for Class C traffic misdemeanors. After the driver signs the citation, the officer must—under state law—allow the driver to continue their journey, hopefully deterred enough to not commit the same violation again, unless the violation was serious enough to warrant an arrest (e.g., driving while intoxicated).

If an AV violates the traffic law, it will continue to do so under the same conditions because its programming contains a flaw that led to the initial violation. Further, a driverless vehicle cannot sign a citation and promise to appear in court. Therefore, the following questions arose related to citing SAE Level 4–5 vehicles:

- Who is liable for self-driving malfunctions under current state law if an SAE Level 4–5 AV equipped with an ADS is sold to a third party, given that vehicles must be titled with the owner of the vehicle listed on the title?
- Can a law enforcement officer issue a citation to the safety driver of an SAE Level 4–5 AV operated by the ADS or must they cite the company? How do they determine the appropriate party and whether the safety driver or the ADS controlled the vehicle at the time of the violation?
- When citing owners, can a law enforcement officer cite a company or must they cite a human (i.e., an agent of the company)?

- Can a law enforcement officer issue a citation to any company employee representing the company (e.g., a representative sent to the scene in the event of an incident)?
- Is there a statewide standardized process for issuing a citation to a company or their agent? Must officers serve process in person or can they utilize some other method (e.g., by mail)?

As the project team prepared this report, these questions largely remained unanswered, although at least one municipality in Texas is developing a process to issue citations to AV companies in coordination with their municipal court. However, until they actually issue citations and a court upholds those citations, such procedures remain in a state of development.

Crash Reporting

Another known unresolved issue relates to crash reporting. An examination of recent crash data utilizing the new CR-3 forms that incorporate fields for AVs revealed that many officers do not understand the different levels of autonomy and how to report them. Additionally, it is difficult for officers to know the status of an ADAS or ADS at the time of the crash, especially without training or the means to verify the activation or deactivation of such systems.

The current CR-3 form includes fields to indicate Autonomous Unit as a driver and the autonomous level engaged. The associated code sheet (CR-3CS) provides the appropriate codes to use in those sections. For Autonomous Level Engaged, the codes loosely match the SAE International levels of automation shown Figure II-1. According to the CR-100 instructions, the selection of Autonomous Unit should capture whether the vehicle has some level of autonomy. The Autonomous Level Engaged field should describe the degree of automation that was engaged at the time of the crash.

However, crash reporting training and an understanding of the new forms lags the implementation of the new forms and instructions. Officers reported during the AV Summit that they struggle to recognize a vehicle's level of automation and determine its status. Crash data reflect this confusion. For example, unknown autonomous level engaged was the most frequently used code (6=unknown) based on recent CRIS data (see Table II-2). In instances where an officer reported an autonomous unit present on the vehicle (1=yes in field 8), unknown autonomous level engaged was marked in nearly half (45.5 percent) of all reports.

While the dissemination of the Texas Automated Vehicle Recognition Guide for First Responders and the Texas First Responder Guide for Interactions *with Automated Vehicles*, developed as part of this project, may assist officers in improving their crash reporting, discussions and a series of changes around these fields over the last year suggest that the CR-3, CR-3CS, and CR-100 may also require changes (with corresponding changes to the crash reporting-related scenarios in this chapter).

Notes on the Development of Scenarios and Best Practices

The project team developed a list of scenarios and best practices to guide first responders in their interactions with AVs, drawing from a wide range of sources. These sources include AV operator law enforcement and first responder interaction plans, federal, state, and local administrative codes, road safety and engineering manuals such as the current edition of the MUTCD, and first responder training materials.

CATALOG OF SCENARIOS AND BEST PRACTICES

Supplemental information to support application of the catalog of scenarios and best practices developed for this project includes the following:

- In each of the developed scenarios, best practice steps marked in **bold** font indicate alterations by TTI/TEEX researchers to existing best practices to address AV-specific considerations.
- References to an *AV recognition guide* and an *AV contact list* in the developed scenarios refer to the *Texas Automated Vehicle Recognition Guide for First Responders* and the *Texas Automated Vehicle Operator Contact Sheet* created as part of this project.
- The developed scenarios reference the SAE International levels of automation (see Figure II-1).
- Figure V-1 compares the SAE International levels of autonomy to the codes utilized on TxDOT's CR-3 form.

SAE Levels of Autonomy	SAE Level Examples	Texas CR-3 Code
SAE Level 0 No Automation	• Automatic Braking • Blind Spot Warning • Lane Departure Warning	**0** No Automation
SAE Level 1 Driver Assistance	• Lane Centering **OR** • Adaptive Cruise Control	**1** Driver Assistance
SAE Level 2 Partial Automation	• Lane Centering **AND** • Adaptive Cruise Control	**2** Partial Assistance
SAE Level 3 Conditional Automation	• Traffic Jam Chauffer • Automated driving in limited conditions	**3** Conditional Automation
SAE Level 4 High Automation	• Local Driverless Taxi Service • May Not Possess Traditional Driving Operation Features (Wheels or Pedals) • Automated driving in limited conditions	**4** High Automation
SAE Level 5 Full Automation	• Vehicle Can Drive Anywhere in All conditions	**5** Full Automation
		6 Automation Level Unknown
NOTE: SAE levels of autonomy may be referred to as an "L" in industry documents (e.g., SAE Level 4 as L4).		**99** Unknown (Use when Autonomous Unit Engaged Status [Box 8] is Unknown)

Figure V-1. SAE International Levels of Driving Autonomy and Corresponding TxDOT CR-3 Codes.

LAW ENFORCMENT ROUTINE INTERACTIONS

The following scenarios address law enforcement officer (LEO) routine interactions with automated vehicles:

- Conduct a traffic stop of an SAE Level 1-3 Automated Vehicle
- Conduct a traffic stop of an SAE Level 4-5 Automated Vehicle (with a safety driver)
- Conduct a traffic stop of an SAE Level 4-5 Automated Vehicle (without a safety driver)

Scenario: Conduct a Traffic Stop of an SAE Level 1-3 Automated Passenger Vehicle

Primary Scenario Type: LEO Routine Interaction
Primary Responder Type: Law Enforcement
Scenario Context: A traffic stop involving an SAE Level 1-3 automated vehicle should follow normal procedures as drivers must remain ready to take control of the vehicle. Under the law, drivers are still responsible for the safe operation of personally owned SAE Level 1-3 vehicles.

Best Practice

1) Assess the situation and execute a traffic stop following departmental procedures
2) Secure the area by positioning your vehicle safely and activating warning lights
3) **If you recognize the vehicle as an SAE Level 1-3 automated vehicle instruct the driver to disable any self-driving features or turn off the vehicle once they pull over**
4) If necessary, approach the vehicle with caution, observing for vehicle movement and any passenger actions
5) Request documentation from driver
6) If required, prepare a citation or warning per departmental procedures
7) Ensure the vehicle is safe to re-enter traffic
8) **If your jurisdiction requires it, submit an AV interaction report through normal procedures**

Notes

Some SAE Level 2 and 3 automated driving features will not respond to law enforcement. Drivers of SAE Level 1-3 vehicles must remain ready to always resume control of such vehicles. Failure to do so violates the Traffic Code.

Drivers of some SAE Level 1-3 vehicles may be more prone to distraction or even fall asleep during operation. While the vehicle may continue to operate, a distracted driver of an SAE Level 1-3 vehicle still violates state or municipal code in such circumstances (due to the requirement to remain ready to resume control of such systems).

Drivers should not operate SAE Level 1-3 vehicles while under the influence of drugs or alcohol, though intoxicated individuals may attempt to utilize self-driving systems in an attempt to evade detection.

Drivers of some SAE Level 2 and 3 vehicles may believe their vehicle has more automated driving capability than it does. Additionally, some SAE Level 2 and 3 manufacturers allow drivers to bypass warnings and enable automated driving features in places and situations where they should not operate. If a vehicle in such circumstances violates the traffic code or behaves in an unsafe matter, the driver is responsible under the traffic code, and you can cite them for the violation(s).

Sources Utilized

Governmental Authorities, 7 Tex. Transp. Code § 541.002 (1995).

Powers of Local Authorities. 7 Tex. Transp. Code § 542.202 (2003).

Requirement to Take Action. 37 Texas Admin. Code § 3.21 (1976).

Scenario: Conduct a Traffic Stop of an SAE Level 4-5 Automated Vehicle (with a Safety Driver)

Primary Scenario Type: LEO Routine Interaction
Primary Responder Type: Law Enforcement
Scenario Context: A traffic stop involving an SAE Level 4-5 automated vehicle with a safety driver should follow relatively normal procedures as safety drivers must remain ready to take control of the vehicle.

Best Practice

1) Assess the situation and execute a traffic stop following departmental procedures
2) **Recognize the vehicle as an AV (see AV recognition guide for information)**
   a) **Identify vehicle make/model and the AV operator through markings, vehicle registration information, or the AV recognition guide**
3) **SAE Level 4-5 AVs should detect sirens and flashing lights from law enforcement and make efforts to slow down and arrive at a stopping point or the safety driver can disable autonomy and take control of the vehicle**
4) **Instruct the driver to disable the automation system and ensure the safety driver is in control of the vehicle's driving operations**
   a) If necessary, instruct the driver drive or pull into a safer area
5) Secure the area by positioning your vehicle safely and activating warning lights
6) Approach the vehicle with caution
7) Request documentation from driver
8) If needed, prepare a citation or warning per departmental procedures
   a) **Document any violations or issues, including the AV's automation level and the presence of a safety driver at the time of the incident**
   b) **Note if the safety driver was in control of the driving operation at the time of the cited incident or if the system was operating autonomously**
9) Ensure the vehicle is safe to re-enter traffic
10) **If your jurisdiction requires it, submit an AV interaction report through normal procedures**

Notes

At the time of publication, no manufacturer sold SAE Level 4-5 vehicles for private use in the United States. All current SAE Level 4-5 automated passenger vehicles operating in Texas are developer owned and operating as taxi services. This may change, requiring modification of these procedures as to the responsible party for any violations.

SAE Level 4-5 vehicle should detect and respond to flashing lights and sirens and respond in accordance with the traffic code.

According to Tex. Transp. Code § 545.453, the AV owner is liable for any violations of traffic laws, regardless of whether a human passenger is present. However, if a safety driver is present and the automated system was disengaged at the time of the violation that driver may be liable (consult departmental policy for guidance).

Sources Utilized

Governmental Authorities, 7 Tex. Transp. Code § 541.002 (1995).

Operator of Automated Vehicle, 7 Tex. Transp. Code. § 545.453 (2017).

Cruise, LLC. (2024). Guide for *law enforcement & first responders for interacting with a cruise autonomous vehicle*: Cruise AV (Chevy Bolt *platform) version*. Cruise, LLC.

Waymo, LLC. (2024). Waymo autonomously driven Jaguar I-PACE: Emergency response guide and law enforcement interaction protocol. Waymo, LLC

Scenario: Conduct a Traffic Stop of an SAE Level 4-5 Automated Vehicle (without a Safety Driver)

Primary Scenario Type: LEO Routine Interaction
Primary Responder Type: Law Enforcement
Scenario Context: Conducting a traffic stop is a routine procedure for law enforcement. However, stopping an SAE Level 4-5 automated vehicle without a safety driver presents new challenges. When a vehicle is operating autonomously (with or without passengers), first responders may need to communicate directly with the vehicle operator remotely, ensuring it safely pulls over and remains stationary. Additionally, the responsible party for any traffic violations by an SAE Level 4-5 vehicle is the company operating the AV.

The following procedures work for SAE Level 4-5 passenger vehicles, commercial motor vehicles, and for delivery robots operating in the roadway.

Best Practice

1) Assess the situation and execute a traffic stop following departmental procedures
2) **Recognize the vehicle as an AV (see AV recognition guide for information)**
    a) **Identify vehicle make/model and the AV operator through markings, vehicle registration information, or the AV recognition guide**
3) Once the AV comes to a stop, secure the area by positioning your vehicle safely and activating warning lights
    a) If passengers are present, inform passengers you stopped the vehicle for unsafe operation and instruct them to remain in the vehicle until instructed otherwise per departmental procedures using loudspeakers (do not approach the vehicle until you verify with the operator it will not move)
4) **Obtain confirmation from the AV operator that the vehicle will not move before approaching the vehicle**
5) If necessary, approach the vehicle with caution, observing for vehicle movement and any passenger actions
6) **If continued operation of the vehicle may endanger passengers or the public, request the AV operator send representatives to the scene to retrieve the vehicle and any passengers**
    i) **Based on the officer's discretion and judgement as to the safety of passengers in the vehicle, officers may request passengers remain in the vehicle or move to a safe area once they confirm the vehicle will not move**
7) **Find operator provided registration and insurance documentation within vehicle**
    a) **Location of this documentation will be AV operator specific (see AV recognition guide to identify operator)**
    b) **Consult operator specific documents (first responder interaction plan/law enforcement interaction plan (FRIP/LEIP)) for more information, if available**
    c) **If necessary, request assistance from remote operator in locating required information in the vehicle**
8) Document any violations or issues, including the vehicle automation level (see AV recognition guide for information) and lack of safety driver at the time of the incident
9) Document any statements made by passengers about vehicle operations and obtain contact information from the passengers for follow up, if needed
10) Based on the officer's judgement, if continued operation of the vehicle would be unsafe, after taking any statements from passengers necessary to document the incident, inform passengers that they may wait until AV Operator personnel arrive to transport them or that they may leave via another means, if they choose
11) If required, prepare a citation or warning per departmental procedures
    a) **Cite the registered owner of the vehicle based on information obtained from the operator or found within the vehicle (see step 7)**
    b) **If, in the judgement of the officer, continued operation of the vehicle might endanger the public, request the operator place the vehicle out of service and issue the citation to company representatives per departmental procedures**
        i) **If company personnel may be some time in responding to your location, assist any passengers with obtaining transportation from the scene before departing**
    c) **If, in the judgement of the officer, continued operation of the vehicle would not endanger the public, inform the operator of the citation, and follow departmental procedures about how to deliver the citation or warning to the operator, before allowing the operator to place the vehicle back into service/depart the scene**

Notes

At the time of publication, no manufacturer sold SAE Level 4-5 vehicles for private use in the United States. All current SAE Level 4-5 automated passenger vehicles operating in Texas are developer owned and operating as taxi services. This may change, requiring modification of these procedures as to the responsible party for any violations.

SAE Level 4-5 vehicles should detect and respond to flashing lights and sirens and respond in accordance with the traffic code.

According to Tex. Transp. Code § 545.453, the AV owner is liable for any violations of traffic laws, regardless of whether a human passenger is present.

Sources Utilized

Governmental Authorities, 7 Tex. Transp. Code § 541.002 (1995).

Operator of Automated Vehicle, 7 Tex. Transp. Code. § 545.453 (2017).

Cruise, LLC. (2024). *Guide for law enforcement & first responders for interacting with a Cruise autonomous vehicle: Cruise AV (Chevy Bolt platform) version*. Cruise, LLC.

Waymo, LLC. (2024). *Waymo autonomously driven Jaguar I-PACE: Emergency response guide and law enforcement interaction protocol*. Waymo, LLC.

Zoox. (2024). *Emergency response guide information for first and second responders for autonomous Zoox vehicles*. Zoox.

Zoox. (2024). *Law enforcement interaction plan: California*. Zoox.

SECONDARY INTERACTIONS

The following scenario addresses secondary first responder interactions with AVs, such as those entering an active response scene or a crowded pedestrian areas.

- Conduct emergency disablement of an SAE Level 4-5 Vehicle (without a safety driver)

Scenario: Conduct Emergency Disablement of an SAE Level 4-5 Vehicle (without a Safety Driver)

Primary Scenario Type: Secondary Interactions
Primary Responder Type: Law Enforcement
Secondary Responder Type: Firefighting
Scenario Context: Law enforcement officers, as well as firefighters, traffic management personnel, and other responders might find it necessary to disable a Level 4-5 vehicle that is unresponsive to human issued commands and where the vehicles continued operation presents a danger to responders or the public.

Best Practice

1) Turn on lights and sirens
2) Recognize the unresponsive vehicle as an SAE Level 4-5 Automated Vehicle (see recognition guide for information)
    a) Identify vehicle make/model and the AV operator through markings, vehicle registration information, or the AV recognition guide
3) If the danger is not immediate, attempt to contact, or have dispatch contact the AV operator and ask them to disengage the autonomy
    a) Attempt to block the vehicle movement with responder vehicles (box it in)
    b) Keep everyone away from the vehicle
4) If you cannot block the vehicle with another vehicle and the danger is immediate, initiate contact with the AV with another vehicle (bump the AV with your vehicle bumper/push bar)
    a) SAE Level 4-5 vehicles should stop in the event of any vehicular incident/damage
5) If the danger is immediate to a pedestrian and another vehicle is not able to intervene, initiate physical contact with the vehicle by any means available
6) Do not approach a moving Level 4-5 AV unless absolutely necessary as it may move or change direction suddenly
7) Based on the officer's discretion and judgement as to the safety of passengers in the vehicle, officers may request passengers remain in the vehicle or move to a safe area once they confirm the vehicle will not move
8) Once the vehicle stops moving attempt to communicate with the AV operator through the in-vehicle communication system (if present) or via phone/dispatch
    a) Inform operator of the emergency situation and request a company representative report to the scene
    b) Request the AV operator send towing to the scene or request towing via departmental procedures
    c) Inform the towing operator the vehicle is an automated vehicle and autonomy is disabled
9) Request passengers wait in a safe area until AV operator arrives to transport them, or the passengers choose to leave via another means
    a) Document any statements made by passengers regarding vehicle operations and their actions and obtain contact information from the passengers for follow up, if needed
10) Find operator provided registration and insurance documentation within vehicle
    a) Location of this documentation will be AV operator specific (see AV recognition guide to identify operator)
    b) Consult operator specific documents (first responder interaction plan/law enforcement interaction plan (FRIP/LEIP)) for more information, if available
    c) If necessary, request assistance from remote operator in locating required information in the vehicle
11) Document any violations or issues, including the vehicle automation level (see AV recognition guide) and lack of safety driver at the time of the incident
12) If required, prepare a citation or warning per departmental procedures
    a) Cite the registered owner of the vehicle based on information obtained from the operator or within the vehicle
    b) If, in the judgement of the officer, continued operation of the vehicle might endanger the public, request the operator place the vehicle out of service and issue the citation to company representatives per departmental procedures
        i) If company personnel may be some time in responding to your location, assist any passengers with obtaining transportation from the scene before departing

c) If, in the judgement of the officer, continued operation of the vehicle would not endanger the public, inform the operator of the citation, and follow departmental procedures about how to deliver the citation or warning to the operator, before allowing the operator to place the vehicle back into service/depart the scene

13) If your jurisdiction requires it, submit an AV interaction report through normal procedures

Notes

SAE Level 4-5 vehicle should detect and respond to flashing lights and sirens and respond per the traffic code.

According to Tex. Transp. Code § 545.453, the AV owner is liable for any violations of traffic laws, regardless of whether a human passenger is present.

Sources Utilized

Governmental Authorities, 7 Tex. Transp. Code § 541.002 (1995).

Powers of Local Authorities. 7 Tex. Transp. Code § 542.202 (2003).

Requirement to Take Action. 37 Texas Admin. Code § 3.21 (1976).

Cruise, LLC. (2024). *Guide for law enforcement & first responders for interacting with a Cruise autonomous vehicle Cruise AV (Chevy Bolt platform) version*. Cruise, LLC.

Waymo, LLC. (2024). *Waymo autonomously driven Jaguar I-PACE: Emergency response guide and law enforcement interaction protocol*. Waymo, LLC.

Zoox. (2024). *Emergency response guide information for first and second responders for autonomous zoox vehicles*. Zoox.

Zoox. (2024). *Law enforcement interaction plan: California*. Zoox.

COMMERCIAL MOTOR VEHICLE INTERACTIONS

The following scenarios address routine first responder interactions specific to commercial motor vehicles:

- Conduct an SAE Level 4-5 Commercial Motor Vehicle Inspection (with a safety driver)
- Conduct an SAE Level 4-5 Commercial Motor Vehicle Inspection (without a safety driver)

Scenario: Conduct an SAE Level 4-5 Commercial Motor Vehicle Inspection (with a Safety Driver)

Primary Scenario Type: Commercial Motor Vehicle Interaction
Primary Responder Type: Law Enforcement
Scenario Context: Inspections of commercial motor vehicles are a routine task for law enforcement and commercial motor vehicle enforcement officials. However, SAE Level 4-5 automated vehicles introduce new complexities. This scenario assumes automated operation but with a safety driver present in the vehicle. The safety driver may not be actively engaged in driving but is present to take over if necessary.

Currently, Texas Automated Commercial Vehicle operators in Texas utilize the Commercial Vehicle Safety Alliance (CVSA) Enhanced Inspection Program for their automated trucks (with and without the use of safety drivers) and operate primarily on interstate highways. Currently, Texas automated commercial motor vehicle operators in Texas utilize the Commercial Vehicle Safety Alliance (CVSA) Enhanced Inspection Program for their automated trucks (with and without the use of safety drivers) and operate primarily on interstate highways. Under this program, the vehicles and trailers undergo a complete FMCSA inspection prior to every dispatch or operating period. Automated Commercial Vehicle operators pass information to the Texas Department of Public Safety during their runs that allow them to bypass DPS operated inspection stations on interstate highways. The following procedure is for situations where officers observe safety defects on an automated vehicle while in operation.

Best Practice

1) Observe a commercial motor vehicle with a safety defect or operating in an unsafe condition (e.g., improperly secured load or dangerous driving)
2) **Recognize the vehicle as an SAE Level 4-5 Automated Commercial Motor Vehicle (see AV recognition guide for information)**
   a) **Identify vehicle make/model and the AV operator through markings, vehicle registration information, or the AV recognition guide**
3) Pull over the vehicle (see Scenario: Conduct a Traffic Stop of an SAE Level 4-5 Vehicle with a Safety Driver)
4) **Instruct the safety driver to disable autonomy and/or to follow your vehicle to a safer location, if necessary to conduct the vehicle inspection**
5) Identify the safety driver and request required documentation
6) Verify financial responsibility of driver/liability insurance
7) Inspect driver's logbook and shipping papers
   a) Verify safety driver is compliant with Federal Motor Carrier Safety Regulations (FMCSR) hours of service requirements [49 CFR § 395.3]
8) Inspect the CMV for compliance with state and federal regulations up to your level of training and certification as a commercial vehicle inspector
   a) If you are not a commercial vehicle inspector, request aid through dispatch from a certified Commercial Vehicle Enforcement (CVE) officer or other trained and certified inspector
9) Document any violations or issues, including the CMV's automation level and safety driver's responses
   a) If there is a violation but the vehicle's conditions do not meet out-of-service criteria, issue notice of the violation and allow the CMV to continue
   b) If the vehicle is determined to be out-of-service, issue a citation and require the driver to cease operation until the noted issue is corrected
      i) Instruct the driver to contact AV Operator/dispatcher to address the safety defect
      ii) Ensure the vehicle returns to operable condition or is towed from the scene for repair
10) Assist the vehicle driver in safely re-entering traffic before departing the scene (if necessary)
11) **If your jurisdiction requires it, submit an AV interaction report through normal procedures**

Notes

For vehicles entering Customs and Border Patrol Inspection areas where vehicles may undergo other inspections, current procedures require AV operators to inform CBP of expected truck arrivals and officers direct the automated CMV utilizing special signs to areas for inspection or bypass of the inspection station.

Currently, no AV-specific procedures exist for USDA or other, non-DPS/CBP inspection stations.

Sources Utilized

Maximum Driving Time for Property-Carrying Vehicles, 49 C.F.R. § 395.3 (2020).

Commercial Vehicle Inspection Items, 37 Tex. Admin. Code. § 23.42 (2017).

Commercial Vehicle Safety Alliance. (n.d.). Inspections. Commercial Vehicle Safety Alliance.

Commercial Vehicle Safety Alliance. (2014). North American *standard inspection procedures*.

Commercial Vehicle Safety Alliance. (2022). Enhanced Commercial Motor Vehicle inspection procedure (for motor carrier operations).

Commercial Vehicle Safety Alliance. (2024). North American standard out-of-service criteria, 2024 edition. Commercial Vehicle Safety Alliance.

Federal Motor Carrier Safety Regulations -Inspection, Repair, and Maintenance, 49 C.F.R. § 396 et seq.

Texas Department of Public Safety. (2023). Chapter 6: Commercial motor vehicle. In *Vehicle inspection operations & training manual for official vehicle inspection stations (vehicle safety inspection)*. Texas Department of Public Safety.

Texas Department of Public Safety, Safety Regulatory Services Division. Texas Department of Public Safety: Vehicle Inspections.

Scenario: Conduct an SAE Level 4-5 Commercial Motor Vehicle Inspection (without a Safety Driver)

Primary Scenario Type: Commercial Motor Vehicle Interaction
Primary Responder Type: Law Enforcement
Scenario Context: Inspections of commercial motor vehicles are a routine task for law enforcement and commercial motor vehicle enforcement officials. However, SAE Level 4-5 automated vehicles introduce new complexities. This scenario assumes fully automated operation without a safety driver present in the vehicle.

Currently, Texas Automated Commercial Vehicle operators in Texas utilize the Commercial Vehicle Safety Alliance (CVSA) Enhanced Inspection Program for their automated trucks (with and without the use of safety drivers) and operate primarily on interstate highways. Under this program, the vehicles and trailers undergo a complete FMCSA inspection prior to every dispatch or operating period. Automated Commercial Vehicle operators pass information to the Texas Department of Public Safety during their runs that allow them to bypass DPS operated inspection stations on interstate highways. The following procedure is for situations where officers observe safety defects on an automated vehicle while in operation.

Best Practice

1) Observe a commercial motor vehicle with a safety defect or operating in an unsafe condition (e.g., improperly secured load or dangerous driving)
2) **Recognize the vehicle as an SAE Level 4-5 Automated Commercial Motor Vehicle (see AV recognition guide for information)**
   a) **Identify vehicle make/model and the AV operator through markings, vehicle registration information, or the AV recognition guide**
3) Pull over the vehicle (see Scenario: Conduct a Traffic Stop for an SAE Level 4-5 Automated Vehicle (without a safety driver)
4) **Contact AV operator and inform them of the observed safety defect or unsafe operation (see contact list)**
   a) **Instruct operator to disable autonomy and refrain from moving the vehicle**
   b) **Obtain confirmation from the AV operator that the vehicle will not move before approaching the vehicle**
   c) **Determine whether it would be necessary for the AV operator to send personnel to the scene and notify the operator**
5) **Consult with operator (or the developer-specific emergency response guide) to determine location and access for any documentation carried with the vehicle necessary for inspection**
6) Inspect the CMV for compliance with state and federal regulations up to your level of training and certification as a commercial vehicle inspector
   a) If you are not a commercial vehicle inspector, request aid through dispatch from a certified Commercial Vehicle Enforcement (CVE) officer or other trained and certified inspector
7) Document any violations or issues, including the CMV's automation level (see AV recognition guide)
8) If there is a violation but the vehicle's conditions do not meet out-of-service criteria or can be corrected on the spot, consult with operator about dispatching personnel to the scene to remedy the defect and coordinate with AV operator regarding where and how you will deliver the notice of citation per departmental procedures
   a) If the vehicle is determined to be out-of-service, issue a citation and require the company personnel to cease operation of the vehicle until they correct the issue
   b) Ensure the vehicle returns to operable condition or operator tows it from the scene for repair
9) If necessary and present, assist the vehicle to safely re-enter traffic before departing the scene (if necessary)
10) **If your jurisdiction requires it, submit an AV interaction report through normal procedure**

Notes

For vehicles entering Customs and Border Patrol Inspection areas where vehicles may undergo other inspections, current procedures require AV operators to inform CBP of expected truck arrivals and officers direct the automated CMV utilizing special signs to areas for inspection or bypass of the inspection station.

Currently, no AV-specific procedures exist for USDA or other, non-DPS/CBP inspection stations.

Sources Utilized

Commercial Vehicle Inspection Items, 37 Tex. Admin. Code. § 23.42 (2017).

Commercial Vehicle Safety Alliance. (2014). North American *standard inspection procedures*.

Commercial Vehicle Safety Alliance. (2022). Enhanced Commercial Motor Vehicle inspection procedure (for motor carrier operations).

Commercial Vehicle Safety Alliance. (n.d.). Inspections. Commercial Vehicle Safety Alliance.

Commercial Vehicle Safety Alliance. (2024). North American *standard out-of-service criteria*, 2024 edition. Commercial Vehicle Safety Alliance.

Federal Motor Carrier Safety Regulations -Inspection, Repair, and Maintenance, 49 C.F.R. § 396 et seq.

Texas Department of Public Safety. (2023). Chapter 6: Commercial motor vehicle. In Vehicle *inspection operations & training manual for official vehicle inspection stations (vehicle safety inspection*). Texas Department of Public Safety.

Texas Department of Public Safety, Safety Regulatory Services Division. (2022). Texas Department of Public Safety: Vehicle Inspections.

LEO NON-ROUTINE INTERACTIONS

The following scenarios address law enforcement and other first responder interactions with automated vehicles in unusual or non-routine situations:

- Conduct a vehicle pursuit of an SAE Level 4-5 Automated Vehicle (without a safety driver)
- Respond to an SAE Level 4-5 Vehicle with an incapacitated passenger

Scenario: Conduct a Vehicle Pursuit of an SAE Level 4-5 Automated Vehicle (without a Safety Driver)

Primary Scenario Type: LEO Non-Routine Interaction
Primary Responder Type: Law Enforcement
Scenario Context: AV developers program their SAE Level 4-5 vehicles to recognize flashing lights and sirens used by law enforcement vehicles and make efforts to slow down and pull over for an officer. However, in instances where this system fails or is tampered with, an officer might need to conduct a vehicular pursuit and apply intervention tactics to stop or immobilize the vehicle.

Best Practice

1) Observe or receive notification of a vehicle fleeing from law enforcement or that a wanted or fleeing suspect is in an automated vehicle
2) **Recognize the vehicle as an AV (see AV recognition guide for information)**
   a) **Identify vehicle make/model and the AV operator through markings, vehicle registration information, or the AV recognition guide**
3) Activate lights and sirens
   a) **SAE Level 4-5 vehicles should detect sirens and flashing lights from law enforcement and make efforts to slow down and arrive at a stopping point in accordance with the traffic code**
4) **If a vehicle fails to respond and stop, contact the AV operator, or request dispatch contact the AV operator (see contact list)**
   a) Notify dispatch of the:
      i) Purpose of the pursuit
      ii) Any safety or environmental factors which might impact the pursuit including road hazards, weather, possession or use of firearms, and the current direction and speed of the pursuit
   b) **Inform dispatch and the AV operator of the situation and request the AV operator assume control of the vehicle or instruct it to stop in a safe area**
   c) If you determine that the vehicle/passenger represents a present danger to the public or officers apply intervention tactics to reduce or eliminate the vehicle's mobility
5) **Once the AV comes to a stop, secure the area by positioning your vehicle safely and activating warning lights**
6) **Follow procedures found in Scenario: Conduct a Traffic Stop of an SAE Level 4-5 Automated Vehicle (without a Safety Driver) from this point**

Notes

At the time of publication, no vehicle manufacturer yet sells SAE Level 4-5 vehicles for private use in the United States. All current SAE Level 4-5 automated passenger vehicles operating in Texas are developer owned and operating as taxi services, delivery robots, or commercial motor vehicles (trucks and tractor trailers). This may change, requiring modification of these procedures.

Procedures for pursuit of an SAE Level 1 to 3 vehicle remain the same as any other vehicle. As human drivers can take control of some Level 1-5 vehicles (when a driver is present), unlike with SAE Level 4-5 vehicles without a safety driver, officers may need to implement more severe intervention tactics to affect a stop.

Sources Utilized

Fleeing or Attempting to Elude Police Officer; Offense, 7 Tex. Transp. Code § 545.421 (2009).

Operator of Automated Vehicle, 7 Tex. Transp. Code. § 545.453 (2017).

International Association of Police Chiefs. (2019). *Vehicular Pursuits*.

Police Executive Research Forum. (2023). *Vehicular Pursuits: A guide for law enforcement executives on managing the associated risks*. Washington, DC: Department of Justice, Office of Community Oriented Policing Services.

Scenario: Respond to an SAE Level 4-5 Vehicle with an Incapacitated Passenger

Primary Scenario Type: LEO Non-Routine interaction
Primary Responder Type: Law Enforcement
Secondary Responder Type: Firefighting (and EMS)
Scenario Context: An SAE Level 4-5 vehicle operating as a taxi or mini-bus service may transport passengers that become unresponsive due to medical emergencies or other problems. These vehicles and their associated phone applications allow passengers to unlock doors and, in an emergency, contact the operator. However, in some circumstances, a passenger may become unconscious due to medical conditions, drug abuse, alcohol consumption, or other factors. Law enforcement officers, as well as firefighters, EMS, and other responders may need to conduct rapid extrication and perform first aid on passengers discovered in SAE Level 4-5 vehicles when notified by the public or the AV Operator of such a situation.

Best Practice

1) Observe or receive notification of an automated vehicle with an incapacitated passenger
2) **Recognize the vehicle as an AV (see AV recognition guide for information)**
   a) **Identify vehicle make/model and the AV operator through markings, vehicle registration information, or the AV recognition guide**
3) **If vehicle is actively driving, utilize the procedures in Scenario: Conduct a Traffic Stop if an SAE Level 4-5 Automated Vehicle (without a Safety Driver)**
   a) **If vehicle not actively driving/moving pull behind the vehicle and activate lights and sirens**
   b) **Attempt to block movement of the vehicle with your or other vehicles**
4) **Contact AV operator (or request dispatch contact them) to request they disable autonomy and to assist with opening the vehicle if the doors do not unlock automatically**
5) **Approach the vehicle cautiously, checking the surroundings for hazards and observing active lights, sounds, or vehicle movement**
6) **If deemed an emergency, and you are unable to contact the operator and if safe to do so, or if the vehicle could move before AV operator is able to disable, initiate physical contact and shout loudly into the vehicle you are a law enforcement officer (or fire department/EMS) responding to a passenger emergency and request the operator disable autonomy immediately**
   a) **If you have access to the relevant emergency response guide and the vehicle has an autonomy indicator and disengage system, disengage the autonomy**
7) **In an emergency, if unable to open the doors or obtain AV operator remote assistance, break a window, and try to open the doors from the inside using mechanical releases (consult relevant AV emergency response guide for location of any door release)**
8) Extricate the passenger if necessary or await arrival of EMS/Fire to extricate the passenger
9) Ensure the safety of the passenger while removing them from the vehicle
10) Provide first aid/medical assistance to your level of training until EMS arrives
11) If necessary following turnover of care to EMS, arrange towing with AV Operator or request towing through normal channels
12) **If your jurisdiction requires it, submit an AV interaction report through normal procedures**

Notes

SAE Level 4-5 vehicle should detect and respond to flashing lights and sirens and respond in accordance with the traffic code.

Sources Utilized

Cruise, LLC. (2024). *Guide for law enforcement & first responders for interacting with a Cruise autonomous vehicle Cruise AV (Chevy Bolt platform) version*. Cruise, LLC.

Waymo, LLC. (2024). *Waymo autonomously driven Jaguar I-PACE: Emergency response guide and law enforcement interaction protocol*. Waymo, LLC.

Zoox. (2024). *Emergency response guide information for first and second responders for autonomous Zoox vehicles*. Zoox.

Zoox. (2024). *Law enforcement interaction plan: California*. Zoox.

CRASH RESPONSE AND INVESTIGATION

The following scenarios address first responder interactions with automated vehicles involved in crashes or other incidents:

- Respond to an SAE Level 1-3 passenger vehicle traffic crash
- Respond to an SAE Level 4-5 passenger vehicle traffic crash
- Respond to an SAE Level 4-5 Commercial Motor Vehicle traffic crash
- Respond to a sodium- or lithium-ion battery fire in a Vehicle
- Conduct driver/passenger extrication from an SAE Level 4-5 vehicle
- Complete Texas CR- 3 Crash Report Form for Automated Vehicle involved crashes

Scenario: Respond to an SAE Level 1-3 Passenger Vehicle Traffic Crash

Scenario Type: Crash Response and Investigation
Primary Responder Type: Combined response involving multiple responding agencies
Scenario Context: Traffic crashes occur regularly. This scenario includes SAE Level 1-3 AVs as one or more of the vehicles involved in the incident. SAE Level 1-3 automated vehicle will have a human operator in charge of the driving operation, though they may have some level of autonomy engaged at the time of the crash, the crash should disable the autonomy.

Best Practice

1) Arrive on incident scene
2) Determine if an involved vehicle is an electric vehicle (see Scenario: Respond to a Sodium- or Lithium-Ion Battery Fire in Vehicle)
3) Recognize an involved vehicle as an SAE Level 1-3 vehicle
    a) Identify vehicle make/model through markings or vehicle registration information
4) Inform dispatch of initial incident details and request additional support from fire and EMS if necessary
5) If SAE Level 1-3 vehicle is still running, turn off the vehicle or request that the driver (if able) turn off vehicle
6) If necessary, conduct emergency extrication and provide primary first aid until the arrival of EMS personnel
7) Secure the scene of the incident and remove vehicles from roadway, if possible
8) Establish traffic control and await fire and EMS response (if necessary)
9) Fire and EMS conduct extrication (if necessary)
10) Record information related to the ownership, make, model, and licensing of involved vehicles
11) Request a towing service to remove vehicle
12) If required, law enforcement officers should prepare a Texas Peace Officer's Crash Report Form CR-3 (see **Scenario: Complete Texas CR- 3 Crash Report Form for Automated Vehicle Involved Collisions**)
    a) Refrain from making statements of liability or fault at the scene
    b) Crashes with apparent damage over $1000 or which result in the death or injury of a person require the completion of a Texas Peace Officer's Crash Report (CR-3) form
    c) Advise involved parties that a CR-3 form will be available in the next three to five business days
13) Serious injury crashes and traffic fatalities may require additional investigation, reporting and information collection, request support from crash investigators, if needed
    a) Vehicle collected data regarding engagement of autonomous features may be evidence
14) If determined appropriate, issue citations to drivers for violations of the traffic code
15) Ensure the restoration of the orderly flow of highway traffic before leaving the scene of the incident
    a) Direct traffic around the scene of the incident if the investigation of facts remains on-going
    b) Contact appropriate municipal officials to request temporary traffic control devices, if necessary
16) Retain evidence and witnesses for fatality crashes
17) **If your jurisdiction requires it, also submit an AV interaction report through normal procedures**

Sources Utilized

Texas Department of Transportation, Traffic Safety Division (2024), *State of Texas instructions to police for reporting crashes CR-100*, Version 28.0, September 5.

Texas Department of Transportation, Traffic Safety Division (2023), *Texas peace officer's crash Report Code sheet CR-3CS*, April 1.

Texas Department of Transportation, Traffic Safety Division (2023), *Texas peace officer's crash report CR-3*, April 1.

Scenario: Respond to an SAE Level 4-5 Passenger Vehicle Traffic Crash

Primary Scenario Type: Crash Response and Investigation
Primary Responder Type: Combined response involving multiple responding agencies
Scenario Context: Traffic crashes are common. Crashes involving one or more SAE Level 4-5 automated vehicles may include injured safety drivers and passengers.

Best Practice

1) Arrive on incident scene
2) Determine if an involved vehicle is an electric vehicle (see Scenario: Passenger Vehicle Sodium- or Lithium-Ion Battery Fire)
3) Recognize the vehicle as an AV (see AV recognition guide for information)
    a) Identify vehicle make/model and the AV operator through markings, vehicle registration information, or the AV recognition guide
4) Inform dispatch of initial incident details and request additional support from fire and EMS if necessary
5) Contact AV operator (or request dispatch contact AV operator) and request assistance (see contact list)
    a) AV should recognize crash conditions and stop moving
    b) Some level 4-5 AVs may still attempt to move in some circumstances (conduct a pull over maneuver following a collision)
6) Request AV operator disable autonomy or, in an emergency and when safe to do so, disable autonomy (if possible) on scene (see vehicle specific emergency response guides)
    a) Obtain confirmation from the AV operator that the vehicle will not move before approaching the vehicle
    b) In minor crashes request a remote operator move the vehicle from the road, or for some models, disable the autonomy that allows a responder or tow operator to move the vehicle from the road (request developer documents (FRIP/LEIP) for that vehicle or obtain instructions from AV operator)
7) If necessary, conduct emergency extrication and provide primary first aid, if needed, until the arrival of EMS personnel
8) Secure the scene of the incident and remove vehicles from roadway, if possible
9) Establish traffic control and await fire and EMS response (if necessary)
10) Fire and EMS conduct extrication (if necessary) (see Scenario: Conduct Driver/Passenger Extrication from an SAE Level 4-5 Vehicle)
    a) If vehicle is an electric vehicle, reference any manufacturer make and model specific cut guide prior to cutting vehicle frame
11) Request AV operator send towing to the scene or request towing via departmental procedures
    a) Inform the towing operator the vehicle is an autonomous vehicle and autonomy is disabled
    b) Instruct towing operator to contact AV operator for instructions for towing and moving vehicle
12) If required, law enforcement officers should prepare a Texas Peace Officer's Crash Report Form CR-3 (see **Scenario: Complete Texas CR-3 Crash Report Form for Automated Vehicle Involved Crashes**)
    a) Refrain from making statements of liability or fault at the scene
    b) Crashes with apparent damage over $1000 or which result in the death or injury of a person require the completion of a Texas Peace Officer's Crash Report (CR-3) form
    c) Advise involved parties that a CR-3 form will be available in the next three to five business days
13) Serious injury crashes and traffic fatalities may require additional investigation, reporting, and information collection, request support from crash investigators, if needed
    a) AV operator collected data and video may be evidence
    b) Request AV operator preserve all data captured before and during the crash
    c) Inform supervisor and crash investigation personnel of the presence of an AV and work through department procedures to obtain AV operator data and video of the crash for use in the crash investigation
14) If determined appropriate, issue citation to AV operating company for violations of the Traffic Code, per departmental procedures
    a) Cite the registered owner of the vehicle based on information obtained from the operator or within the vehicle
    b) If, in the judgement of the officer, continued operation of the vehicle might endanger the public, request the operator place the vehicle out of service and issue the citation to company representatives per departmental procedures

c) **If company personnel may be some time in responding to your location, assist any passengers with obtaining transportation from the scene before departing**
d) **If, in the judgement of the officer, continued operation of the vehicle would not endanger the public, inform the operator of the citation, and follow departmental procedures about how to deliver the citation or warning to the operator, before allowing the operator to place the vehicle back into service/depart the scene**

15) Ensure the restoration of the orderly flow of highway traffic before leaving the scene of the incident
    a) Direct traffic around the scene of the incident if the investigation of facts remains on-going
    b) Contact appropriate municipal officials to request temporary traffic control devices, if necessary
16) Retain evidence and witnesses for fatality crashes

Notes

Under current Texas law, AVs must obey the rules of the road as defined in the Texas traffic code.

According to Tex. Transp. Code § 545.453, the AV owner is liable for any violations of traffic laws, regardless of whether a human passenger is present. However, if a safety driver is present and the automated system was disengaged at the time of the violation that driver may be liable (consult departmental policy for guidance).

Sources Utilized

Texas Commission on Law Enforcement. (2023). Traffic code/crash investigation/TIM. In *Basic peace officer course licensing requirement*.

Texas Department of Transportation, Traffic Safety Division (2024), *State of Texas Instructions to Police for Reporting Crashes CR-100*, Version 28.0, September 5.

Texas Department of Transportation, Traffic Safety Division (2023), *Texas Peace Officer's Crash Report Code Sheet CR-3CS*, April 1.

Texas Department of Transportation, Traffic Safety Division (2023), *Texas Peace Officer's Crash Report CR-3*, April 1.

Scenario: Respond to an SAE Level 4-5 Commercial Motor Vehicle Traffic Crash

Primary Scenario Type: Crash Response and Investigation
Primary Responder Type: Combined response involving multiple responding agencies
Scenario Context: Traffic crashes involving Commercial Motor Vehicles are often more serious than those involving passenger vehicles. Safety drivers may be present and injured.

Best Practice

1) Arrive on incident scene
2) Recognize the vehicle as an AV (see AV recognition guide for information)
   a) Identify vehicle make/model and the AV operator through markings, vehicle registration information, or the AV recognition guide
3) If it is safe to do so and you are certain the vehicle will not move, attempt to determine if the vehicle has a safety driver present
   a) If a safety driver is present continue next steps
4) Inform dispatch of initial incident details and request additional support from fire and EMS if necessary
5) **If no safety driver present, or driver incapacitate, contact AV operator (or request dispatch contact AV Operator) and request assistance (see contact list)**
   a) **AV should recognize crash conditions and stop moving**
   b) **Some level 4-5 AVs may still attempt to move in some circumstances (e.g., conduct a pull over maneuver following a minor collision)**
6) **Request AV operator disable autonomy or, in an emergency and when safe to do so, disable autonomy (if possible) on scene (see vehicle specific emergency response guides)**
   a) **In minor crashes request a remote operator move the vehicle from the road, or for some models, disable the autonomy that allows a responder or tow operator to move the vehicle from the road**
   b) **See emergency response guide for that vehicle or obtain instructions from AV operator**
7) If necessary, conduct emergency extrication and provide primary first aid, if needed, until the arrival of EMS personnel
8) Secure the scene of the incident and remove vehicle(s) from roadway, if possible
9) Establish traffic control and await fire and EMS response (if necessary)
10) Fire and EMS conduct extrication (if necessary) (See Scenario: Conduct Driver/Passenger Extrication from an SAE Level 4-5 Vehicle)
11) NOTE: Commercial motor vehicle saddle tanks if leaking/damaged may require hazardous materials response/cleanup and additional reporting due to the quantities involved
12) Request a commercial towing service to remove automated commercial motor vehicle
    a) Inform the towing operator the vehicle is an autonomous vehicle and autonomy is disabled
    b) Instruct towing operator to contact AV operator for instructions for towing and moving vehicle
13) If required, law enforcement officers should prepare a Texas Peace Officer's Crash Report Form CR-3 (see **Scenario: Complete Texas CR- 3 Crash Report Form for Automated Vehicle Involved Crashes**)
    a) Refrain from making statements of liability or fault at the scene
    b) Crashes with apparent damage over $1,000 or which result in the death or injury of a person require the completion of a Texas Peace Officer's Crash Report (CR-3) form
    c) Advise involved parties that a CR-3 form will be available in the next three to five business days
14) Serious injury crashes and traffic fatalities may require additional investigation, reporting, and information collection, request support from crash investigators, if needed
    a) AV operator collected data and video may be evidence
    b) Request AV operator preserve all data captured before and during the crash
    c) Inform supervisor and crash investigation personnel of the presence of an AV and work through department procedures to obtain AV Operator data and video of the crash for use in the crash investigation
15) If required, prepare a citation or warning per departmental procedures
    a) **Cite the registered owner of the vehicle based on information obtained from the operator or within the vehicle**
    b) **If, in the judgement of the officer, continued operation of the vehicle might endanger the public, request the operator place the vehicle out of service and issue the citation to company representatives per departmental procedures**

c) **If company personnel may be some time in responding to your location, assist any passengers with obtaining transportation from the scene before departing**
d) **If, in the judgement of the officer, continued operation of the vehicle would not endanger the public, inform the operator of the citation, and follow departmental procedures about how to deliver the citation or warning to the operator, before allowing the operator to place the vehicle back into service/depart the scene**

16) Ensure the restoration of the orderly flow of highway traffic before leaving the scene of the incident
    a) Direct traffic around the scene of the incident if the investigation of facts remains on-going
    b) Contact appropriate municipal officials to request temporary traffic control devices, if necessary
17) Retain evidence and witnesses for fatality crashes
18) **If your jurisdiction requires it, submit an AV interaction report through normal procedures**

Notes

Currently in Texas, Automated Commercial Motor Vehicles (SAE Level 4-5) are traditional diesel vehicles with the automated driving system added. However, AV systems may draw power from a high energy battery mounted on the vehicle that poses hazards to responders, especially during extrication. There are also several developers testing and developing electric powered commercial trucks, though none yet operating in Texas. If a commercial motor vehicle is an electric vehicle, see Scenario: Sodium- or Lithium-Ion Battery Fire.

Additionally, commercial motor vehicles in the future may utilize alternative fuels (e.g., compressed natural gas, propane, or hydrogen). These require additional response measures (still in development) due to the possibility of boiling liquid evaporating vapor explosions (BLEVEs) and other dangers associated with compressed flammable gases.

Under current Texas law, AVs must obey the rules of the road as defined in the Texas traffic code.

According to Tex. Transp. Code § 545.453, the AV owner is liable for any violations of traffic laws, regardless of whether a human passenger is present. However, if a safety driver is present and the automated system was disengaged at the time of the violation that driver may be liable (consult departmental policy for guidance). Safety drivers may also have FMCSR rules that apply to them (e.g., hours of service).

Due to the involvement of a licensed Commercial Motor Vehicle, you may also need to submit additional reporting for violations of FMCSA rules and regulations (consult departmental policy and commercial vehicle enforcement officers for further guidance).

Sources Utilized

Federal Motor Carrier Safety Regulations -Inspection, Repair, and Maintenance, 49 C.F.R. § 396 et seq.

Texas Commission on Law Enforcement. (2023). Traffic code/crash investigation/TIM. In *Basic peace officer course licensing requirement*.

Texas Department of Transportation, Traffic Safety Division (2024), *State of Texas Instructions to Police for Reporting Crashes CR-100*, Version 28.0, September 5.

Texas Department of Transportation, Traffic Safety Division (2023), *Texas Peace Officer's Crash Report Code Sheet CR-3CS*, April 1.

Scenario: Respond to a Sodium- or Lithium-Ion Battery Fire in a Vehicle

Primary Scenario Type: Crash Response and Investigation
Primary Responder Type: Combined response involving multiple responding agencies
Scenario Context: Many AV passenger vehicles and delivery robots are electric vehicles with large lithium- and sodium-ion battery packs. These electric powered vehicles pose unique challenges for fire officials due to a condition known as thermal runaway which can occur in defective batteries, crashes damaging the battery, or due to other environmental or use conditions. In a thermal runaway, vehicle batteries will emit toxic, flammable gas through holes in the battery pack or a relief valve. The battery will quickly heat to extremely high temperatures capable of damaging surround infrastructure and igniting additional fires. The flammable, toxic gas emitted may contact an ignition source and flash back, which may result in an explosion from inside the vehicle or in a confined space. Lithium-ion battery fires are difficult to extinguish and require specialized emergency responses. Battery fires may also re-ignite posing danger to towing operators and impound/storage lots.

Best Practice

1) Arrive on scene
2) Block traffic immediately
3) Determine an electric vehicle is involved in the incident
    a) Look for signs of a thermal runaway or fire (e.g., smoke, hissing sounds, fire)
    b) During thermal runaway prior to ignition, lithium-ion batteries begin to vent a whitish cloud of toxic, flammable gases through holes in the battery casing or from a relief port
    c) Gases may ignite and flash back if they reach an ignition source or result in an explosion in the vehicle cabin or an enclosed space
4) Instruct all vehicles in the immediate vicinity to turn off their vehicles
5) Instruct other responders and bystanders to remain at least 75 feet from the vehicle, upwind and uphill
6) If responsive, instruct the driver of the Level 1-3 AV to turn off the vehicle, exit, and move away from the vehicle
    a) A running EV makes little sound due to the lack of an internal combustion engine
7) Request dispatch provide fire department support for an electric vehicle incident if not already enroute and if enroute have dispatch inform them of an electric vehicle incident
8) Park all response assets upwind and uphill from the involved electric vehicle, if possible
9) All responders approaching the vehicle must wear full PPE and SCBA when vehicle fires or a thermal runaway occurs
10) Require those not engaged in active firefighting to wear a high-visibility vests (the gases from a thermal runaway may reduce visibility)
11) Conduct an initial 360-degree size-up with a thermal imaging camera to note any heat pattern or fire extension near the battery case – located either on the frame of the EV or on some models behind the back seat
12) Confirm the vehicle's power source is a lithium-ion battery
13) Determine your tactical priorities: fire, extrication, victim care
14) Stabilize the vehicle with chocks or cribbing to avoid it moving
15) Determine if the vehicle is on and if so, power down the EV from the information on that vehicle's specific high-voltage procedure
16) Understand your fire attack options - letting the vehicle burn is often the best option or you risk the batteries constantly reigniting
    a) Do not attempt to breach or punch holes in battery cases to introduce water
    b) Sodium- and Lithium-Ion battery fire responses may produce runoff containing toxic heavy metals – attempt to contain runoff and prevent entry of run off into drains and waterways
17) If extrication of victims is necessary, do so using a manufacturer specific cut-guide to avoid high-voltage electrical hazards
18) Extinguishment of battery fires with water typically involves anywhere from 5,000 to 30,000 gallons of water over hours, requiring multiple pump trucks
19) Share information with the towing company that this is an EV with the possibility of reignition and to store it separated from other vehicles by at least 75 feet

20) Conduct decontamination of all responders and victims exposed to runoff/debris and initiate medical monitoring for heavy metal exposure

Notes

Consider an EV incident as not only a potential fire, extrication, and victim care emergency, but also a hazmat response. Have sufficient personnel and air management refill equipment on hand for crew rotation, traffic blocking and rehabilitation.

Some AVs, while not electric, may have high energy batteries and wiring to power AV systems.

Store EVs involved in incidents at least 75 feet from other vehicles, buildings, or flammable materials.

Sources Utilized

Cruise, LLC. (2024). *guide for law enforcement & first responders for interacting with a Cruise autonomous vehicle Cruise AV (Chevy Bolt platform) version*. Cruise, LLC.

International Association of Fire Chiefs. (2021, October 15). *IAFC Bulletin: Fire department response to electric vehicle fires*. International Association of Fire Chiefs.

National Highway Traffic Safety Administration. (2014). *Interim guidance for electric and hybrid-electric vehicles equipped with high-voltage batteries: Law enforcement/emergency medical services/fire department*. United States Department of Transportation.

Rielage, R. (2024, June 17). *Developing SOPs for electric vehicle incidents*. FireRescue1.

Texas A&M Engineering Extension Service. (2023). *Report from the TEEX Electric Vehicle/ Energy Storage Systems Summit*. Texas A&M Engineering Extension Service.

Texas A&M Engineering Extension Service. (2024, March). *Current Practices: Electric vehicle and energy storage systems*. Texas A&M Engineering Extension Service.

U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration (2024). "Guide 147: Lithium ion and sodium ion batteries," *Emergency response guidebook.*

Waymo, LLC. (2024). *Waymo autonomously driven Jaguar I-PACE: Emergency response guide and law enforcement interaction protocol*. Waymo, LLC.

Zoox. (2024). *Emergency response guide information for first and second responders for autonomous Zoox vehicles*. Zoox.

Scenario: Conduct Driver/Passenger Extrication from an SAE Level 4-5 Vehicle

Primary Scenario Type: Crash Response and Investigation
Primary Responder Type: Combined response involving multiple responding agencies
Scenario Context: Traffic crashes involving passenger vehicles are a common scenario for first responders. However, when an SAE Level 4-5 automated vehicle is involved, additional considerations may require modifications to normal procedures. In this scenario, one or more SAE Level 4-5 automated passenger vehicles have been involved in a crash, and extrication of occupants is required. Additionally, special attention must be given to the location of lithium-ion batteries and other high-voltage components that may pose additional risks during the extrication process.

Best Practice

1) Receive notification of a vehicle crash
2) Arrive on incident scene
3) **Recognize the vehicle as an AV (see AV recognition guide for information)**
   a) **Identify vehicle make/model and the AV operator through markings, vehicle registration information, or the AV recognition guide**
4) Survey the scene of the incident
5) Inform dispatch of initial incident details and request additional support if necessary
6) **Obtain confirmation from the AV operator that the vehicle will not move before approaching the vehicle**
   a) **See contact list**
   b) **Consult operator specific emergency response guide for more information**
   c) **Seek additional guidance from AV operator, if needed**
7) Secure the scene of the incident and remove other vehicles from roadway if necessary and possible
8) Provide primary first aid to impacted passengers and other individuals
9) Begin the vehicle extrication process
10) Stabilize the vehicle to prevent any movement during the extrication
   a) Ensure all safety systems are deactivated, including airbags, to prevent accidental deployment during extrication
11) Use the appropriate tools to gain access to the vehicle, such as hydraulic cutters or spreaders, if doors or windows are jammed
   a) **Ensure the vehicle remains immobile by engaging the parking brake or other immobilization methods as instructed by the AV operator**
12) Safely remove any trapped individuals

Notes

At the time of publication, no vehicle manufacturer sells SAE Level 4-5 vehicles for private use in the United States. All current SAE Level 4-5 automated passenger vehicles operating in Texas are developer owned and operating as taxi services, delivery robots, or commercial vehicles (trucks and tractor trailers). This may change, requiring modification of these procedures.

Procedures for extrication from an SAE Level 1 to 3 vehicle remain the same as any other vehicle. Note: For Level 1-3 vehicles that are electric vehicles, be sure to reference the relevant make/model cut guide.

Sources Utilized

Cruise, LLC. (2024). Guide for law enforcement & first responders for interacting with a Cruise autonomous vehicle: Cruise AV (Chevy Bolt platform) version. Cruise, LLC.

Daley, M. (2019, April 23). Motor vehicle extrication: Initial response considerations. Firehouse. .

Michigan Firefighter Training Council. (2001). State of Michigan basic vehicle extrication student guide.

Waymo, LLC. (2024). Waymo autonomously driven Jaguar I-PACE: Emergency response guide and law enforcement interaction protocol. Waymo, LLC

Scenario: Complete Texas CR-3 Crash Report Form for Automated Vehicle Involved Crashes

Scenario Type: Crash Response and Investigation
Primary Responder Type: Law Enforcement
Scenario Context: Traffic crashes occur regularly. Changes to the Texas Peace Officer's Crash Report Form (CR-3), Code Sheet (CR-3CS) and Instructions to Police for Reporting Crashes (CR-100) now include specific requirements for automated vehicles.

Best Practice

1) The Autonomous Unit Field is a mandatory reporting field on the CR-3
2) Prepare the Form CR-3 according to instructions contained in CR-100 and the CR-3CS Code Sheet
   a) For (Autonomous Unit) select 1 for Yes, 2 for No, and 99 for Unknown
      i) If the Unit Description is NOT 1 – Motor Vehicle, or 7 – Non-Contact, then 'Autonomous Unit' must be set to 'No'
      ii) If the vehicle year is less than 2000, then 'Autonomous Unit' must be set to 'No'
      iii) If 'Autonomous Unit' is set to 'Yes' for a unit, the 'Make' and 'Model' must be populated for that unit and cannot be 'Unknown'
      iv) If the Hit and Run is set to Yes and Vehicle Make is Unknown or blank, then the Autonomous Unit must be set to Unknown
      v) If the entered unit VIN has the autonomous features of adaptive cruise control, lane centering assistance or lane keeping assistance, set to Standard, then Autonomous Unit field should be set to 'Yes'
   b) For (Autonomous Level Engaged) utilize the SAE Level to Code Sheet Crosswalk, the AV recognition guide, and CR-100 instructions to enter the appropriate value
      i) If Autonomous Unit is Yes, Autonomous Level Engaged must be 1 - Driver Assistance, 2 -Partial Automation, 3 - Conditional Automation, 4 - High Automation, 5 - Full Automation, or 6 - Automation Level Unknown
      ii) When Autonomous Unit is No, then the Autonomous Level Engaged must be 0 - No Automation
      iii) When Autonomous Unit is Unknown, Autonomous Level Engaged must be 99 - Unknown
      iv) Unit Description is 2-Train, 3-Pedalcyclist, 4-Pedestrian, 5-Motorized Conveyance, 6-Towed/Pushed/Trailer, or 98-Other, therefore the Autonomous Level Engaged must be 0 -No Automation
   c) For (Total Number of Persons) the total number of persons must match the actual person count. If Person Type for one of the persons is 95-Autonomous, the Autonomous unit does not count as a person
   d) For (DL/ID Type) if Person Type is set to 95-Autonomous, then the DL/ID Type must be set to 95-Autonomous
   e) For (DL/ID State) if DL/ID Type is 95-Autonomous, then DL/ID State must be blank
   f) For (DL/ID Number) if DL/ID Type is 95-Autonomous, then DL/ID Number must be blank
   g) For (DL Class) if the person type is 95-Autonomous then DL Class must be set to 95-Autonomous
   h) For (CDL Endorsements) If person type is 95-Autonomous then CDL Endorsement must be set to 95-Autonomous
   i) For (DL Restrictions) if Person Type is 95-Autonomous then DL Restriction must be set to 95-Autonomous
   j) For (Date of Birth) if Person Type is 95-Autonomous then Date of Birth is not allowed/must be blank
   k) For (Person Number) if Person Type is set to 95-Autonomous the Person Number must be set to 1
   l) For (Person Type) set to 95-Autonomous Unit
      i) If unit description is 1-Motor Vehicle or 7-Non-Contact, only one person associated with that unit may have a Person Type of 95-Autonomous
      ii) If a person type for a unit 95- Autonomous then the person must be the primary person in the unit and the person number must be 1
      iii) If the unit description field is 1-Motor Vehicle or 7-Non-Contact, the Person Type field for persons in the unit must be 1-Driver, 5-Driver of Motorcycle Type Vehicle, 2-Passenger Occupant, 6-Passenger Occupant on Motorcycle, 95-Autonomous, or 99-Unknown
      iv) If Autonomous Level is set to 0-No Automation, 1-Driver Assistance, 2-Partial Automation, 3-Conditional Automation, 6-Automation Level Unknown, or 99-Unknown, the Person Type cannot be set to 95-Autonomous for the primary person in the unit

   v) If unit description is 1-Motor Vehicle or 7-Non-Contact, and if one or more persons are entered, one should be a driver
   vi) If Autonomous Level is set to 4-High Automation or 5-Full Automation, then the Person Type must be set to 95-Autonomous for the primary person in the unit
m) For (Seat Position) if the Person type is 95 – Autonomous, the Seat Position must be 95 – Autonomous
   i) The person sitting in the front left seat is a considered a passenger/occupant for the Autonomous Level engaged is 4 – High Autonomation or 5-Full Autonomation only and will be captured on the second line
n) For (Name: Last, First, Middle) if person type is set to 95-Autonomous:
   i) For (Owner/Lessee Name and Address) if Autonomous Level is 4-High Automation or 5-Full Automation then Owner/Lessee Last Name cannot be blank
   ii) The Last Name must equal the owner/lessee last name
   iii) The First Name must equal the owner/lessee first name
   iv) The Middle Name must equal the owner/lessee middle name
o) For (Injury Severity) Injury code 95-Autonomous is used when Person type is 95 – Autonomous
p) (Age) is not allowed if Person Type is 95-Autonomous
q) For (Ethnicity) if person type is 95-Autonomous then Ethnicity must be 95-Autonomous
r) For (Sex) if Person type is 95-Autonomous then Sex must be 95-Autonomous
s) For (Ejected) if Person Type is 95-Autonomous then Ejected must be 97-Not Applicable
t) For (Restraint Used) if Person Type is 95-Autonomous then Restraint Used must be 97-Not Applicable
u) For (Airbag) if Person Type is 95-Autonomous then Airbag must be 97-Not Applicable
v) For (Solicitation) if Person Type is 95-Autonomous, Solicitation must be N-No Solicit
w) For (Alcohol Specimen Type) if Person Type is 95 Autonomous, Alcohol Specimen Type must be 96-None
x) For (Drug Specimen Type) if Person Type is 95 Autonomous, Drug Specimen Type must be 96-None
y) For (Contributing Factors) if Autonomous Level is set to 4-High Automation or 5-Full Automation for a Unit, then the following contributing factors are NOT allowed for that Unit:
   i) 19-Distraction in Vehicle
   ii) 20-Driver Inattention
   iii) 40-Fatigued or Asleep
   iv) 45-Had Been Drinking
   v) 46-Handicapped Driver (Explain in Narrative)
   vi) 47-Ill (Explain in Narrative)
   vii) 59-Pedestrian FTYROW to Vehicle
   viii) 62-Taking Medication (Explain in Narrative)
   ix) 67-Intoxicated - Alcohol
   x) 68-Intoxicated - Drug
   xi) 73-Road Rage
   xii) 74-Cell/Mobile Device Use-Talking
   xiii) 75-Cell/Mobile Device Use-Texting
   xiv) 76-Cell/Mobile Device Use-Other
   xv) 77-Cell/Mobile Device Use-Unknown
z) For (Contributing Factors) and (May Have Contributed) and (Contributing Vehicle Defect) Vehicle Defect 14-Automation Failure can only be set when Autonomous Level is set to 3-Conditional Automation, 4-High Automation or 5-Full Automation for a unit

Sources Utilized

Texas Department of Transportation, Traffic Safety Division (2024), *State of Texas Instructions to Police for Reporting Crashes CR-100*, Version 28.0, September 5.

Texas Department of Transportation, Traffic Safety Division (2023), *Texas Peace Officer's Crash Report Code Sheet CR-3CS*, April 1.

Texas Department of Transportation, Traffic Safety Division (2023), *Texas Peace Officer's Crash Report CR-3*, April 1.

TRAFFIC/PARKING MANAGEMENT AND ENFORCEMENT

The following scenarios address interactions with automated vehicles related to traffic/parking management and enforcement:

- Move or tow a damaged, malfunctioning, abandoned, or illegally parked SAE Level 4-
- 5 Automated vehicle
- Direct an SAE Level 1-3 Automated vehicle under abnormal road conditions
- Direct an SAE Level 4-5 Automated vehicle under abnormal road conditions (with a safety driver)
- Direct an SAE Level 4-5 automated vehicle under abnormal road conditions (without a safety driver)
- Directing traffic in a school zone with automated vehicles present

Scenario: Move or Tow a Damaged, Malfunctioning, Abandoned, or Illegally Parked SAE Level 4-5 Automated Vehicle

Primary Scenario Type: Traffic/Parking Management and Enforcement
Primary Responder Type: Courtesy Patrol, Highway Emergency Response Operator (HERO) and towing/traffic management
Secondary Scenario Type : Law Enforcement
Scenario Context: Stalled, damaged, abandoned and illegally parked motor vehicles impede traffic causing backups and delays for motorists and responders. If positioned on the shoulder, they may hinder first responders by limiting the space needed for emergency operations and increasing the risk of crashes for both responders and passing traffic.

Best Practice

1) Arrive on scene
2) Secure the area by setting up warning signals and ensuring a safe distance for other vehicles
3) **Recognize the vehicle as an AV (see AV recognition guide for information)**
    a) **Identify vehicle make/model and the AV operator through markings, vehicle registration information, or the AV recognition guide**
4) **Contact or have dispatch contact the AV operator obtain further directions (see contact list)**
    a) **Request the AV operator remotely operate the vehicle to another location or request towing for the safe removal of the vehicle by the AV operator**
    b) **If an urgent necessity to protect other drivers or restore the flow of traffic from a critical facility, request AV operator provide instructions (if possible) for an officer on the scene to drive the vehicle to a safe area**
        i) **Obtain confirmation from the AV developer that the vehicle will not move**
        ii) **Approach the vehicle cautiously and checking the surroundings for hazards**
        iii) **Check the vehicle status for active lights, sounds, or movement**
5) **If parked illegally or violating the traffic code,**
    a) **Prepare citation**
    b) **Issue citation according to departmental procedures to the registered owner of the automated vehicle**
6) **If towing vehicle:**
    a) **Request AV operator send towing to the scene or request towing via departmental procedures**
    b) **Inform towing operator the vehicle is an automated vehicle, and autonomy is disabled**
    c) Continue to provide traffic direction until tow truck departs with vehicle and normal traffic flow resumes
7) **If your jurisdiction requires it, also submit an AV interaction report through normal procedures**

Notes

Most AVs currently operated by AV operators will *fail-safe* when they encounter an unfamiliar circumstance, road incidents, or suffer a fault in their programming. Often, this means that these vehicles will attempt to pull onto a nearby shoulder until given instructions by the AV operating staff or towed away. This can present challenges for highway users and first responders when these vehicles unintentionally park or stop in the middle of the road or in front of fire and police stations. To prevent AVs parking and blocking access to critical facilities, communities where testing occurs may coordinate with developers to geo-fence specific areas (like hospital emergency entrances or fire stations) so that AVs will not stop there.

Sources Utilized

Stopping, Standing, or Parking Prohibited in Certain Places, 7 Tex. Transp. Code § 545.302 (1999).

Cruise, LLC. (2024). *Guide for law enforcement & first responders for interacting with a Cruise autonomous vehicle: Cruise AV (Chevy Bolt platform) version*. Cruise, LLC.

Maxfield, M. (2008). *Problem-oriented guides for police, No. 53: Abandoned Vehicles*. United States Department of Justice, Community Oriented Policing Services.

Waymo, LLC. (2024). *Waymo autonomously driven Jaguar I-PACE: Emergency response guide and law enforcement interaction protocol*. Waymo, LLC.

Scenario: Direct an SAE Level 1-3 Automated Vehicle Under Abnormal Road Conditions

Primary Scenario Type: Traffic/Parking Management and Enforcement
Primary Responder Type: Flaggers/Traffic Direction (e.g., Law Enforcement, Public Works, Road Construction Crews, School Crossing Guards)
Secondary Responder Type: Law Enforcement
Scenario Context: Level 1-3 automated vehicles rely on human operators for most driving tasks, though they may assist with certain functions such as lane keeping or adaptive cruise control. While the vehicle's autonomous systems may still assist, the human driver remains in control of the primary driving operation. Responders should provide direct instructions as normal.

Best Practice

1) Utilize standard traffic direction signaling as proscribed under state law and federal guidance (the Manual on Uniform Traffic Control Devices also includes instructions for the human direction of traffic during abnormal conditions)
   a) **If an SAE Level 1-3 vehicle fails to comply, instruct driver to disable autonomy and follow directions**
   b) **If driver still fails to follow instructions, instruct them to pull to the side and disable autonomy**
2) If required, prepare a citation or warning per departmental procedures
3) **If your jurisdiction requires it, also submit an AV interaction report through normal procedures**

Notes

37 Tex. Admin. Code § 3.41 (b-c) contains guidance to officers for directing traffic in Texas

7 Tex. Transp. Code § 542.501 criminalizes the failure to obey traffic directions given by police officers, school crossing guards, or escort flaggers for oversize or overweight vehicles

Sources Utilized

Legal Authorities for Police Officers to Direct Traffic, 37 Tex. Admin. Code § 3.41 (1976).

Obedience Required to Police Officers, School Crossing Guards, and Escort Flaggers, 7 Tex. Transp. Code § 542.501 (2019).

Federal Highway Administration. (2023). Part 6: Temporary traffic control. In *Manual on uniform traffic control devices for streets and highways* (11th ed.) (pp. 765-968). Federal Highway Administration.

Texas Commission on Law Enforcement. (2023). *Traffic code/crash investigation/TIM. In Basic peace officer course licensing requirement.*

Scenario: Direct an SAE Level 4-5 Automated Vehicle Under Abnormal Road Conditions (with a Safety Driver)

Primary Scenario Type: Traffic/Parking Management and Enforcement
Primary Responder Type: Flaggers/Traffic Direction (e.g., Law Enforcement, Public Works, Road Construction Crews, School Crossing Guards)
Secondary Responder Type: Law Enforcement
Scenario Context: Personnel must direct traffic through abnormal or deviated roadway conditions, with one or more SAE Level 4-5 automated vehicles present. Currently, automated motor vehicles rely on pre-mapped routes and programming to determine their path. Developers program AVs to prioritize safe driving, and the vehicles may resist deviations from normal conditions, such as temporarily driving in the oncoming lane. Although SAE Level 4-5 automated vehicles should detect and respond to traffic signaling instructions, this scenario assumes safety drivers are available to intervene if necessary.

Best Practice

1) **Recognize the vehicle as an AV (see recognition guide)**
   a) **Identify vehicle make/model and the AV operator through markings, vehicle registration information, or the AV recognition guide**
2) Utilize standard traffic direction signaling as proscribed under state law and federal guidance (the Manual on Uniform Traffic Control Devices includes instructions for the human direction of traffic during abnormal conditions)
   a) **If vehicle fails to comply, instruct driver to disable autonomy and follow directions**
   b) **If driver still fails to follow instructions, instruct them to pull to the side and disable autonomy**
3) If deemed appropriate and you possess the legal authority to issue citation
   a) Cite the driver for violating the traffic code if they failed to intervene or the autonomy was disengaged at the time of the violation
4) **Cite the registered owner of the vehicle or the safety driver according to departmental procedures**
5) **If your jurisdiction requires it, also submit an AV interaction report through normal procedures**

Notes

37 Tex. Admin. Code § 3.41 (b-c) contains guidance to officers for directing traffic in Texas.

Under current Texas law, AVs must obey the rules of the road as defined in the Texas traffic code.

According to Tex. Transp. Code § 545.453, the AV owner is liable for any violations of traffic laws, regardless of whether a human passenger is present. However, if a safety driver is present and the automated system was disengaged at the time of the violation that driver may be liable (consult departmental policy for guidance).

7 Tex. Transp. Code § 542.501 criminalizes the failure to obey traffic directions given by police officers, school crossing guards, or escort flaggers for oversize or overweight vehicles.

Sources Utilized

Legal Authorities for Police Officers to Direct Traffic, 37 Tex. Admin. Code § 3.41 (1976).

Obedience Required to Police Officers, School Crossing Guards, and Escort Flaggers, 7 Tex. Transp. Code § 542.501 (2019).

Operator of Automated Vehicle, 7 Tex. Transp. Code. § 545.453 (2017).

Cruise, LLC. (2024). *Guide for law enforcement & first responders for interacting with a Cruise autonomous vehicle: Cruise AV (Chevy Bolt platform) version*. Cruise, LLC.

Federal Highway Administration. (2023). Part 6: Temporary traffic control. In *Manual on uniform traffic control devices for streets and highways* (11th ed.) (pp. 765-968). Federal Highway Administration.

Texas Commission on Law Enforcement. (2023). *Traffic code/crash investigation/TIM. In Basic peace officer course licensing requirement*.

Scenario: Direct an SAE Level 4-5 Automated Vehicle Under Abnormal Road Conditions (without a Safety Driver)

Primary Scenario Type: Traffic/Parking Management and Enforcement
Primary Responder Type: Flaggers/Traffic Direction (e.g., Law Enforcement, Public Works, Road Construction Crews, School Crossing Guards)
Secondary Responder Type: Law Enforcement
Scenario Context: Personnel must direct a fully autonomous SAE Level 4-5 vehicle through abnormal or hazardous road conditions, such as construction zones or crash scenes, without the presence of a safety driver. These vehicles operate independently using pre-mapped routes and advanced safety algorithms, but they may struggle to adjust to unplanned deviations like temporary lane shifts or detours. Without a human operator to intervene, responders must rely on the vehicle's ability to detect and respond to traffic signals, ensuring it navigates safely. If this system fails, the responder must contact the AV operator.

Best Practice

1) **Recognize the vehicle as an AV (see AV recognition guide for information)**
   a) **Identify vehicle make/model and the AV operator through markings, vehicle registration information, or the AV recognition guide**
2) Utilize standard traffic direction signaling as proscribed under state law and federal guidance (the Manual on Uniform Traffic Control Devices includes instructions for the human direction of traffic during abnormal conditions)
   a) **If the vehicle fails to respond or pulls onto the shoulder blocking traffic, attempt to contact the AV operator (see contact list)**
   b) **Request the AV operator instruct the vehicle to navigate the temporary traffic route or move to a safer location that does not impede traffic flow**
   c) **If the vehicle behaves erratically or presents a danger to you or others, block traffic, warn others in the vicinity, and keep clear of the vehicle until you can contact the operator**
3) **If deemed appropriate and you possess the authority, issue a citation to the registered owner of the vehicle for failure to follow the traffic code, per departmental procedures**
4) **If your jurisdiction requires it, submit an AV interaction report through normal procedures**

Notes

Some Level 4-5 automated passenger vehicles may temporarily pull onto the shoulder or stop in the roadway, obstructing traffic, if they determine deviations from normal roadway rules or conditions (e.g., an officer guides vehicles to drive on the shoulder around a crash).

37 Tex. Admin. Code § 3.41 (b-c) contains guidance to officers for directing traffic. Under current Texas law, AVs must obey the rules of the road as defined in the Texas traffic code.

According to Tex. Transp. Code § 545.453, the AV operator, through the installation of the automated driving system, is liable for any violations of traffic laws.

7 Tex. Transp. Code § 542.501 criminalizes the failure to obey traffic directions given by police officers, school crossing guards, or escort flaggers for oversize or overweight vehicles.

Sources Utilized

Legal Authorities for Police Officers to Direct Traffic, 37 Tex. Admin. Code § 3.41 (1976).

Obedience Required to Police Officers, School Crossing Guards, and Escort Flaggers, 7 Tex. Transp. Code § 542.501 (2019).

Operator of Automated Vehicle, 7 Tex. Transp. Code. § 545.453 (2017).

Cruise, LLC. (2024). *Guide for law enforcement & first responders for interacting with a Cruise autonomous vehicle: Cruise AV (Chevy Bolt platform) version*. Cruise, LLC.

Federal Highway Administration. (2023). Part 6: Temporary traffic control. In *Manual on uniform traffic control devices for streets and highways* (11th ed.) (pp. 765-968). Federal Highway Administration.

Texas Commission on Law Enforcement. (2023). *Traffic code/crash investigation/TIM. In Basic peace officer course licensing requirement*.

Scenario: Direct Traffic in a School Zone with Automated Vehicles Present

Primary Scenario Type: Traffic/Parking Management and Enforcement
Primary Responder Type: School Crossing Guards
Secondary Responder Type: Law Enforcement
Scenario Context: Any SAE Level of automated vehicle may operate in school zones where they may encounter pedestrian crossings during school arrival and departure times where a school crossing guard is present. Some current automated driving systems struggle to recognize human directed traffic.

Best Practice

1) Law enforcement officers performing school crossing supervision and adult crossing guards shall wear high-visibility retroreflective safety apparel labeled as ANSI 107-2020 standard performance for Class 2, Type R, as described in Section 6C.05
2) Adult crossing guards shall not direct traffic in the usual law enforcement regulatory sense. In the control of traffic, they shall pick opportune times to create a sufficient gap in the traffic flow. At these times, they shall stand in the roadway to indicate that pedestrians are about to use or are using the crosswalk, and that all vehicular traffic must stop
3) Adult crossing guards shall use a STOP paddle. The stop paddles shall be the primary hand-signaling device. The STOP paddle shall comply with the provisions for a stop/slow paddle (see Section 6D.02) except both sides shall be a STOP face. The paddle shall be retroreflective or illuminated when used during hours of darkness
4) Utilize standardized traffic direction signaling
5) If a vehicle of any level of autonomy approaches the pedestrian crossing and fails to respond to instructions:
   a) **If a driver is present, instruct driver to disable autonomy**
   b) **Based on the officer's discretion and judgment as to the safety of the passengers in the vehicle, officers may request passengers remain in the vehicle or move to a safe area**
   c) **Do not stand in front of a moving autonomous vehicle, even if it is inching forward slowly**
   d) **If possible to do so safely, note the license plate of the vehicle**
   e) **Report incident to law enforcement and if your jurisdiction requires it, have them submit an AV interaction report through normal procedures**
6) **Law enforcement officers present for such violations may follow Scenario: Conduct a Traffic Stop for the appropriate level of autonomy and presence of a safety driver and issue a citation according to departmental procedures**
7) **If your jurisdiction requires it, submit an AV interaction report through normal procedures**

Notes

Some automated vehicles have difficulty interpretating hand and arm signals. This may extend to the misinterpretation of a crossing guard with a STOP paddle and signals to pedestrians and cars associated with allowing the safe crossing of pedestrians across a crosswalk.

Note: While current Level 1-3 vehicles are not capable of driving safely on city streets with the automation on, several manufacturers authorize drivers to bypass warnings and enable "self-driving features." If a Level 1-3 vehicle driver has self-driving features engaged and the vehicle is not responding to crossing guard instructions, take precautions as one would for any other distracted or dangerous driver in a school zone.

Sources Utilized

Legal Authorities for Police Officers to Direct Traffic, 37 Tex. Admin. Code § 3.41 (1976).

Obedience Required to Police Officers, School Crossing Guards, and Escort Flaggers, 7 Tex. Transp. Code § 542.501 (2019).

Texas Department of Transportation. (2014). Part 7: Traffic control for school areas. In *Texas manual on uniform traffic control devices* (2011, 2nd revised ed.) (pp. 755-770). Texas Department of Transportation.

Federal Highway Administration. (2023). Part 6: Temporary traffic control. *Manual on uniform traffic control devices for streets and highways* (11th ed.) (pp. 765-968). Federal Highway Administration.

VI. CATALOG OF INTERACTION PLANS

CATALOGING APPROACH

The goal of this task (Task 6) was to prepare a catalog of AV interaction plans (FRIPs/LEIPs) and match them to the scenarios developed in Task 5 and described in the previous chapter. Specifically, the project team focused on obtaining, cataloging, and reviewing FRIPs/LEIPs provided by AV operators/developers to the project team as part of Tasks 4, 5 or 6.

Since completing this task's evaluation, several AV operators/ developers created new or modified existing FRIPS/LEIPs. Therefore, the scoring reported herein may not reflect current content.

In the previous task (Task 5), the project team incorporated material from the various AV interaction plans and ERGs received from AV developers into best practices, where possible. Given that this met some of the goals for this task (which ran concurrently with Task 5 in the initial phases), the project team focused on cataloging and reviewing plans and guides received from AV developers based on various standards. Each plan was evaluated against three standards—two standards developed by the project team and a third standard based on the California regulatory standards for LEIPs, which expand on the requirements listed in the California Department of Motor Vehicle's Manufacturer's Permit to Test Autonomous Vehicles that Do Not Require a Driver, 13 Cal. Code Regs. § 227.38(e). The project team submitted the catalog of plans obtained for this task, including some still in draft stages, to TxDOT along with a task memorandum outlining the findings of this task. The team provided an updated catalog, containing any new or modified plans received following the completion of Task 5 to TxDOT with and separate from this report.

Work Performed

Standards Review

As a first step in this task, the project team identified and cataloged current regulatory frameworks and standards by state, in addition to the voluntary AVIA and other standards.

Currently, no federal regulations require AV operators to develop or publish FRIPS/LEIPs, and neither NHTSA nor FHWA have official frameworks outlining their content. However, industry groups like the AVSC argue that creating and publishing these plans under a consistent framework will give first responders timely support and essential knowledge that enhances the safety of both officials and the public (AVSC, 2024).

California implemented a regulatory framework in 2018 when the California DMV proposed regulations authorizing operators to deploy driverless AVs on public roadways. In California, an AV company looking to qualify for a state operating permit must annually submit updated LEIPs that, at a minimum, address the following items:

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(A) How to communicate with a remote operator of the vehicle who is
available at all times that the vehicle is in operation, including
providing a contact telephone number for the manufacturer;
(B) Where, in the vehicle, to obtain owner information, vehicle
registration, and proof of insurance in the event of a collision or
traffic violation involving the vehicle;
(C) How to safely remove the vehicle from the roadway;
(D) How to recognize whether the vehicle is in autonomous mode, and if
possible, how to safely disengage the autonomous mode;
(E) How to detect and ensure that the autonomous mode has actually been
deactivated,
(F) How to safely interact with electric and hybrid vehicles, when
applicable.
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(G) A description of the operational design domain of the vehicle.
(H) Any additional information the manufacturer deems necessary regarding hazardous conditions or public safety risks associated with the operation of the autonomous vehicle.

Following this legislation, the Self-Driving Coalition for Safer Streets, now known as AVIA, developed model legislation to help guide state legislatures establishing a framework for AV use and testing on public roads. This model legislation outlines key regulatory and legal changes necessary to ensure the safety of both AVs and the public.

As part of this model legislation, AVIA included a section that, if enacted by a state legislature, would require companies testing or operating AVs on public roads to submit a LEIP to a relevant state police or traffic agency that details:

(1) How to communicate with a fleet support specialist who is available during the times the vehicle is in operation;
(2) How to safely remove the fully autonomous vehicle from the roadway;
(3) How to recognize whether the fully autonomous vehicle is in autonomous mode and steps to safely tow the vehicle; and
(4) Any additional information the manufacturer or owner deems necessary regarding hazardous conditions or public safety risks associated with the operation of the fully autonomous vehicle.

As of October 2024, at least nine states had incorporated elements of the AVIA model legislation into their authorizing statutes or state testing plan requirements.

Similarly, in 2022, the EU instituted regulatory requirements for manufacturers of vehicles equipped with ADS located in member state nations to publish operating manuals containing information for occupants, transportation service operators, and relevant state and national authorities. Relevant to first responders and law enforcement are the following stipulations regarding manual content:

11.3. The operating manual shall include the technical measures (e.g. checks and maintenance works of vehicle and off-board infrastructure, transport and physical infrastructure requirements such as localization marker and perception sensors), operational restrictions (e.g. speed limit, dedicated lane, physical separation with oncoming traffic), environmental conditions (e.g. no snow) and operational measures (e.g. on-board operator or remote intervention operator needed) necessary to ensure safety during the fully automated vehicle operation.
11.4. The operating manual shall describe the instructions for vehicle occupants, transport service operator, on board operator (where applicable) and remote intervention operator (where applicable) and public authorities in case of failures and ADS request.
11.7. The Operating Manual shall be made available to the owner and, where applicable, to the transport service operator, on-board operator (where applicable), remote intervention operator (where applicable) and any relevant national authorities.

These three frameworks from California, AVIA, and the EU, along with requirements from several other states, highlight several common aspects that officials consider to be important for the safe and efficient interactions with AVs. These common aspects include the following:

- An easy to find emergency contact phone number.
- A nonemergency contact number or channel.
- Vehicle recognition photos or guidance.
- Procedures for acquiring vehicle operating documents (insurance, registration, etc.).
- Procedures for disabling the vehicle’s autonomy and ensuring that it remains in this state.
- Procedures for responding to fires, including lithium-ion battery system fires (if applicable).

- Procedures for safely and quickly removing a disabled or malfunctioning vehicle from the roadway.
- The ODD of the vehicle.

Interaction Plan Review and Scoring Criteria

Based on the review of standards, the project team developed three criteria for reviewers to utilize when evaluating available FRIPS/LEIPs. Multiple project team members reviewed each plan separately, with averages of their scoring reported in the results. The project team developed two criteria based on a plan's primary contents and individual contents and chose a third criterion—the California regulatory standard for LEIPs, as codified under Manufacturer's Permit to Test Autonomous Vehicles that Do Not Require a Driver*,* 13 Cal. Code Regs. § 227.38(e). The project team chose California's existing standard as the third criterion because that state had the most detailed LEIP standard currently in law. Therefore, the state's standard had the potential to become a *de facto* national standard for developers hoping to market their vehicles across the country. Researchers developed a series of questions intended to guide the reviewers, each with a unique evaluation focus, for each criterion as follows:

- The primary contents criterion included 11 questions focused on the presence of key content items and the availability of information.
- The individual contents criterion included 8 questions focused on the presence and quality of key content items.
- The California standard criterion included 11 questions focused on the presence of key content items required for LEIPs submitted to the state as part of the AV licensing process.

Note that the scoring for two of the criteria—primary contents and California standard—focused on the *presence* of specific material without evaluating the *quality* of that material. to provide an objective review given most current standards do not provide guidance as to the specifics of the information provided, only that it be present in an LEIP. The scoring for the third criterion—individual contents—offered an opportunity for some subjective analysis by reviewers regarding the plan content's quality, while maintaining a focus on more objective measures (i.e., the presence of key content items in the plan). Select scoring criteria also considered the presentation of information. Detailed descriptions of each criterion's series of questions, scoring criteria, and resultant overall score follow.

Primary Contents

The primary contents evaluation criterion included the following series of guiding questions, scoring criteria, and resultant overall score:

- Questions included the following:
  - Is the plan public or private?
  - Is the plan specific to Texas?
  - Can the plan be found on the company's website?
  - Does the plan contain information for specific vehicle models?
  - Does the plan include an emergency phone number?
  - Does the plan include nonemergency contact information?
  - Does the plan include a vehicle identification guide?
  - Does the plan describe where to access vehicle documents (e.g., registration, proof of insurance, etc.)
  - Does the plan include frequently asked questions or other general information?
  - Does the plan include pictures or diagrams?
  - Does the plan contain information for communities, agencies, and/or organizations?
  - Does the plan provide information for frontline first responders (squad car level)?

- Scoring criteria included the following:
  - 0-No, not present/not answered/not addressed.
  - 1-Partially, answered in part but not completely (explained in notes).
  - 2-Yes, fully addressed.
- Overall score included the following:
  - 0-Contains little to no information on first responder interactions with AVs.
  - 1-Contains an emergency contact number.
  - 2-Contains an emergency contact number and information for responders interacting with AVs (e.g., identification guides, frequently asked questions, etc.).
  - 3-Contains an emergency contact number information for responders interacting with AVs (e.g., identification guides, frequently asked questions, etc.), and descriptions of possible situations/scenarios.

Individual Contents

The individual contents evaluation criterion included the following series of guiding questions, scoring criteria, and resultant overall score:

- Questions included the following:
  - Does the plan include basic scenario how-tos?
  - Does the plan include step-by-step or detailed instructions, when applicable, for the scenarios?
  - Does the plan address routine law enforcement interactions?
  - Does the plan address crash response (e.g., fire department, EMS, etc.)?
  - Does the plan address towing/recovery?
  - Does the plan address vehicle fires?
  - Does the plan address confirmation of automated status?
  - Does the plan include a high-voltage cut reference guide (e.g., manufacturer's ERG or electrical safety information)?
- Scoring criteria included the following:
  - 0-Not addressed/no applicable content.
  - 1-Partially addressed (explained in notes).
  - 2 – Addressed/meets expectations/meets minimum standards.
  - 3-Addressed/exceeds expectations/could serve as a model for others.
- Overall score included the following:
  - Average of each reviewer score for each question, summed and divided by the number of questions (eight).

California Standard

The California standard evaluation criterion included the following series of guiding questions (based on that state's regulatory requirements for LEIPs submitted to the state to obtain a license to operate an AV in the state), scoring criteria, and resultant overall score:

- Questions included the following:
  - Does the plan include an emergency phone number?
  - Does the plan describe how to communicate with remote operators?
  - Does the plan describe where responders can access vehicle documents (e.g., registration, proof of insurance, etc.)?
  - Does the plan describe how to remove a vehicle from roadway?
  - Does the plan describe how to determine if vehicle is operating autonomously?
  - Does the plan describe how to disable the autonomous mode?

- Does the plan describe how to confirm automated status?
- Does the plan include a high-voltage cut reference guide (e.g., manufacturers ERG or electrical safety information)?
- Does the plan include other information related to the lithium-ion or hybrid power source?
- Does the plan include a description of the vehicle's ODD?
- Does the plan include any other information regarding hazardous conditions associated with the operation of the vehicle?

- Scoring criteria included the following:
  - 0-No, not present/not answered/not addressed.
  - 1-Partially, answered in part but not completely (explain in notes).
  - 2-Yes, fully addressed.
- Overall score included the following:
  - Standard met: All questions answered 1-Partially, or 2-Yes.
  - Standard not met: One or more questions answered 0-No.

After all reviewers completed their evaluation using all three criteria, project leaders evaluated their scoring for any discrepancies. For example, if one reviewer noted material not present, and two reviewers noted the same material fully or partially addressed, the project leaders examined the plan to determine the correct scoring. Any such, the project leaders noted corrections in the documentation. If the correct scoring was not obvious due to alternate interpretations based on ambiguous content, the project leaders used the averaged values of the reviewer scores.

Catalog of Interaction Plans

While there is no requirement in Texas for AV developers to have or submit an FRIP/LEIP to operate in the state, many developers already have these plans because other states require them. Utilizing the list of current Texas AV operators/developers created for previous project tasks, the project team contacted each company to request copies of (or links to) their FRIPs/LEIPs, ERGs, or other documentation provided to states or first responders.

In response to these requests, the project team received seven interaction plans. Six companies proved unreachable or did not respond based on contact information obtained for this project. Five companies were unable to share their FRIPs/LEIPs—some of which were still in development. Two companies provided drafts of their incomplete LEIPs for review. In addition, the project team attempted to locate publicly available plans from AV operators/developers that did not submit any documents for review by this project. For example, the project team obtained a publicly available copy of the Mercedes-Benz LEIP for their SAE Level 3 vehicles from an online source, despite the fact that this vehicle is currently unable to operate at SAE Level 3 in Texas. Table VI-1 lists the companies contacted and the materials received.

Table VI-1. Interaction Plans Received and Reviewed by the Project Team.

Developer/Manufacturer	Interaction Plan	Emergency Response Guide	High-Voltage and Lithium-Ion Battery Guide
Aurora Innovation	Yes	No	Yes
AV Ride	No	No	No
Bot Auto	No	No	No
Clevon	No	No	No
Cruise	Yes	Yes[1]	Yes
Gatik	Yes	No	Yes
Kiwibot	No	No	No
Kodiak Robotics	Yes	No	Yes

Developer/Manufacturer	Interaction Plan	Emergency Response Guide	High-Voltage and Lithium-Ion Battery Guide
May Mobility	No	No	No
Mercedes-Benz[2]	Yes[1]	No	Yes
Nuro	Yes	Yes[3]	Yes
Plus	No	No	No
Refraction	No	No	No
Stack	Yes	No	No
Starship	No	No	No
Torc Robotics	Yes	Yes	Yes
Volkswagen ADMT	Yes	Yes[3]	Yes
Waabi	No	No	No
Waymo	Yes	Yes[3]	Yes
Zoox	Yes[1]	Yes[3]	Yes

[1]Obtained from public sources.
[2]The company did not receive a request for interaction plans.
[3]The ERG is part of the interaction plan.

CATALOGING RESULTS

Standards Review

Currently, Texas has no regulatory or legal requirement for operators to submit FRIPs/LEIPs to the state or any other authority. Instead, Texas requires AVs on Texas roadways to follow all elements of the traffic code. AVIA has defined model legislation for LEIPs. However, the most stringent in law currently in effect is in California, make it a likely *de facto* U.S. standard for any company hoping to market their technology or vehicles nationwide. Other U.S. states either set different standards or, like Texas, set no standard for LEIPs. Table VI-2 summarizes current state regulations and laws regarding LEIPs. Figure VI-1 shows a map of current state regulations and laws regarding LEIPs. A complete set of regulations for all states requiring LEIPs is included in Appendix A.

Table VI-2. Summary of State LEIP Requirements.

State	LEIP Requirements
Alabama	No LEIP required[1]
Alaska	No authorized AV use under law[2]
Arizona	Department of Public Safety; Law Enforcement Protocols; Law Enforcement Interaction Plan, Ariz. Rev. Stat. § 28-9703(III) (2021) and *Law Enforcement Protocol for Fully Autonomous Vehicles* (ADPS 2018)
Arkansas	No LEIP required
California	Manufacturer's Permit to Test Autonomous Vehicles that Do Not Require a Driver, 13 Cal. Code Regs. § 227.38(e) (2024)
Colorado	No LEIP required
Connecticut	No LEIP required
Delaware	No specific legislation/regulation[3]
Florida	No LEIP required
Georgia	No LEIP required
Hawaii	No LEIP required
Idaho	No LEIP required
Illinois	No specific legislation/regulation
Indiana	No authorized AV use under law
Iowa	No LEIP required
Kansas	Operation of Driverless-Capable Vehicle; Conditions, Kan. Stat. § 8-2902(b) (2023)
Kentucky	Use of Fully Autonomous Vehicle Permissible; Conditions; Law Enforcement Interaction Plan, Ky. Rev. Stat. § 186.763(3) (2024)

State	LEIP Requirements
Louisiana	No LEIP required
Maine	Autonomous Vehicle Pilot Program Rules-Application Process, 17 Me. Code Rules § 229-800-3(5) (2018)
Maryland	No specific legislation/regulation
Massachusetts	Application to Test Automated Driving Systems on Public Ways in Massachusetts-Detail #4: First Responders Interaction Plan (2019)
Michigan	No LEIP required
Minnesota	No specific legislation/regulation
Mississippi	Submission of Law Enforcement Interaction Plan to Department of Public Safety Prior to Operation Required-Contents, MS Code § 63-35-7 (2023)
Missouri	No authorized AV use under law
Montana	No specific legislation/regulation
Nebraska	No LEIP required
Nevada	No LEIP required
New Hampshire	Automated Vehicle Testing Pilot Program and Deployment Requirement, NH Rev. Stat. § 242:1 (2022)
New Jersey	No specific legislation/regulation
New Mexico	Law Enforcement Interaction Protocol, N.M. Admin. Code § 18.24.1.10 (2022)
New York	State of New York Senate-Assembly, S. 2005-C, A. 3005-C (2017) and *Autonomous Vehicle Technology Demonstration/Testing Addendum* (New York State Police, 2019)
North Carolina	No LEIP required
North Dakota	No LEIP required
Ohio	No LEIP required
Oklahoma	Conditions Required to Operate Fully Autonomous Vehicles Without A Human Driver, 47 OK Stat. § 1703 (2023)
Oregon	No LEIP required
Pennsylvania	Highly Automated Vehicles-Powers of Department, 75 Pa. Cons. Stat. § 8505(4) (2023)
Rhode Island	No specific legislation/regulation
South Carolina	No specific legislation/regulation
South Dakota	No LEIP required
Texas	No LEIP required
Tennessee	No LEIP required
Utah	No LEIP required
Vermont	No LEIP required
Virginia	No specific legislation/regulation
Washington	No LEIP required
Washington, D.C.	No LEIP required
West Virginia	Operation of Fully Autonomous Vehicles Without a Human Driver, W. Va. Code § 17H-1-5 (2023)
Wisconsin	No authorized AV use under law
Wyoming	No LEIP required

[1]*No LEIP required* means that the state has legislation or a regulatory framework authorizing the use of AVs, but the law does not currently prescribe the publishing of interaction plans as a requirement for testing, operating, or selling a vehicle.
[2]*No authorized AV use under law* means that the state does not currently have legislation or a regulatory framework authorizing the use of AVs; they are thus prohibited from testing or operating on public roadways in all or most circumstances.
[2]*No specific legislation/regulation* means that the state does not currently have legislation or a regulatory framework authorizing the use of AVs; however, their use for testing or operating is authorized de facto on public roadways in all or most circumstances.

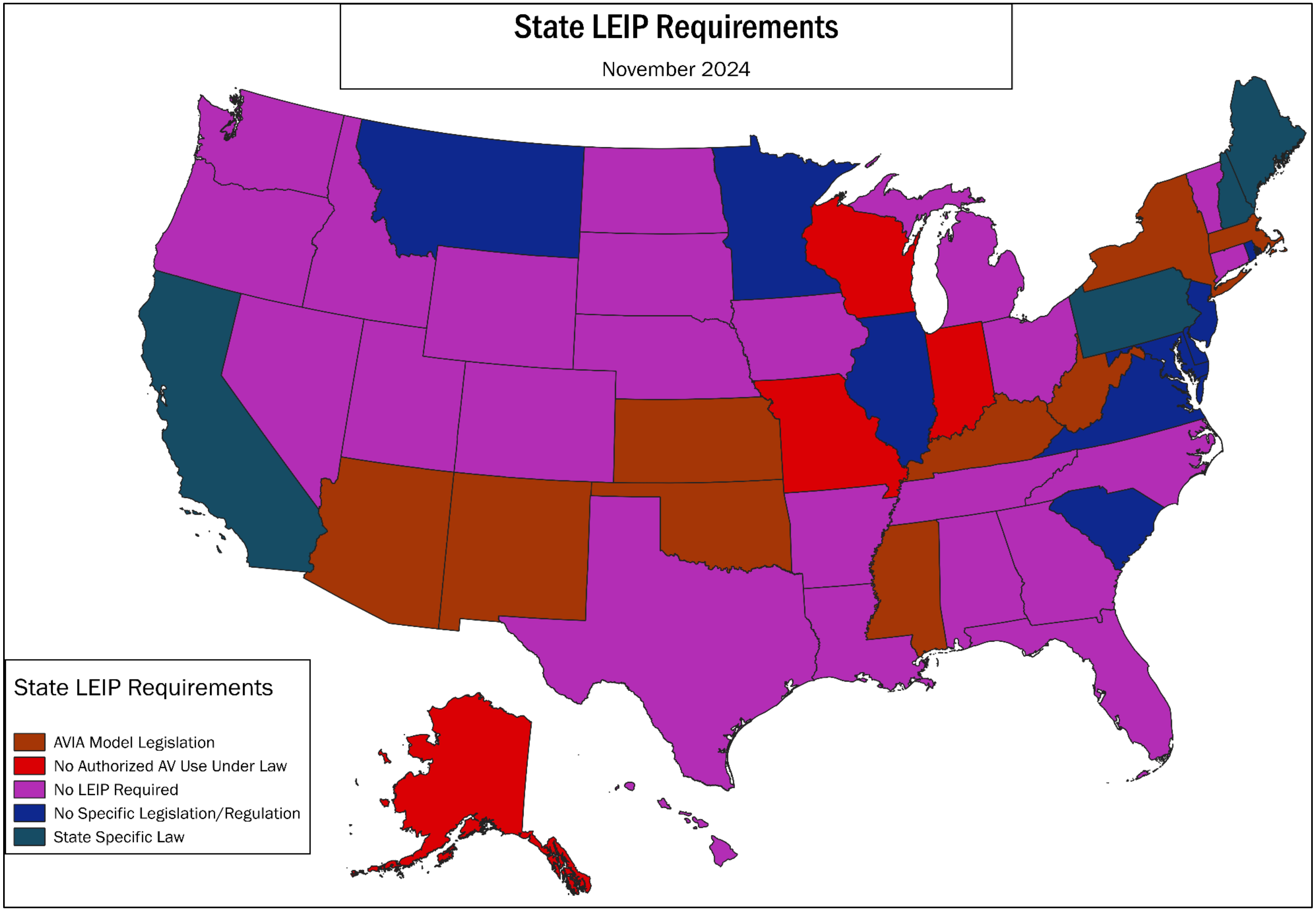

Figure VI-1. Map of State LEIP Requirements.

FRIP/LEIP Scores

Table VI-3 summarizes the scoring results for the various FRIPS/LEIPs evaluated as part of this task. A more detailed assessment of each plan follows.

Table VI-3. FRIP/LEIP Scoring Results.

Developer/Manufacturer	Primary Contents	Individual Contents	California Standard
Cruise	3	1.75	2
Gatik	2.67	1.38	0
Kodiak Robotics	3	2	2
Mercedes-Benz (SAE Level 3)	2	1.84	0
Nuro	3	2.83	0
Torc Robotics	3	1.75	0
Volkswagen ADMT	2	1.46	0
Waymo	3	3	2
Zoox	3	2.46	2

Cruise

Last year, as this project began, a very public accident involving a pedestrian dragged by a Cruise vehicle in San Franscisco, California, occurred. Following a subsequent attempt to cover up details about the accident, the company underwent a significant restructuring and refocused on safety. The scoring results in Table VI-3 reflected this refocusing effort. However, shortly after the completion of this report, GM, which acquired Cruise in 2016, announced they were ending Cruise's operations as a taxi service and folding the company into GM to work on assisted driving features and future personally owned AVs.

Scoring

Reviewers rated Cruise's LEIP in the top percentile across the three scoring criteria (California standard=2, primary contents=3, individual contents=1.75). This high ranking across the criteria reflects both the company's established operations in California—requiring its LEIP to align with state legal standards—and its strong emphasis on safety within the documentation.

Reviewer Comments

One feature shared by many of the interaction plans was the inclusion of the company's emergency phone number on every main page of the document. The inclusion of this feature can assist a responder in quickly finding the contact information in an emergency.

Unique to Cruise's LEIP was the addition of a nonemergency email address through which first responders and other vested stakeholders can pose questions to the company's first responder team.

Gatik

Scoring

Reviewers scored Gatik's LEIP near the median of scores (California standard=0, primary contents=2.67, individual contents=1.38). The project team obtained a working draft edition of *Gatik's First Responder Interaction Plan*. While this document was incomplete (certain sections were outlined for the inclusion of graphics or explanatory text) at the time of the review, the project team noted that the overall layout, content, and quality of the document was standard and would meet the needs of responding officials when Gatik finalized the draft.

Reviewer Comments

Unique to Gatik's LEIP was the inclusion of photos of the company's remote monitoring centers. These control rooms are where Gatik's remote supervision officers monitor and respond to incidents impacting the company's vehicle as they occur. While all other SAE Level 4 AV operators reviewed in this study had some form of remote supervision, only Gatik provided a photo and brief description of their remote supervisory duties.

Kodiak Robotics

Scoring

Reviewers scored Kodiak Robotics' LEIP highly among the various interaction plans (California standard=2, primary contents=3, individual contents=2). This document provides emergency responders and local interest officials with pertinent information for safely interacting with their automated CMVs.

Reviewer Comments

Reviewers observed that this document provided more limited guidance on vehicle operation and basic scenarios than a comprehensive interaction guide. Additionally, the content primarily focused on law enforcement and first responders, with comparatively less emphasis on broader community engagement and other stakeholders. This finding does not suggest that the interaction plan is lacking in content but rather highlights standardization gaps reflected in other plans reviewed during this task.

Mercedes-Benz

The project team did not request interaction plans from Mercedes-Benz given that they do not currently operate in Texas. Instead, the project team obtained a publicly available guide for responders for Mercedes-Benz's SAE Level 3 AVs, currently for sale in California. Mercedes-Benz limits the functionality of their ADS to specific corridors on California and Nevada highways; the SAE Level 3 autonomous driving features will not function outside of those designated areas (presumably, some SAE Level 2 functions would operate anywhere as with most other vehicles at that level of automation). Under the current ODD limitations, a driver bringing one of these vehicles into Texas could only operate at SAE Level 2 or below, although Mercedes-Benz likely anticipates a wider deployment of the system in the future.

Because Mercedes-Benz offers the only true SAE Level 3 vehicle currently for sale to consumers, the project team included their plan in this review with the understanding that, unlike the other LEIPs reviewed, the lower level of automation and the ownership (by consumers) made any response involving one of these vehicles substantially different from current SAE Level 4–5 vehicles undergoing testing and development in Texas.

Scoring

Reviewers scored the Mercedes-Benz's LEIP in the middle to lower percentile across the three criteria (California standard=0, primary contents=2, individual contents=1.84). Although the plan touched on several key elements, reviewers noted that coverage was either insufficient or lacked the depth necessary for a higher score. In part, the SAE Level 3 automation level of the vehicle may reflect this scoring, given that some key purposes of interaction plans may not apply.

Reviewer Comments

Reviewers noted that the Drive Pilot interaction plan describes how to interact with an SAE Level 3 vehicle. However, the scoring criteria were largely based on how well the plan communicates and advises scenarios and situations when a human is not on scene. Because an SAE Level 3 vehicle always requires a human operator present to take control, if necessary, this emphasis on scenarios without human intervention does not fully align with the realities of this system. This discrepancy led to a lower score in some areas because the rating system's focus on fully autonomous scenarios did not directly reflect the Drive Pilot system's current operational context where a human is always available to intervene.

Torc Robotics

In addition to Torc Robotics' *First Responder Guide* (equivalent to a LEIP), the project team acquired a separate *First Responder Quick Reference* document from Torc Robotics. Although it is not a full interaction plan, this document distills four key scenarios into a two-page, front-and-back format that responders can quickly reference when encountering a Torc Robotics truck. These scenarios include identifying the truck, determining its autonomous status, disengaging the autonomous systems, and understanding the vehicle's high-voltage and electrical system layout. (Note that Torc and other autonomous CMV operators do not power their truck cabs through lithium-ion or other electrical battery systems. However, the autonomous driving computers contained within the cab often have high-voltage power connections with the various components of the sensor array.)

Scoring

Reviewers scored Torc Robotics' LEIP in the middle of the reviewed interaction plans (California standard=0, primary contents=3, individual contents=1.75). While the two documents provided a solid foundation for detailing basic procedures and emergency responses, the documents do not conform to the California standard, likely because California currently does not authorize automated CMVs.

Reviewer Comments

Reviewers noted that the inclusion of a contact phone number on every page of the document significantly enhanced accessibility, allowing officers or responders in the field to quickly reach support when needed.

Volkswagen ADMT

Scoring

Reviewers scored Volkswagen's LEIP lowest of all plans reviewed by the team (California standard=0, primary contents=2, individual contents=1.84). The low score reflects the document's limited coverage of key interaction scenarios and a lack of detailed guidance for first responders. Two key factors accounted for this scoring. First, the interaction plan reviewed by the team was an incomplete, early draft; as such, the project team expects many of the deficiencies to improve over time. Second, Texas does not require Volkswagen to have any such plan. As of November 2024, Volkswagen was only evaluating their software in Texas, which does not require an interaction plan. Nevertheless, the fact that the Volkswagen ADMT team provided a plan is a positive indication of their intent to be proactive in addressing safety and preparedness for first responders.

Reviewer Comments

Reviewers noted that much of the guidance in the LEIP was preliminary and placed heavy emphasis on waiting for company representatives to arrive on scene before proceeding with further interactions. Additionally, some sections of the plan referred to parts of the document not yet developed in the draft, such as instructions to disable the autonomous status of the vehicle. It is likely that both issues stem from the draft status of the document.

Waymo

Scoring

Reviewers scored Waymo's LEIP highest among all interaction plans reviewed by the project team (California standard=2, primary contents=3, individual contents=2.46). The documents made effective use of color, graphics, and stylized instructions, which enhanced clarity and accessibility. Because the documents met most or all requirements, Waymo may expect wider deployment of its vehicles in several states, including California.

Reviewer Comments

Waymo's LEIP used color, graphics, and stylized instructions, which enhanced information clarity and accessibility. One example of this was the use of color-coded sections to differentiate between key safety procedures, making it easy for responders to locate critical instructions quickly during an emergency. The use of color-coding, section dividers, and bolded text draw readers' attention to key steps, enabling responders to quickly locate essential instructions for safely ensuring the vehicle remains stationary. Additionally, the LEIP listed Waymo's hotline for emergency responders in four separate locations, each visually stark and in locations easy to spot for a responder quickly thumbing through the booklet.

Beyond scoring, reviewers of Waymo's LEIP appreciated their quality, layout, and organization, with one reviewer commenting that their plan could serve as a model for others.

Zoox

Scoring

Zoox is moving toward deployment in Texas. Reviewers obtained their LEIP from a public source. Reviewers scored Zoox's LEIP as the third highest among reviewed documents (California standard=2, primary contents=3, individual contents=2.46). Reviewers highlighted the documents' effective use of graphics, color-coded highlights, and clear step-by-step instructions to convey essential information to responders, enhancing usability and clarity.

Reviewer Comments

The Zoox LEIP uses color and bold text to highlight notes and clarify common questions that first responders may have while working in the field or reviewing the booklet for the first time. These notes often address misconceptions that may arise when initially reading the instructions. For example, the document provides a warning to first responders that a Zoox vehicle flashing its hazard lights does not mean it is exiting autonomous driving mode. These clarifying statements, and the way in which Zoox presents them to responders, strengthens the overall functionality of the plan for in-field and training purposes. Several reviewers also noted that Zoox's LEIP, while quite comprehensive, was easy to read and understand compared to some of the other plans reviewed.

FRIPs/LEIPs not Received or Reviewed

The project team made a concerted effort to contact each AV operator currently testing or deploying in Texas to request a copy of their FRIP/LEIP. Most AV companies—except Starship and Stack—received requests for their LEIPs months prior to the task end date. Starship and Stack received the request for their FRIPs/LEIPs one month before the end of this task, after the project team learned of their operations and obtained their contact information. Because Texas does not require a FRIP/LEIP to operate in the state, failure to submit a FRIP/LEIP for this review does not imply any deficiency on the part of any company.

For the AV operators contacted that did not submit a FRIP/LEIP, the status of each request, and any additional information or response to requests appears below:

- **Aurora Innovation:** The project team attempted to contact the operator of Aurora Innovation through prior points of contact. Despite multiple attempts, the project team received no responses.
- **AV Ride:** In a response to the project team, an AV Ride representative inquired whether the catalog and subsequent guide would be publicly available. The project team did not receive a FRIP/LEIP.
- **BotAuto:** In a response to the project team, BotAuto indicated that they were working on their FRIP/LEIP and that they would share the document with the project team upon completion. The project team did not receive a FRIP/LEIP before completion of this task.
- **Clevon:** The project team attempted to contact the operator of Clevon through prior points of contact and the operator's website contact form. Despite multiple attempts, the project team received no responses.
- **Kiwibot:** The project team attempted to contact the operator of Kiwibot through prior points of contact and the operator's website contact form. The email to the prior point of contact was returned as undeliverable, indicating that the email address no longer existed. Despite multiple attempts via other methods, the project team received no responses.
- **May Mobility:** The project team attempted to contact the operator of May Mobility through prior points of contact and the operator's website contact form. A new point of contact engaged with the project team after reading the message from the website contact form. The contact noted that the operator would not receive internal approval to share their FRIP/LIEP with the project team before the completion of this task.
- **Plus AI:** The project team attempted to contact the operator of Plus AI through prior points of contact and the operator's website contact form. Despite multiple attempts, the project team received no responses.
- **Refraction AI:** The project team attempted to contact the operator of Refraction AI through prior points of contact and the operator's website contact form. The email to the prior point of contact was returned as undeliverable, indicating that the email address no longer existed. Despite multiple attempts via other methods, the project team received no responses.
- **Starship:** The project team attempted to contact the operator of Starship through a point of contact provided by TxDOT and the operator's website contact form. Despite multiple attempts, the project team received no responses.
- **Stack:** The project team attempted to contact the operator of Stack through a point of contact provided by TxDOT. In a response to the project team, the representative indicated that they were updating their FRIP/LEIP and that they would share the document with the project team upon completion. The project team did not receive a FRIP/LEIP before the completion of this task.
- **Waabi:** In a response to the project team, a Waabi representative informed the project team that they were working on their FRIP/LEIP and that they would share the document with the project team upon completion. The project team did not receive a FRIP/LEIP before the completion of this task.
- **Zoox:** The project team attempted to contact the operator of Zoox through prior points of contact. Despite multiple attempts, the project team received no responses. The project team obtained a LEIP through the company's publicly available website.

The project team noted that several companies that did submit FRIPs/LEIPs for review included both emergency and nonemergency contact information not linked to a specific individual. Given the difficulty experienced by the project team in contacting some AV companies for nonemergency questions and the lack of response by some operators, the team's difficulties may reflect problems for responders attempting to contact operators for nonemergency purposes. Therefore, one finding of this task is that including an actively monitored nonemergency contact in material provided to first responders that is not linked to a specific individual (that may leave the company) and that responds to requests in a timely fashion could form an industry best practice.

ERGs

In addition to the LEIPs and FRIPs received and evaluated above, some AV operators/developers provided additional materials, including ERGs, and cut guides for some EVs. The project team also acquired similar materials that were publicly available. The project team did not score or evaluate these materials as part of this task but did review them and make several observations.

ERG Templating

The project team reviewed several ERGs (most of which were included as sections in their respective LEIPs) that aligned—in whole or in part—with the specifications and standards established by the International Standard Organization's (ISO's) *Road Vehicles—Information for First and Second Responders* (ISO Standard No. 17840). This document, which covers passenger cars and light commercial vehicles, outlines a standardized set of information and symbols that OEMs should provide to emergency responders in their ERGs. These specifications include the layout of rescue sheets, the colors OEMs should use on rescue diagrams and imagery, and common symbols to assist responders in reviewing rescue sheets.

The standard also includes the following guidelines relevant to AV safety:

- Instructions for handling vehicles involved in traffic incidents, including accessing occupants, turning off the vehicle, and managing hazards.
- Guidance for responding to fire or vehicle submersion incidents.
- Procedures for towing, transporting, and immobilizing a vehicle.
- Information about a vehicle's rechargeable electrical energy storage and high-voltage systems.

Waymo

Waymo included their ERG as a section within their overall LEIP. As with other sections of the plan, the ERG instructions used color graphics and diagrams. The project team noted that the Do Not Cut Zones instructions were readily understandable and included a picture of the vehicle with red outlining to improve the overall legibility and quality of the high-voltage safety information.

Note that the Waymo and many other AVs have a high-power line running along the top of the a-frame in the passenger compartment that may impact the ease and speed of extrication in an emergency; for traditional vehicles, responders often quickly remove the roof of the passenger compartment by cutting the supporting posts and peeling back/removing the roof of the vehicle (see Figure VI-2).

Zoox

In addition to their LEIP, the project team obtained an ERG from the company's website. This guide offers graphical instructions to help first responders address emergency situations involving a Zoox vehicle. Unlike other ERGs reviewed by the project team, Zoox's guide features a uniquely color-coded diagram that specifically highlights the high-voltage power lines and labels key components of the high-voltage system.

Additionally, the Zoox *Emergency Response Guide* includes labeled diagrams to assist responders with vehicle demobilization and towing. For example, one diagram shows stabilization and lifting points on the vehicle that can support the vehicle when lifted. Such instruction was unique among the interaction plans and ERGs reviewed by the project team.

Figure VI-2. U.S. Soldiers with the 179th Fire Detachment Raise the Roof Off a Minivan they Severed With the Jaws of Life to Safely Remove the Mannequins Inside, During their Vehicle Extrication Rescue Training at Almeida's Used Car and Parts Lot in Carver, Massachusetts on June 3, 2010 (Photo: U.S. Army Spc. Michael V. Broughey, 65th Theater Public Affairs Support Element. The appearance of U.S. Department of Defense [DoD] visual information does not imply or constitute DoD endorsement).

Torc Robotics

Torc Robotics provided an ERG several months after providing their *First Responder Guide* (equivalent to a LEIP). The project team reviewed this document as a FRIP/LEIP. A company representative informed the project team that the ERG is meant to replace their *First Responder Guide* that they originally submitted. The ERG contains updated information for the truck models that they operate in Texas. The original *First Responder Guide* provided included models the company plans to phase out of use. It is unclear whether Torc Robotics plans to create a new FRIP/LEIP in the future.

The ERG includes an image of a Torc Robotics automated CMV with arrows calling out visual components found on the truck for easier recognition. Some components are exclusive to AVs, while other components are required for all CMVs operating in the United State (i.e., USDOT information).

Additionally, the ERG contains information and images to identify the ADS status of the truck including instructions for placing the truck into emergency manual override. This information is essential for responders when immobilizing or stabilizing the truck. The inclusion of this information could serve as a model to other AV companies creating ERGs.

ISSUES IDENTIFIED

The majority of FRIPs/LEIPs reviewed for this task met most requirements, although a few lacked key elements. A few suffered from qualitative issues that might affect usability. While the AVIA model legislation and California state law (for those companies operating in California) appear to shape most FRIPs/LEIPs and ERGs, the lack of detailed standards and evaluative criteria makes for wide variations in plan makeup, level of detail, and overall design/structure.

Standardization significantly improves the ability of responders to quickly identify relevant issues and apply safety and response measures to protect themselves and the public in the event of an incident. Standardization, coordination, and some level of regulation will become increasingly necessary to ensure a common operating environment for first responders addressing emergencies involving AVs.

A similar model exists related to the transportation of hazardous materials. Despite the high number of different hazardous material types, efforts related to regulation, interstate/international harmonization, categorization of similar hazard materials into classes, labeling standards, display placards during transportation, and response information (in the form of hazardous material safety data sheets and the North American *Emergency Response Guidebook* [PHMSA, 2024]) provide essential information for responders in easy-to-use, standardized formats. The opportunity exists to develop a similar combined effort to address AV interactions with first responders.

The lack of standardization across FRIPs/LEIPs and ERGs with company specific information makes scaling up response measures for first responders difficult. Such an ad hoc system may work for testing and development with a limited number of players but such a system be challenged as AVs enjoy more mainstream consumer deployment. Without a standard format or evaluative criteria, such plans and guides will grow increasingly diversified in the information they provide and the means through which they provide it—a recipe for confusion.

Fortunately, time is available to address these variations and complexities before such systems and vehicles begin to enter widespread utilization. Multiple opportunities exist to improve not only the quality of FRIPs/LEIPs and ERGs, but to create a system in which all stakeholders can contribute to address the problems inherent in widespread adaptation of new technology. Several examples of these opportunities offered by the project team follow.

Industry may conflate or confuse the purposes of ERGs and FRIPs/LEIPS. While some FRIPs/LEIPs contain or reference an ERG, others do not. Companies that had separate ERGs for responders also sometimes included highly relevant information (like where to find licensing, insurance, or registration documents) only in their LEIP.

Because a FRIP/LEIP or an ERG is not required for a developer to operate in Texas and standards for such documents remain voluntary and divergent in format and specificity (based on this review), first responders consulting one document may not have the critical information they require to respond accordingly. Given their wider use and public availability in some cases, responders may more likely possess an ERG than a FRIP/LEIP for consultation in an emergency, even though the relevant information they need is in a FRIP/LEIP.

FRIPs/LEIPs appear to function more at the community planning level, while ERGs exist primarily for frontline responders. Some of these issues may be resolved by specifying that an ERG describes how a responder should address AV interactions, while a FRIP/LEIP describes how the company and its vehicles will interact with responders.

Some industry standards exist for FRIPs/LEIPs. AVSC publishes the *AVSC-Best Practice for First Responder Interactions with Fleet-Managed Automated Driving System-Dedicated Vehicles (ADS-DVs)*, last updated in April 2024 (AVSC, 2024). This AVSC best practices guide shapes FRIP development by recommending the following topics to be included, some of which are required by regulation in some states and some of which are arguably more appropriate for an ERG:

- Introduction.
- Description of the ODD.
- Fleet operations.
- Identifying ADS-DVs.
- Contact information.
- Disabling ADS-DV.

- Accessing required documentation.
- Depowering ADS-DV.
- Moving ADS-DV from roadway.
- Determining presence of passengers.
- Extricating Passengers.
- Firefighting on or around ADS-DV.
- Safe towing ADS-DV.
- Releasing ADS-DV.
- Access ADS-DV data.
- Other considerations.

Absent more specific standards or regulatory requirements, the potential exists for development of a FRIP/LEIP and ERG development guide containing more robust industry standards that AV companies could utilize to ensure they convey the right information in the right documents for the right audiences. AVSC and AVIA both provide examples of how such a standard might work, although currently, the standards and best practices do not appear to align between the two organizations and have not achieved widespread adoption.

Additionally, reviewers noted that none of the FRIP/LEIP documents reviewed specifically addressed border checkpoints (the AVSC best practices guide does include border checkpoints as one scenario). Currently, no AV operating in Texas crosses the border; however, they do interact with CBP at inland checkpoints, especially along the I-10 corridor coming from El Paso, Texas.

Finally, many of the AV companies operating in Texas proved unreachable when attempting to request copies of a FRIP/LEIP or an ERG for their vehicles. Given the difficulties of contacting some companies experienced by the project team, first responders attempting to contact or coordinate with them may encounter similar problems.

VII. TEXAS FIRST RESPONDER AV RECOGNITION AND RESPONSE GUIDE

As part of Task 7, the research team synthesized all previous work into three products:

- *Texas Automated Vehicle Recognition Guide for First Responders.*
- *Texas First Responder Guide for Interactions with Automated Vehicles.*
- *Texas Automated Vehicle Operator Contact Sheet* (for official use- limited distribution).

This report reflects AV operator and first responder best practices at project completion. Given the rapid pace of change in the AV sector, users of these guides should consult departmental policies/procedures and any new/updated guidance.

The *Texas Automated Vehicle Recognition Guide for First Responders* contains photos, diagrams, and information on each of the AVs known to operate in Texas as of the completion of this report. Its purpose is to assist responders with identifying AVs in the course of their duties, identify the vehicle's level of autonomy, and note any critical information necessary for their response.

The *Texas First Responder Guide for Interactions with Automated Vehicles* contains the scenarios and best practices developed as part of Task 5 of this project, as approved by TxDOT. These practices include procedures adapted from existing procedures used by first responders, while incorporating any new or additional steps necessary for AV response. The guide also includes several community level recommendations—developed from previous tasks or provided by officials in locations where AVs currently operate in Texas—to provide communities with lessons learned for safely incorporating AVs into their community.

The *Texas Automated Vehicle Operator Contact Sheet* includes all known AV operators in Texas. However, many companies failed to provide information to the project team and or do not publish contact information (emergency or nonemergency). As such, the list of AV companies remained incomplete at the close of this project. In discussions with AV operators that did provide information, the list is intended for official use only and provided exclusively to TxDOT for its limited distribution.

DEVELOPMENT APPROACH

Work Performed

To develop these three documents, project team members contacted AV operators identified in previous tasks to request photos and information specific to their vehicles for inclusion in the AV recognition guide and contact information for inclusion in the AV contact list. Specifically, the project team:

- Incorporated information developed in previous tasks.
- Obtained new or updated information from AV developers regarding their vehicles, vehicle types, contact information, and any relevant information needed for completion of the AV recognition guide.
- Obtained photo image releases for any photos provided by AV operators for use in the AV recognition guide.

Texas Automated Vehicle Recognition Guide for First Responders

Using information gathered from past project tasks, communications with industry officials, and discussions with first responder educators, the project team developed the *Texas Automated Vehicle Recognition Guide for First Responders*. This guide contains photos, diagrams, and information on each of the AVs known to operate in Texas as of the completion of this report. Its purpose is to assist responders with identifying AVs in the course of their duties, identify the vehicle's level of autonomy, and noting any critical information necessary for their response.

In addition, working with TTI's Marketing and Communications department, the project team developed a series of simplified graphics to improve recognition and accessibility for first responders. Part of this series included simplified diagrams of the different types of AVs currently operating in the state (or expected to in the near future) (see Figure VII-1). These visuals help first responders quickly identify AVs, regardless of the operator or branding. The images appear in both the *Texas Automated Vehicle Recognition Guide for First Responders* and the *Texas First Responder Guide for Interactions with Automated Vehicles.*

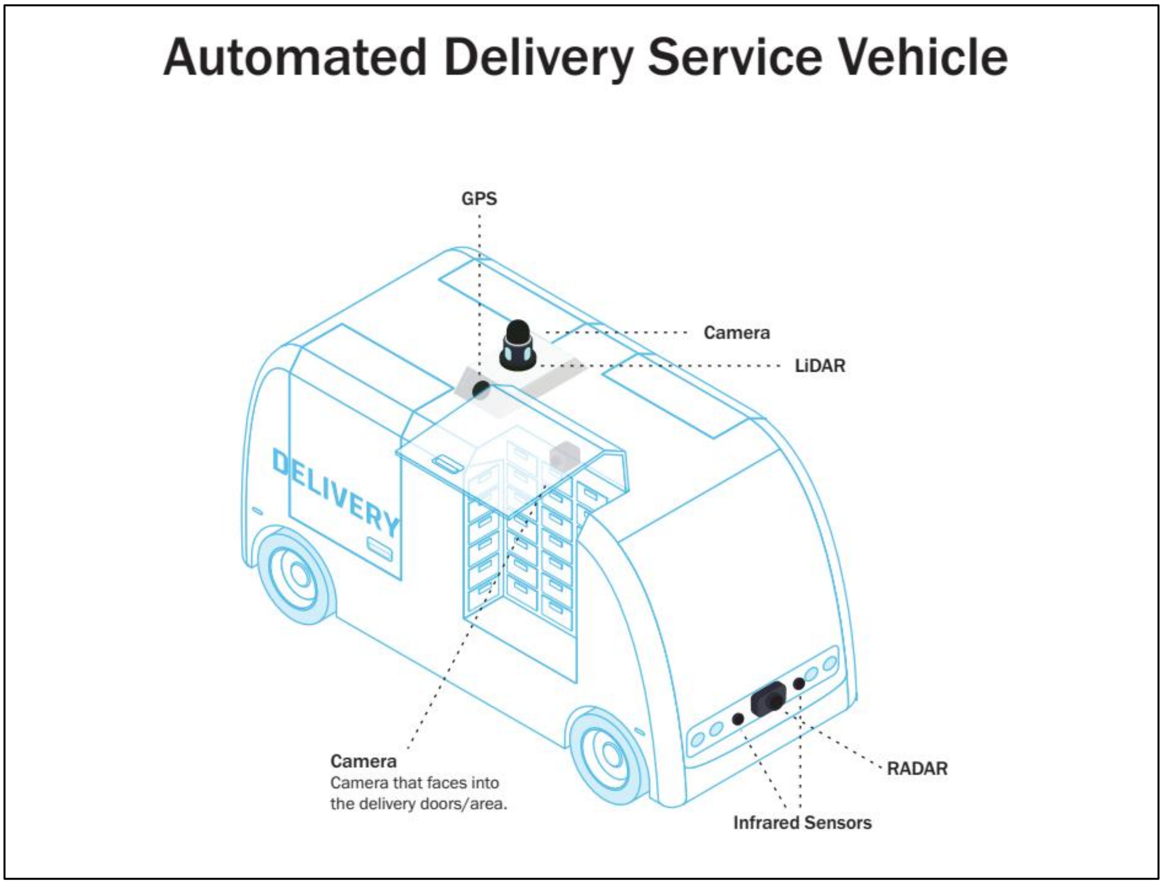

Figure VII-1. Example Diagram from the Texas Automated Vehicle Recognition Guide for First Responders.

Texas First Responder Guide for Interactions with Automated Vehicles

The *Texas First Responder Guide for Interactions with Automated Vehicles* is a formatted and visually accessible version of the Task 5 technical memorandum, *Catalog of Scenarios and Best Practices*. This guide incorporates the previously approved scenarios and revisions provided by the project monitoring committee and external reviewers, enhanced with visuals taken from *the Texas Automated Vehicle Recognition Guide for First Responders.* As of the publication of this report, this guide includes 19 different scenarios organized under 6 broad categories that first responders might encounter during their duties as follows:

- Law enforcement officer routine interaction (e.g., a traffic stop) scenarios include:
  - Conduct a traffic stop of an SAE Level 1–3 vehicle.
  - Conduct a traffic stop of an SAE Level 4–5 vehicle (with a safety driver).
  - Conduct a traffic stop of an SAE Level 4–5 vehicle (without a safety driver).

- Secondary interaction (e.g., AV entering an active response scene) scenarios include:
    - Conduct emergency disablement of an SAE Level 4–5 vehicle (without a safety driver).
- CMV interaction (e.g., inspection and enforcement) scenarios include:
    - Conduct an SAE Level 4–5 Automated CMV inspection (with a safety driver).
    - Conduct an SAE Level 4–5 Automated CMV inspection (without a safety driver).
- Law enforcement officer nonroutine interaction (e.g., emergency responses, unusual or nonroutine situations) scenarios include:
    - Conduct a vehicle pursuit of an SAE Level 4–5 automated vehicle (without a safety driver).
    - Respond to an SAE Level 4–5 automated vehicle with an incapacitated passenger.
- Crash response and investigation scenarios include:
    - Respond to an SAE Level 1–3 passenger vehicle traffic crash.
    - Respond to an SAE Level 4–5 automated passenger vehicle traffic crash.
    - Respond to an SAE Level 4–5 automated CMV traffic crash.
    - Respond to a sodium- or lithium-ion battery fire in a vehicle.
    - Conduct a driver/passenger extrication from an SAE Level 4–5 automated vehicle.
    - Complete a TxDOT CR-3 form for an automated vehicle involved crash.
- Traffic/parking management and enforcement scenarios include:
    - Move or tow a damaged, malfunctioning, abandoned, or illegally parked SAE Level 4–5 automated vehicle.
    - Direct an SAE Level 1–3 vehicle under abnormal road conditions.
    - Direct an SAE Level 4–5 automated vehicle under abnormal road conditions (with a safety driver).
    - Direct an SAE Level 4–5 automated vehicle under abnormal road conditions (without a safety driver).
    - Directing traffic in a school zone with automated vehicles present.

Figure VII-2 shows an example scenario and best practices for the conduct of a traffic stop of an SAE level 4–5 passenger vehicle (with a safety driver). Each scenario includes a primary scenario type, the first responder type most likely to encounter it, a context section describing the conditions under which the scenario may apply, and best practices for handling that scenario. The project team attempted to make scenarios and best practices accessible to all responders, regardless of their training level or official duties. As such, these best practices may form the basis for a local jurisdiction to refine and adapt procedures into existing policies and procedures that suit their local conditions.

Researchers created scenarios based on previously identified scenarios from industry organizations like the AVSC, previous studies and information discovered during the literature review and crash data analysis, input from stakeholders during the AV summit, and suggestions made by key stakeholders in follow-up discussions. Best practices attempted to use established and common policies and procedures currently used by responders for nonautomated vehicle response, incorporating any new AV-specific procedures where necessary to avoid major deviation from established practices. These additional steps created as part of the scenario and best practice development appear highlighted on the scenario pages in light blue. All procedures went through a review process that included both members of the TTI and TEEX project teams, subject matter experts, the TxDOT Project Monitoring Committee, and other key stakeholders.

The project team also developed the *SAE International Levels of Driving Autonomy and Corresponding TXDOT CR-3 Codes* (Figure V-1 in this report). This resource assists Texas law enforcement officers to identify a vehicle's SAE International autonomy level and select the appropriate code for completing the TxDOT CR-3 forms.

01. LEO Routine Interaction Scenarios

Scenario:

Conduct a Traffic Stop of an SAE Level 4-5 Automated Vehicle (with a safety driver)

Primary Scenario Type: LEO Routine Interaction

Primary Responder Type: Law Enforcement

Scenario Context: A traffic stop involving an SAE Level 4-5 automated vehicle with a safety driver should follow relatively normal procedures as safety drivers must remain ready to take control of the vehicle.

Best Practice

1) Assess the situation and execute a traffic stop following departmental procedures
2) Recognize the vehicle as an SAE Level 4-5 AV (see Texas AV Recognition Guide for First Responders for guidance)
   a) Identify vehicle make/model and the AV operator through markings, vehicle registration information, or the AV recognition guide
3) SAE Level 4-5 AVs should detect sirens and flashing lights from law enforcement and make efforts to slow down and arrive at a stopping point or the safety driver can disable autonomy and take control of the vehicle
4) Instruct the driver to disable the automation system and ensure the safety driver is in control of the vehicle's driving operations
   a) If necessary, instruct the driver drive or pull into a safer area
5) Secure the area by positioning your vehicle safely and activating warning lights
6) Approach the vehicle with caution
7) Request documentation from driver
8) If needed, prepare a citation or warning per departmental procedures
   a) Document any violations or issues, including the AV's automation level and the presence of a safety driver at the time of the incident
   b) Note if the safety driver was in control of the driving operation at the time of the cited incident or if the system was operating autonomously
9) Ensure the vehicle is safe to re-enter traffic
10) If your jurisdiction requires it, submit an AV interaction report through normal procedures

Notes

At the time of publication, no manufacturer sold SAE Level 4-5 vehicles for private use in the United States. All current SAE Level 4-5 automated passenger vehicles operating in Texas are developer owned and operated as taxi services. This may change, requiring modification of these procedures as to the responsible party for any violations.

SAE Level 4-5 vehicle should detect and respond to flashing lights and sirens and respond in accordance with the Traffic Code.

According to Tex. Transp. Code § 545.453, the AV owner is liable for any violations of traffic laws, regardless of whether a human passenger is present. However, if a safety driver is present and the automated system was disengaged at the time of the violation that driver may be liable (consult departmental policy for guidance).

Figure VII-2. Example Scenario and Best Practices for the Conduct of a Traffic Stop of an SAE Level 4–5 Passenger Vehicle (With a Safety Driver).

Texas Automated Vehicle Operator Contact Sheet

The *Texas Automated Vehicle Operator Contact Sheet* is a compilation of various communication methods (emergency and nonemergency phone lines and emails) sourced from AV operators known to currently test or operate within the state at the time of preparation. The project team acquired this information through public documentation, information provided directly by AV operators on request, and private or internal-use documents provided with restrictions by AV operators. As such, this list includes contact information that some AV operators requested be withheld from public distribution.

This list remains incomplete because several AV companies either did not provide information or did not respond to requests for information. The AV operators that did not have public contact information available and did not provide information on request are noted on this list. Following a decision made after discussions between the project team and the TxDOT Project Manager and Project Monitoring Committee, the project team provided this contact sheet for official use only and exclusively to TxDOT for limited distribution at TxDOT's discretion, separate from any distribution or publication of the AV recognition and interaction guides.

Given the limited nature of this list and its distribution, response organizations utilizing the AV recognition and interaction guides may wish to coordinate with any AV operator testing in their jurisdiction to ensure that they have up-to-date contact information for both emergency and nonemergency situations and regularly check those contacts to ensure that they continue to remain up to date. As recommended in the guides and in this report, a useful means to coordinate such communication is to utilize a local AV safety task force, as well as maintain contact with the Texas CAV Task Force.

VIII. CONCLUSIONS AND SUMMARY OF FINDINGS

SUMMARY OF FINDINGS

Task 2: Literature Review

Key findings from a review of the literature included the following:

- The absence of consistent standards and regulations regarding safety measures, first responder protocols, and training results in widely varied levels of first responder capabilities for AV interactions, which are largely dependent on the vehicle model, developer, and jurisdiction.
- Consumers who own vehicles with Level 2 or Level 2+ advanced driver assistance systems (ADASs), as defined by the Society of Automotive Engineers (SAE) International, may mistakenly perceive a higher degree of autonomy in their vehicles, leading to an increased risk of roadway incidents.
- The availability and quality of AV and electric vehicle (EV) first responder guides varies significantly by manufacturer and vehicle make.
- Many AVs are also EVs, posing additional response considerations due to the hazards associated with battery fires and thermal runaways.
- Traffic incident management (TIM) forms a central focus of first responder concerns, particularly regarding AV navigation at active incident scenes or through other unusual traffic patterns that deviate from roadway rules (e.g., around construction zones or special events). Many of these issues relate to the ability of current AVs to process and correctly interpret human-provided directions that deviate from normal roadway rules, signals, or markings.
- Responders requested clear, conspicuous markings on or in vehicles identifying them as AVs and providing operator contact information. Automotive industry representatives expressed concerns that such markings on the exterior of vehicles may lead to aberrant driving behavior around AVs.
- A lack of data availability and a hesitancy by companies to share data with investigators may hamper crash investigations.
- Foreign-operated AVs may pose unique security risks for individuals, security-sensitive sites, and national defense related locations.
- Some nongovernmental responders (e.g., highway emergency response operator [HERO], Tow and Go) reported not receiving joint first responder AV training provided by the AV companies.
- The Texas Commission on Fire Protection (TCFP) and the Texas Commission on Law Enforcement (TCOLE) have yet to publish training standards or requirements for AV interactions.

Task 3: Policy and Needs Assessment

The TTI research team performed an analysis of policies regarding first responder interactions with AVs to develop an assessment of operational, legal, and other mechanisms that would address first responder awareness and safety concerns when interacting with AVs. The work involved interviewing state first responder and HERO stakeholders and reviewing state laws and regulations governing AVs in Texas, in other states, and at the federal level. These efforts resulted in the development of policy suggestions federal rulemaking authorities.

Federal Policy

Federal policy suggestions included the following:

- Modify the National Highway Traffic Safety Administration's (NHTSA's) Federal Motor Vehicle Safety Standards (FMVSSs) to address the unique features of AVs and provide consistency across all AVs that first responders will interact with in the United States.
- Modify the Federal Motor Carrier Safety Administration's (FMCSA's) Federal Motor Carrier Safety Regulations (FMCSRs) to address first responder interaction needs with automated trucks.
- Adopt a federal rule that provides a minimum standard for (LEIPs).
- Amend rules around federal grant programs administered by NHTSA and FMCSA to allow use of highway and commercial motor vehicle (CMV) grant program funds to develop and deliver targeted training for first responder interactions with AVs.

State Policy

State policy suggestions included the following:

- Amend existing AV law to grant TxDOT and the Texas Department of Public Safety (DPS) authority to implement and enforce the law through standard procedures and rules that are not unreasonable or unduly burdensome.
- Amend 7 Texas Transportation Code (Tex. Transp. Code) § 545.454 to require LEIPs as a condition of deployment and mandate training for first responders.
- Collaborate with the Commercial Vehicle Safety Alliance (CVSA) and the American Association of Motor Vehicle Administrators (AAMVA) to draft federal standards for AVs (including trucks) that inform federal rulemaking.
- Evaluate and resolve conflicting laws governing AVs and transportation network companies (TNCs).
- Amend the TNC law to account for the fact that digitally prearranged rides could be provided by a driver or a vehicle equipped with an automated driving system (ADS).
- Amend the Texas statutes that extend immunity to HERO personnel by expanding the definition of first responders in Texas Civil Practice and Remedies Code (Tex. Civ. Prac. Code) § 78A.
- Add a provision to 7 Tex. Transp. Code Subtitle C Subchapter J to clarify that autonomous trucks are subject to state CMV safety laws.

Texas State Operations

Operational policy suggestions at the state level included the following:

- Maintain formal channels of communication between the government and AV companies through the Texas Connected Autonomous Vehicle (CAV) Task Force.
- Establish a formal means of public reporting for AV-involved incidents and provide information about such incidents statewide via publicly accessible data tracking.
- Continue collaboration with other state agencies and local governments.
- Establish statewide guidelines for AV companies.
- Coordinate and standardize in-person training conducted by AV companies to familiarize all first responders with AVs that will operate on Texas roadways.
- Adopt and implement CVSA's Enhanced CMV Inspection Program for Autonomous Trucks.

Task 4: AV Summit

In April 2024, TTI and TEEX hosted a first-of-its-kind summit, bringing together autonomous vehicle developers, researchers, regulators, and first responders. The goal of the *First Responder Interactions with Automated Vehicle Summit* was to bring together stakeholders to develop information for subsequent tasks, specifically the development of interaction scenarios and best practices and the review of existing interaction plans and guidance to support development of a first responder guide for AV interactions. Summit participants engaged in a positive, collaborative set of discussions that resulted in significant findings that the project team utilized for further tasks.

The following were common points of discussion across breakout groups and in the larger group:

- The need for a two-way information-sharing portal that:
  - Communicates roadway and traffic management center (TMC) information to AV companies from first responders and vice versa.
  - Allows for the exchange of information regarding issues and solutions between industry and first responders.
- Issues involving AVs and human-directed traffic; standard hand and arm signals for human-directed traffic in Texas, as defined in the Texas Administrative Code (Tex. Admin. Code), may not be adequate for AVs.
- First responder difficulty identifying AVs and obtaining contact numbers for vehicle operators; wait times to reach remote operators or emergency contacts may be lengthy.
- Standardization of training and procedures for industry and first responders rather than each company and jurisdiction developing separate training and procedures.
- First responder ability to determine autonomy status (i.e., autonomy engaged indicator lights) and manually override/disable autonomy.

Task 5: Catalog of Scenarios and Best Practices

Several recommendations emerged during Task 5's work and previous task efforts. Several recommendations correlated to efforts occurring during this project, including the establishment of new first responder advisory councils to the AV industry/associations and ongoing federal-level efforts to explore some of this project's same issues related to automated CMVs. These early-stage efforts may play a role in addressing some of the needs identified below:

- Creation of established forums for the exchange of information between first responders and AV developers to address scenarios and best practices as they develop.
- Involvement of law enforcement and fire training standard authorities, like TCOLE and TCFP, in the creation and establishment of training standards and programs for first responders regarding AV interactions.
- Ongoing studies leveraging incident data (as it develops over time) to assess first responder interaction scenario relevancy and the emergence of new scenarios.
- Validation of best practices to determine adequacy to address scenarios identified using first responders in simulated conditions with operational AVs.
- Development of a single source, unified training program for Texas first responders in AV interactions.

Task 5 identified a number of first responder- AV interaction scenarios and developed best practices for addressing those scenarios based on input from first responders and established protocols for such situations involving normal (nonautomated) vehicles, which were reviewed independently by TxDOT and several key stakeholders prior to approval. These scenarios and best practices included the following:

- Conduct a Traffic Stop of an SAE Level 1–3 Vehicle.
- Conduct a Traffic Stop of an SAE Level 4–5 Automated Vehicle (with a Safety Driver).
- Conduct a Traffic Stop of an SAE Level 4–5 Automated Vehicle (without a Safety Driver).
- Conduct Emergency Disablement of an SAE Level 4–5 Automated Vehicle (without a Safety Driver).
- Conduct an SAE Level 4–5 Automated CMV Inspection (with a Safety Driver).
- Conduct an SAE Level 4–5 Automated CMV Inspection (without a Safety Driver).
- Conduct a Vehicle Pursuit of an SAE Level 4–5 Automated Vehicle (without a Safety Driver).
- Respond to an SAE Level 4–5 Automated Vehicle with an Incapacitated Passenger.
- Respond to an SAE Level 1–3 Passenger Vehicle Traffic Crash.
- Respond to an SAE Level 4–5 Automated Passenger Vehicle Traffic Crash.
- Respond to an SAE Level 4–5 Automated CMV Traffic Crash.
- Respond to a Sodium- or Lithium-Ion Battery Fire in a Vehicle.
- Conduct Driver/Passenger Extrication from an SAE Level 4–5 Automated Vehicle.
- Complete Texas CR-3 Crash Report Form for Automated Vehicle Involved Crashes.
- Move or Tow a Damaged, Malfunctioning, Abandoned, or Illegally Parked SAE Level 4–5 Automated Vehicle.
- Direct an SAE Level 1–3 Vehicle Under Abnormal Road Conditions.
- Direct an SAE Level 4–5 Automated Vehicle Under Abnormal Road Conditions (with a Safety Driver).
- Direct an SAE Level 4–5 Automated Vehicle Under Abnormal Road Conditions (without a Safety Driver).
- Directing Traffic in a School Zone with Automated Vehicles Present.

Task 6: Catalog of FRIPs/LEIPs

Key findings from a review of catalogued FRIPs/LEIPs included the following:

- An established standard, format, or model design for emergency response guides (ERGs) and FRIPs/LEIPs would improve uniformity and ease of use across all guides reviewed during this project.
- In the absence of such a standard, a guidebook describing their development may assist the AV industry in improving and standardizing the quality and content of their ERGs and FRIPs/LEIPs.
- Such a guidebook may also address the differences in focus between ERGs and FRIPs/LEIPs; FRIPs/LEIPs should focus on how operators and vehicles interact with the transportation network and first responders and ERGs should focus on how first responders interact with vehicles and operators.
- California's standards for FRIPs/LEIPs currently exceed the Autonomous Vehicle Industry Association's (AVIA's) model standard and may provide the basis for a nationwide standard, pending federal or other state action to further define the requirements of AV LEIPs.
- Current FRIPs/LEIPs focus mostly on systems and vehicles under testing and development, which limits the scalability of the solution. As more vehicles and more systems enter the market, the number of FRIPs/LEIPs and ERGs will grow. Without standardization of systems and response measures, this market may exceed the capacity of first responders to account for the many variations between companies and vehicles.
- FRIPs/LEIPs may provide a temporary solution to the problem, but the longer-term implications and changes to emergency response procedures require coordination, standardization, and unified training solutions to meet the needs of first responders.

- An online centralized system or database containing copies of all ERGs and FRIPs/LEIPs accessible to first responders could provide a single, vetted source for responders to obtain manufacturer-specific information in an emergency and a valuable supplement to the first responder guide developed as a final deliverable for this project.
- To maintain such a database/single-source information portal, states could require submission of a FRIP/LEIP, an ERG, and a cut guide (for EVs) as part of any vehicle licensing process.
- Development of a combined ERG for AVs could model the North American *Emergency Response Guidebook* (Pipeline and Hazardous Material Safety Administration [PHMSA], 2024) for hazardous materials emergencies, which groups together materials with shared properties that affect response, thus limiting the number of separate response procedures for a wider array of materials.
- The project team experienced difficulties when contacting or receiving responses from some AV companies. Because an AV company is not required to have a FRIP/LEIP to operate in Texas, failing to submit one for this project is not a deficiency. However, the difficulty in contacting a company representative to discuss submitting a plan for the project could be a deficiency if it affects the ability of first responders to contact companies for nonemergency questions or to conduct coordination efforts. Companies should consider providing both emergency and nonemergency contact information for responders that is not tied to an individual email account that may cease functioning if that individual leaves the company. Some companies already do this; this is a best practice identified during this review.

Task 7: First Responder AV Interaction Guide

The first responder AV interaction guide comprises the following three separate documents, provided to TxDOT as the Product 1 deliverable:

- *Texas Automated Vehicle Recognition Guide for First Responders.*
- *Texas First Responder Guide for Interactions with Automated Vehicles.*
- *Texas Automated Vehicle Operator Contact Sheet* (for official use-limited distribution).

The *Texas Automated Vehicle Recognition Guide for First Responders* provides information to responders to assist them in identifying AVs, their level of autonomy, and important manufacturer-specific information regarding the vehicle (when provided by the company). For AV operators that did not provide information, diagrams, or photos of their vehicles, the researchers developed line art diagrams of generalized AV types to provide some guidance regarding the identification of vehicles.

The *Texas First Responder Guide for Interactions with Automated Vehicles* incorporates the scenarios developed in Task 5 into a ready-to-use manual that responders and their organizations can reference quickly or utilize to develop departmental level policies and procedures. It also contains information of interest to communities on actions they can take to integrate AVs safely into their communities and prepare for their deployment, as well as additional resources of interest to first responders related to AV response scenarios.

The *Texas Automated Vehicle Operator Contact Sheet* is a limited-distribution document for official use only and contains emergency and nonemergency contact information for some of the AV operators in Texas. The contact list does not include this information for every operator in Texas because several operators did not respond to requests for that information and/or do not publish it.

INTEGRATING AV OPERATIONS INTO COMMUNITIES

Tasks 1 through 4 of this project identified numerous challenges, opportunities, and lessons learned that applied to policies, procedures, and methods to safely integrate AV operations and development into communities and states. This section describes these challenges, opportunities, and lessons learned. Because no established *playbook* currently exists for community level integration, this topic could form the basis for additional research or implementation projects.

Interagency and Industry Coordination via Task Forces

Various states and cities have established AV task forces and coordinating bodies to coordinate with AV operators, address any safety issues that emerge, assist with obtaining first responder training, and address any other issues that may arise. These groups provide a unified forum and point of contact for the AV industry, community first responders, community leaders, and other stakeholders to discuss the challenges and opportunities posed by AVs within their communities and present these concerns to the operators deploying AVs within their communities.

Intermunicipal and Interstate Coordination

Cities experiencing new AV deployments often communicate with cities that already have AV operations occurring. For example, as AV deployments grew in Austin, Texas, the city's AV Safety Task Force communicated with the cities of San Francisco, California, and Phoenix, Arizona, to obtain lessons learned. Some of this communication develops and remains in place over time, creating an informal communication network where cities can share lessons learned with their counterparts as they emerge. Additionally, cities within a state may participate in state-level task forces, allowing information sharing between cities within a state experiencing AV deployment. While no formal coordinating body exists for such coordination, these informal networks can offer significant benefits by helping cities avoid and prepare for problems before they arise.

Geofencing

Geofencing uses GPS and other geographic information system based technologies to create virtual barriers around specific buildings, routes, or locations that restrict unwanted AV activity. Depending on the technology or the company implementing it, AVs encountering a geofenced area may either deprioritize the location in their routing software or avoid it entirely. Geofences can be permanent, like geofences established around fire stations and police departments, or temporary, like geofences deployed in response to high-traffic events like major sports or civic gatherings.

Municipal task forces began requesting that AV developers testing or operating in their cities implement geofences after incidents where vehicles idled in front of first responder driveways or became stuck and confused by temporary traffic control measures near sports venues (Farivar, 2023; Herron, 2024; Swiatecki, 2023). In response, most AV companies complied with these requests by either integrating geofencing capabilities into their systems or actively collaborating with municipal groups to address the identified issues. Some communities worked with AV operators to establish protocols allowing officials to request that certain routes be temporarily geofenced, particularly during preparations for mass traffic control measures. The San Francisco AV Task Force created a system that directs dispatch officials to include AV operators when notifying other agencies, such as public transit, about incidents. Other cities found this system to be resource intensive, opting instead to rely on AV operators to monitor first responder and other official public social media accounts to geofence or reroute their vehicles based on disruptions announced through these official channels. In either a dispatch-driven or media-monitoring system, compliance with any traffic redirection and the measures used by companies to respond to such situations remains voluntary and at the discretion of the AV operators in the jurisdiction.

Currently, this system of requests and voluntary compliance works well for both parties, ensuring the safety of first responders and the AV operators' vehicles. However, as more companies deploy vehicles and personal AV ownership becomes more widespread, newer systems will be necessary. One idea proposed by responders during this project's Task 4 AV Summit involved creating a uniform portal where state and local officials could submit mass requests for AVs to avoid specific areas.

Similar technologies already exist in personal GPS services like Apple Maps and Google Maps, allowing public officials to limit navigation-guided traffic over identified routes. This portal would ideally be accessible to both public transportation officials and any AV operator, or even the public.

Citation Procedures

A persistent question in AV and first responder interactions is how law enforcement officers can issue traffic citations and tickets to AVs observed violating state and local traffic codes. While this may seem straightforward given the limited number of vehicles operated by a small group of closely monitored AV firms, the issue grows more complex as AV deployments expand to involve larger fleets, smaller companies leasing vehicles from other firms, and a potential shift to consumer ownership.

Even now, large departments that have strong working relationships with AV operators in their jurisdictions face challenges in defining clear enforcement protocols. While the scenarios developed for the AV interaction guide include steps for issuing citations, no established practice exists. As such, different interpretations may lead to varying procedures by jurisdiction.

During the completion of this report, the Texas Legislature met and proposed several bills to alter the language in 7 Tex. Transp. Code § 545 related to AVs, although none had reached the floor for a vote as of this report's publication. As of March 2025, 7 Tex. Transp. Code § 545.454(b)(1) states the following (emphasis added in bold font):

> Sec. 545.453. OPERATOR OF AUTOMATED MOTOR VEHICLE
> (a) When an automated driving system installed on a motor vehicle is engaged:
> (1) **the owner of the automated driving system is considered the operator of the automated motor vehicle solely for the purpose of assessing compliance with applicable traffic or motor vehicle laws, regardless of whether the person is physically present in the vehicle while the vehicle is operating**; and
> (2) the automated driving system is considered to be licensed to operate the vehicle.
> (b) Notwithstanding any other law, a licensed human operator is not required to operate a motor vehicle if an automated driving system installed on the vehicle is engaged.

Under 7 Tex. Transp. Code § 541.001(2), the owner is "a person who has a property interest in or title to a vehicle." This law also requires that AVs operate in compliance with the traffic laws as follows:

> Sec. 545.454. AUTOMATED MOTOR VEHICLE OPERATION
> (a) An automated motor vehicle may operate in this state with the automated driving system engaged, regardless of whether a human operator is physically present in the vehicle.
> (b) An automated motor vehicle may not operate on a highway in this state with the automated driving system engaged unless the vehicle is:
> (1) capable of operating in compliance with applicable traffic and motor vehicle laws of this state, subject to this subchapter;

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(2) equipped with a recording device, as defined by
Section 547.615(a), installed by the manufacturer of the
automated motor vehicle or automated driving system;
(3) equipped with an automated driving system in
compliance with applicable federal law and federal motor
vehicle safety standards;
(4) registered and titled in accordance with the laws of
this state; and
(5) covered by motor vehicle liability coverage or self-
insurance in an amount equal to the amount of coverage
that is required under the laws of this state.
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Most traffic violations are Class C misdemeanors in Texas under 7 Tex. Transp. Code Subtitle C. When a law enforcement officer conducts a traffic stop for a misdemeanor violation of the traffic laws, they effectively place the individual driving the vehicle under temporary arrest and the citation that individual signs is a promise to appear before the court at a later date or pay a fine of up to $500—the only penalty allowed for Class C traffic misdemeanors. After the driver signs the citation, the officer must—under state law—allow the driver to continue their journey, hopefully deterred enough to not commit the same violation again, unless the violation was serious enough to warrant an arrest (e.g., driving while intoxicated).

If an AV violates the traffic law, it will continue to do so under the same conditions because its programming contains a flaw that led to the initial violation. Further, a driverless vehicle cannot sign a citation and promise to appear in court. Therefore, the following questions arose related to citing SAE Level 4–5 vehicles:

- Who is liable for self-driving malfunctions under current state law if an SAE Level 4–5 AV equipped with an ADS is sold to a third party, given that vehicles must be titled with the owner of the vehicle listed on the title?
- Can a law enforcement officer issue a citation to the safety driver of an SAE Level 4–5 AV operated by the ADS or must they cite the owner/company? How do they determine the appropriate party and whether the safety driver or the ADS controlled the vehicle at the time of the violation?
- When citing owners, can a law enforcement officer cite a company or must they cite a human (i.e., an agent of the company)?
- Can a law enforcement officer issue a citation to any company employee representing the company (e.g., a representative sent to the scene in the event of an incident)?
- Is there a statewide standardized process for issuing a citation to a company or their agent? Must officers serve process in person or can they utilize some other method (e.g., by mail)?

As the project team prepared this report, these questions largely remained unanswered, although at least one municipality in Texas is developing a process to issue citations to AV companies in coordination with their municipal court. However, until they issue actual citations, and a court upholds those citations, such procedures remain in a state of development.

Emergency and Nonemergency Contacts

One tool of great importance in current AV-first responder interactions is the presence and use of a dedicated phone number for reporting AV-related incidents, obtaining additional information from AV operators, and coordinating responses to ensure public safety. These phone numbers are often included in a company's FRIP/LEIP and are prominently displayed—typically near the front or as a header or footer on every page—to ensure accessibility.

However, this system presents several challenges. First, like the FRIPs/LEIPs themselves, the inclusion of an emergency contact number is not always required as a condition for operating within a state. AV operators independently decide whether to include a number based on their testing or deployment intentions. Second, some AV operators with emergency contact numbers limit their distribution or include them only in confidential versions of their FRIPs/LEIPs, making them unavailable to the public. Finally, some operators maintain separate numbers for emergencies and general inquiries, requiring first responders to differentiate between the two depending on the situation. AV operators that do not provide nonemergency or general contact numbers generally require first responders to contact them through a web portal or via email to ask their questions, potentially slowing down the response.

Exhibition Petting Zoos and Training

When deploying, testing, or mapping vehicles to new cities, many AV operators have made it a best practice to first introduce and demonstrate the vehicles to first responders who may encounter or interact with them during their duties. These *exhibition petting zoos* allow responders to examine the vehicles, learn to recognize their AV status, and receive preliminary interaction training. This training often includes identifying the vehicle, locating stored documentation, and performing emergency actions such as disabling autonomous mode (Cruise and Waymo made time for a micro demonstration of their vehicles at the Task 4 AV Summit).

While this approach has successfully introduced AVs to some first responders and ensured limited hands-on experience, the TTI research team identified several shortcomings that must be addressed as AV deployments grow. First, the current developer-by-developer training model requires each company to staff representatives, schedule sessions, and independently reach out to as many relevant first responder agencies as possible in every city where they operate. This fragmented approach is resource-intensive and risks leaving some agencies or personnel uninformed. A centralized training model, such as one mandated by TCOLE or TCFP could streamline this process and would ensure consistent education across agencies, reduce duplication of effort, and comprehensively prepare first responders for AV interactions, regardless of the operating company.

Secondly, the developer-by-developer model relies on AV operators being exhaustive in their training efforts. If an operator fails to engage with a specific first responder agency or does not fully cover critical information during training, first responders may encounter situations where they are unprepared to handle the vehicle or its systems effectively. The TTI research team identified that the TxDOT HERO program, and other similar highway quick clearance programs, are often forgotten when AV companies contact local first responder or parties that may frequently encounter these vehicles. A centralized training system might address these gaps by standardizing curriculum, ensuring all relevant topics are covered, and requiring participation from all first responder agencies within areas of deployment.

First Responder Training Certification and Credit

Over the course of this project, one of the most cited concerns by first responders has been the relative lack of any training—required or not required—when interacting with AVs.

As of this report's publication, the TTI research team found no first responder certifications, professional training opportunities, or requirements for working with or interacting with AVs in Texas, despite first responders at the AV Summit frequently identifying training and continuing education on the subject as a top priority.

Texas has the infrastructure to implement such training or continuing education requirements. TCOLE and TCFP set training standards for law enforcement officers, firefighters, and other emergency personnel. These commissions could develop and coordinate specialized AV training modules that provide professional credit and certification, ensuring first responders are prepared for AV-related incidents.

Guide Recommendations

The *Texas First Responder Guide for Interactions with Automated Vehicles*, developed in Task 7, includes a list of recommended actions to take prior to AV deployment in a community. Upon learning an AV operator intends to operate in your jurisdiction, best practices—developed by cities with current AV operations—include the following:

- Consult with the AV operator to:
  - Request first responder guides, FRIPs/LEIPs, emergency response guides, and extrication guides
    - NOTE: Interaction plans and guides may not be available as they are currently not required in Texas
  - Request AV Operators to conduct training for your first responders on how to interact with their vehicles
  - Obtain emergency contact and non-emergency contact information for the AV operator and share that information with your first responder organizations and dispatch centers
    - NOTE: Some AV operator emergency and non-emergency contact information can be found in the Texas Automated Vehicle Operator Contact Sheet
- Form an AV safety task force including key stakeholders (e.g., police, fire, public works, local elected leaders)
  - Conduct regular meetings between AV operator representatives and the AV safety task force and first responders to address issues identified during operations
  - Consult with cities where AVs operate now
- Consider creating an AV incident tracking system for first responders that tracks incident details involving AVs and can provide the basis for discussions with AV operators
- Consider implementing geofencing
  - Provide the AV operator with the locations of sensitive facilities their vehicles should avoid (such "geofencing" is typical around fire stations, hospital entrances, and similar locations) or where the company may wish to exercise caution or choose to avoid (school zones, bus stops, youth centers)
  - Consider implementing a temporary geofence request system for serious or prolonged incidents or special events where humans may direct traffic or an active response may require a driver to deviate from the established rules of the road (e.g., drive on the shoulder of the roadway) – coordinate with the AV Operators to implement temporary geofences, discuss duration, and consider how the location may shift or, the duration may extend
  - Request for the AV operator to monitor response organizations' social media accounts in their operating jurisdiction to react to incidents that may cause roadway shutdowns or affect their operations in another way
    - Recommend that they establish an internal key word notification system to monitor official social media accounts and give quick notification of a key word being used (e.g., traffic, crash, fire, swat, homicide, emergency) in a location or specific road where they operate

INDUSTRY COORDINATION WITH FEDERAL, STATE, AND LOCAL AGENCIES

FMCSA Inspections Procedures

Currently, automated CMV freight carriers in Texas voluntarily adhere to CVSA's Enhanced Commercial Vehicle Inspection Program (CVSA, 2022a, 2022b). Under this program, automated trucks undergo an enhanced no-defect inspection prior to every dispatch by company employees trained and certified by CVSA. Through coordination with Texas DPS, SAE Level 4–5 automated freight vehicles are allowed to bypass inspection stations en route. During transit, Texas DPS commercial vehicle law enforcement inspections of automated CMVs occur only when an officer observes an imminent hazard en route or as part of a post-crash investigation. Because the vehicles must follow the rules of the road, the automated CMV, if driverless, should respond to law enforcement attempting to pull over the vehicle.

CBP Inspections Procedures

Currently, several automated CMV firms are testing routes along interstates and federal routes that intersect with CBP interior checkpoints. At these locations, federal officers are authorized to stop vehicles, inspect cargo, verify compliance with immigration and customs regulations, and ensure adherence to federal transportation laws. Right now, these checkpoints pose little concern because automated CMV runs still include a safety driver in the vehicle who is ready to take control of the driving operation and able to adhere to the instructions and signage posted at these checkpoints.

However, in the near term, automated CMV operators, such as Aurora Innovation and Kodiak Robotics, are seeking to fully remove the human presence from automated CMVs. When an automated CMV navigates along a corridor without a human ready to take control, the vehicle itself will need to be able to understand and adhere to the commands of the CBP agent at a nearly or fully independent level. In response to these concerns, companies, such as Aurora Innovation, have programmed their vehicles to be able to respond and follow large signage used by CBP officials, allowing the vehicles to navigate and exit the checkpoint process.

While the enhanced inspection system and the CBP checkpoint system function relatively effectively at present, long-term challenges must be addressed. Primarily, commercial vehicle enforcement officers have expressed concerns about the scalability of these solutions. Additionally, because the vehicles can bypass inspection stations, only company employees inspect the vehicle unless an officer notices a defect. Commercial vehicle enforcement officers have expressed concerns about how these solutions can be enforced as they scale. While AV developers have a vested interest in their vehicles' safety, some risk exists that the enhanced inspections system may introduce conflicts of interest that could potentially reduce safety. Law enforcement should consider new processes for terminal inspections, as well as new and potentially more severe penalties for inspections process violations.

Additional coordination and procedure development may be required at less common CMV checkpoints, including USDA inspection points and roadblocks established by law enforcement in some situations. Similarly, while CBP may be able to conduct its inspections of automated CMVs, automated trucks in the hands of third parties could present different challenges for enforcing trafficking regulations.

IX. OPPORTUNITIES FOR IMPLEMENTATION

VALIDATION

As part of Task 5's cataloging of scenarios and best practices, the research team adapted and developed scenarios and best practices to guide first responders in their interactions with AVs. This catalog reflects insights gathered from industry professionals, first responders, first responder training organizations, and relevant publications available during this project. However, the project did not include work to validate these scenarios and best practices in real-world or simulated scenarios involving first responders and functional AVs. Validation of the scenarios and best practices could form the basis for additional work and revision to the scenarios.

TRAINING

AV development, mapping, and testing continue to expand into new states, jurisdictions, and municipalities nationwide. Cities like San Francisco, California, and Austin, Texas—long hubs for AV testing and deployment—established centralized task forces and training programs that equip local law enforcement officers and first responders to safely interact with AVs. As AV deployments expand, new municipalities and jurisdictions must develop their own standards, coordination hubs, and training programs.

A potential implementation project, Preparing Communities for AV Deployment, offers a training series that could help equip community leaders, first responders, and elected officials with the successful strategies pioneered by municipal AV task forces in the United States. Potential training topics include:

- Forming an AV safety task force.
- Communicating with local AV operators.
- Requesting FRIPs/LEIPs, specialized training, and emergency/nonemergency contact information.
- Deploying geofences.
- Event/special activity coordination.
- Scenario and best practice training.

FRIP/LEIP BEST PRACTICES

As identified in Task 6 of this project, significant variation exists between regulatory standards, compliance with those standards, and industry best practices. Similarly, some confusion remains between the purpose and use of FRIPs/LEIPs and ERGs. A project to develop and recommend best practices for FRIPs/LEIPs and ERGs in Texas could significantly benefit both industry and first responders. Such a project would not require significant resources given the work already completed during this project, although the project might benefit from an additional AV summit that brings together relevant stakeholders to inform the project outcome.

REVISION

The three guidance documents developed as part of this project reflected best practices as determined at the time of this report's publication. However, it is highly likely that many of the best practices for scenarios will change as mass deployment allows officers and AV operators to experiment and create new solutions. Thus, the project team recommends periodic reviews and revisions of these documents and scenarios to align with emerging industry standards and first responder needs.

REFERENCES

American Journal of Transportation. (2023, August 9). *Seaports to deploy over 370,000 autonomous guided vehicles by 2030 to alleviate congestion*. https://www.ajot.com/news/seaports-to-deploy-over-370000-autonomous-guided-vehicles-by-2030-to-alleviate-congestion

American National Standards Institute/Underwriters Laboratory. (2023). *Evaluation of autonomous products* (ANSI/UL 4600, 3rd ed.) https://www.shopulstandards.com/ProductDetail.aspx?productid=UL4600

Arizona Department of Public Safety. (2018). *Law enforcement protocol for fully autonomous vehicles. https://azdot.gov/sites/default/files/2019/07/law-enforcement-protocol.pdf*

Associated Press. (2024, September 12). *It took 50,000 gallons of water to put out Tesla semi fire in California, U.S. agency says*. https://apnews.com/article/tesla-semi-fire-battery-crash-water-firefighters-7ff04a61e562b80b73e057cfd82b6165

Austin Transportation and Public Works Department. (2024). *Autonomous vehicles: Documented issues*. https://www.austintexas.gov/page/autonomous-vehicles

Automated Vehicle Safety Consortium. (2024). *AVSC best practice for first responder interactions with fleet-managed automated driving system-dedicated vehicles (ADS-DVs).* https://www.sae.org/standards/content/avsc-i-01-2024/

*A*utomated Vehicle Testing Pilot Program and Deployment Requirement, NH Rev. Stat. § 242:1 (2022). https://law.justia.com/codes/new-hampshire/2022/title-xx/title-242/section-242-1/

Autonomous Vehicle Industry Association. (n.d.). *Policy*. https://theavindustry.org/policy#state_policy

Autonomous Vehicle Pilot Program Rules-Application Process, 17 Me. Code Rules § 229-800-3(5) (2018). https://regulations.justia.com/states/maine/17/229/chapter-800/section-229-800-3/

Behrndt, R. (2024, November 16). *Sidewalk delivery robots will roll out to Dallas sidewalks soon*. WFAA. https://www.wfaa.com/article/money/dallas-text-delivery-vehicles-sidewalks-avride/287-8bb58e9c-c19c-480f-b7b5-8229a86a90c9

Bellan, R. (2024, October 2). *TuSimple founder Xiaodi Hou is back with a new autonomous truck startup*. TechCrunch. https://techcrunch.com/2024/10/02/tusimple-founder-xiaodi-hou-is-back-with-a-new-autonomous-truck-startup/

Bender, K. (2024, October 2). Cruise fined $1.5 million by federal safety regulators for failing to report robotaxi crash details. *The Mercury News*. https://www.mercurynews.com/2024/10/01/cruise-fined-1-5-million-by-federal-safety-regulators-for-failing-to-report-robotaxi-crash-details/

Bensinger, G. (2024, January 31). *GM's Cruise faces long road back to city streets in wake of safety review*. https://www.reuters.com/business/autos-transportation/gms-cruise-faces-long-road-back-city-streets-wake-safety-review-2024-01-31/

Bigelow, P. (2023, April 5), Near the U.S. border, Aurora teaches self-driving trucks to navigate checkpoints. *Automotive News*. https://www.autonews.com/mobility-report/auroras-self-driving-trucks-greeted-us-border-checkpoint

Bishop, R. (2024, July 29–August 1). *Automated driving in 2024: Launching and ramping* [Conference presentation]. The 2024 Transportation Research Board Annual Automated Road Transportation Symposium Highlights Session. San Diego, CA, United States.

Black, T. (2024, January 5). *Driverless truck companies plan to ditch human copilots in 2024.* Bloomberg. https://www.bloomberg.com/news/articles/2024-01-05/aurora-other-driverless-truck-firms-plan-to-ditch-human-copilots-in-2024

Boeriu, H. (2023, September 26). *BMW 7 Series receives approval level 3 automated driving in Germany*. BMW Blog. https://www.bmwblog.com/2023/09/26/bmw-7-series-receives-approval-level-3-automated-driving-in-germany/

Bote, J. (2023, December 1). GM is pulling away from Cruise. What happens to the robotaxi company now? *The San Francisco Standard*. https://sfstandard.com/2023/12/01/cruise-future-gm-pullback/

Brooke, L. (2020). *Level 2+: Making automated driving profitable, mainstream*. https://www.sae.org/news/2020/12/rise-of-sae-level-2

California Department of Motor Vehicles. (2023). *California DMV approves Mercedes-Benz automated driving system for certain highways and conditions*. https://www.dmv.ca.gov/portal/news-and-media/california-dmv-approves-mercedes-benz-automated-driving-system-for-certain-highways-and-conditions/

California Public Utilities Commission. (2023). *Order instituting rulemaking on regulations relating to passenger carriers, ridesharing, and new online enabled transportation services*. https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M521/K133/521133499.PDF

Canadian Mining Journal Staff. (2023, September 13). Volvo to supply autonomous transport to Boliden's Swedish mines. *Canadian Mining Journal*. https://www.canadianminingjournal.com/news/volvo-to-supply-autonomous-transport-to-bolidens-swedish-mines/

Commercial Vehicle Inspection Items, 37 Tex. Admin. Code § 23.42 (2017).

Commercial Vehicle Safety Alliance. (2014). *North American standard inspection procedures.* https://csa.fmcsa.dot.gov/safetyplanner/documents/396%20Forms/Inspection%20Procedure.pdf

Commercial Vehicle Safety Alliance. (2022a). *CVSA announces new enhanced CMV inspection program for autonomous truck motor carriers*. https://www.cvsa.org/news/new-enhanced-cmv-inspection-program/

Commercial Vehicle Safety Alliance. (2022b). *Enhanced commercial motor vehicle inspection procedure (for motor carrier operations)*. https://downloads.regulations.gov/FMCSA-2018-0037-0324/attachment_1.pdf

Commercial Vehicle Safety Alliance. (2024). *North American standard out-of-service criteria*.

Commercial Vehicle Safety Alliance. (n.d.). *Inspections*. https://www.cvsa.org/inspections/

Commission implementing regulation (EU) 2022/1426 of 5 August 2022 laying down rules for the application of regulation (EU) 2019/2144 of the European Parliament and of the Council as regards uniform procedures and technical specifications for the type-approval of the automated driving system (ADS) of fully automated vehicles (2022). https://eur-lex.europa.eu/eli/reg_impl/2022/1426/oj

Conditions required to operate fully autonomous vehicles without a human driver, 47 OK Stat. § 1703 (2023). https://law.justia.com/codes/oklahoma/title-47/section-47-1703/

Cruise, LLC. (2023). *Cruise team updates*. https://www.getcruise.com/news/blog/2023/cruise-team-updates/

Cruise, LLC. (2024). *Guide for law enforcement and first responders for interacting with a Cruise autonomous vehicle: Cruise AV (Chevy Bolt platform) version*.

Cruise, LLC. (n.d.). *First responder Cruise AV interaction protocol*. https://assets.ctfassets.net/95kuvdv8zn1v/73y2vYw09PviD0xuGJX085/cdcfbebc9d85c9fb22e75ad6019062d5/First_Responder_Interaction_Protocol_-_FAQs.pdf

Cui, Y., Liu, J., Cong, B., Han, X., and Yin S. (2022). Characterization and assessment of fire evolution process of electric vehicles placed in parallel. *Process Safety and Environmental Protection, 166*(1), 524–534.

Cybersecurity and Infrastructure Security Agency. (2021). *Autonomous ground vehicle security guide: Transportation systems sector.* https://www.cisa.gov/sites/default/files/publications/Autonomous%20Ground%20Vehicles%20Security%20Guide.pdf

Daley, M. (2019, April 23). *Motor vehicle extrication: Initial response considerations*. Firehouse. https://www.firehouse.com/rescue/vehicle-extrication/article/21075292/motor-vehicle-extrication-initial-response-considerations

Dempsey, R. P., Brunet, J. R., and Dubljević, V. (2023). Exploring and understanding law enforcement's relationship with technology: A qualitative interview study of police officers in North Carolina. *Applied Science*, *13*(1), 1–17.

Department of Public Safety Law Enforcement Protocols, Law Enforcement Interaction Plan, Ariz. Rev. Stat. § 28-9703(III) (2021). https://law.justia.com/codes/arizona/title-28/section-28-9708/

Duggan, P. (2017, December 14). Charge upgraded to first-degree murder for driver accused of ramming Charlottesville crowd. *The Washington Post*. https://www.washingtonpost.com/local/crime/driver-accused-of-plowing-into-charlottesville-crowd-killing-heather-heyer-due-in-court/2017/12/13/6cbb4ce8-e029-11e7-89e8-edec16379010_story.html

Elsberry, A. (2024, February 22). *Officials raise concerns about China-made cranes like those at Port of Wilmington.* WilmingtonBiz. https://www.wilmingtonbiz.com/officials_raise_concerns_about_china-made_cranes_like_those_at_port_of_wilmington/2024/02/22/officials_raise_concerns_about_china-made_cranes_like_those_at_port_of_wilmington/25325

Eskenazi, J., and Jarrett, W. (2023, August 9). *Explore: See the 55 reports—so far—of robot cars interfering with SF Fire Dept.* Mission Local. https://missionlocal.org/2023/08/cruise-waymo-autonomous-vehicle-robot-taxi-driverless-car-reports-san-francisco/

Executive Order No. 14,116. (2024). https://www.federalregister.gov/documents/2024/02/26/2024-04012/amending-regulations-relating-to-the-safeguarding-of-vessels-harbors-ports-and-waterfront-facilities

Executive Order No. 14117. (2024). https://public-inspection.federalregister.gov/2024-04573.pdf

Farivar, C. (2023, August 31). The mystery around a robotaxi, the fire department, and a death in San Francisco. *Forbes*. https://www.forbes.com/sites/cyrusfarivar/2023/08/30/cruise-robotaxis-waymo-san-francisco-firefighters/?sh=285c51ed1fea

Federal Highway Administration. (2023a). Part 6: Temporary traffic control. In *Manual on uniform traffic control devices for streets and highways* (11th ed.). United States Department of Transportation.

Federal Highway Administration. (2023b). *Welcome to traffic incident management*. United States Department of Transportation. https://ops.fhwa.dot.gov/tim/

Federal Motor Carrier Safety Regulations-Inspection, Repair, and Maintenance, 49 CF. § 396 et seq. (2008).

Fire Safety Research Institute. (2024, July 10). *FSRI researchers transfer key knowledge at the Society of Fire Protection Engineers' first Lithium-Ion Battery Summit*. https://fsri.org/research-update/fsri-researchers-transfer-key-knowledge-society-fire-protection-engineers-first

Galvan, J. E., and Kless, T. (2024, August 5). *Driver dies after Tesla Cybertruck slams into culvert, bursts into flames in Baytown area, DPS says*. KHOU 11. https://www.khou.com/article/news/local/cyber-truck-deadly-fire-fisher-road-baytown-texas/285-1b631e4f-7b1b-4645-9050-0cb839aa104a

Gatik. (2024). *Gatik's first responder interaction plan.*

General Motors. (2024). *GM to refocus autonomous driving development on personal vehicles*. https://news.gm.com/home.detail.html/Pages/news/us/en/2024/dec/1210-gm.html

Gilboy, J. (2024, January 29). *Tesla autopilot cheat devices reveal U.S. cars have less safe software than exports*. The Drive. https://www.thedrive.com/news/tesla-autopilot-cheat-devices-reveal-us-cars-have-less-safe-software-than-exports

Goodison, S. E., Barnum, J. D., Vermeer, M. J. D., Woods, D., Lloyd-Dotta, T., and Jackson, B. A. (2020). *Autonomous road vehicles and law enforcement: Identifying high-priority needs for law enforcement interactions with autonomous vehicles within the next five years*. https://www.rand.org/pubs/research_reports/RRA108-4.html

Governmental Authorities, 7 Tex. Transp. Code § 541.002 (1995).

Graham, E. (2023, November 17). *China-owned autonomous vehicle firms are collecting data during U.S. tests—And lawmakers are concerned*. Nextgov FCW. https://www.nextgov.com/emerging-tech/2023/11/china-owned-autonomous-vehicle-firms-are-collecting-data-during-us-tests-and-lawmakers-are-concerned/392127/

Grigorian, C. H, and Englund, R. N. (2021). *NHTSA and motor vehicle safety*. https://www.foley.com/insights/publications/2021/04/nhtsa-and-motor-vehicle-safety/

Griswold, A. (2023, July 11). *The self-driving cars wearing a cone of shame*. Slate. https://slate.com/business/2023/07/autonomous-vehicles-traffic-cones-san-francisco-cruise-waymo-cpuc.html

Hawkins, A. J. (2023, January 27). *Mercedes-Benz is the first to bring level 3 automated driving to the U.S.* The Verge. https://www.theverge.com/2023/1/27/23572942/mercedes-drive-pilot-level-3-approved-nevada

Herron, D. (2024, December 18). *More self-driving robotaxis could come to Austin in 2025*. KVUE. https://www.kvue.com/article/news/local/austin-texas-more-self-driving-cars-2025/269-3aed92a3-8066-4dc4-88d1-c9b9a7bdc89a

Highly Automated Vehicles, Powers of Department, 75 Pa. Cons. Stat. § 8505(4) (2023). https://law.justia.com/codes/pennsylvania/title-75/chapter-85/section-8505/

Hope, G. (2023, September 5). *Volvo removes safety driver from autonomous mining trucks*. IOT World Today. https://www.iotworldtoday.com/transportation-logistics/volvo-removes-safety-driver-from-autonomous-mining-trucks

Hyatt, K. (2021, January 27). *Elon Musk says Tesla's full self-driving tech will have level 5 autonomy by the end of 2021*. CNET. https://www.cnet.com/roadshow/news/elon-musk-full-self-driving-tesla-earnings-call/

Ingram, D. (2023, October 3). *Chinese tech startups are testing self-driving cars on California roads*. NBC News. https://www.nbcnews.com/tech/tech-news/chinese-self-driving-car-testing-china-california-pony-ai-waymo-cruise-rcna102787

International Association of Fire Chiefs. (2021, October 15). *Fire department response to electric vehicle fires* (IAFC bulletin). https://www.iafc.org/docs/default-source/1haz/respondingtoelectricalvehiclefires.pdf?sfvrsn=9421650c_6

International Association of Police Chiefs. (2019). *Vehicular pursuits*. https://www.theiacp.org/sites/default/files/2019-12/Vehicular%20Pursuits%20-%202019.pdf

International Organization for Standardization. (2022). *Road vehicles—Information for first and second responders* (ISO Standard No. 17840).

Irwin, K. (2024, January 29). Tesla autopilot recall fix reportedly flops as drivers claim it's a safety hazard. *PCMag.com*. https://www.pcmag.com/news/tesla-autopilot-recall-fix-reportedly-flops-as-drivers-claim-its-a-safety

Isidore, C. (2024, December 10). *GM is pulling the plug on its robotaxi efforts*. CNN. https://www.cnn.com/2024/12/10/business/gm-general-motors-robotaxi/index.html

Javaid, M. (2024, February 12). San Francisco crowd sets self-driving car on fire. *The Washington Post*. https://www.washingtonpost.com/technology/2024/02/12/waymo-set-on-fire-san-francisco/

Jones Day. (2021). *Autonomous vehicles: Legal and regulatory developments in the United States*. https://www.jonesday.com/en/insights/2021/05/autonomous-vehicles-legal-and-regulatory-developments-in-the-us

Kelly, G. (2024, January 7). Robotaxi company Cruise offers $75,000 to settle San Francisco crash probe. *The San Francisco Standard*. https://sfstandard.com/2024/01/07/robotaxi-company-cruise-offers-75000-to-settle-san-francisco-crash-probe/

Kim, A. (2022). *FHWA traffic incident management webinar: Overview of law enforcement and first responder interaction plans for automated driving systems (ADS)* [PowerPoint slides]. Volpe National Transportation Systems Center. https://transops.s3.amazonaws.com/uploaded_files/FHWA-NOCoE%20Webinar-Talking%20TIM-Jan%202022-Volpe%20Slides.pdf

Kodiak Robotics, Inc. (n.d.). *Law enforcement and first responder interaction plan*.

Korosec, K. (2024, January 31). *Autonomous vehicle company Motional is about to lose a key backer*. TechCrunch. https://techcrunch.com/2024/01/31/autonomous-vehicle-company-motional-is-about-to-lose-a-key-backer/?guccounter=1

Krisher, T. (2023, December 19). *Tesla's recall of 2 million vehicles to fix its autopilot system uses technology that may not work*. Associated Press. https://apnews.com/article/tesla-autopilot-recall-fix-software-9a9bd6fea76a564f417788f1430d5166

KVUE Staff. (2024, December 19). *More self-driving cars expected to roll out in Austin for 2025.* Culturemap Austin. https://austin.culturemap.com/news/city-life/self-driving-cars-waymo-development/

Law enforcement interaction protocol, N.M. Admin. Code § 18.24.1.10 (2022). https://regulations.justia.com/states/new-mexico/title-18/chapter-24/part-1/section-18-24-1-10/

Lee, S. H., Block, A., Patil, V., Pandya, A., Schmitt, P., Britten, N., and Jung, M. F. (2023). Safe to approach: Insights on autonomous vehicle interaction protocols with first responders. *Companion Proceedings of the 2023 ACM/IEEE International Conference on Human-Robot Interaction*,399–402.

Legal Authorities for Police Officers to Direct Traffic, 37 Tex. Admin. Code § 3.41 (1976).

Liu, J., Xu, N., Shi, Y., Rahman, M., Barnett, T., and Jones, S. (2023). Do first responders trust connected and automated vehicles (CAVs)? A national survey. *Transport Policy, 140*(1), 85–99.

Manufacturer's permit to test autonomous vehicles that do not require a driver, 13 Cal. Code Regs. § 227.38(e) (2024). https://regulations.justia.com/states/california/title-13/division-1/chapter-1/article-3-7/section-227-38/

Massachusetts Department of Transportation. (2023). *Application to test automated driving systems on public ways in Massachusetts.* https://www.mass.gov/doc/application-to-test-automated-driving-systems-on-public-ways-in-massachusetts/download

Maxfield, M. (2008). *Problem-oriented guides for police—No. 53: Abandoned vehicles*. United States Department of Justice, Community Oriented Policing Services.

Maximum Driving Time for Property-Carrying Vehicles, 49 CFR § 395.3 (2020).

McKinsey and Company. (2024). *Autonomous vehicles moving forward: Perspectives from industry leaders*. https://www.mckinsey.com/features/mckinsey-center-for-future-mobility/our-insights/autonomous-vehicles-moving-forward-perspectives-from-industry-leaders

Mendoza, R. (2023). Autonomous vehicles (AVs) on city roadways [Memorandum]. https://services.austintexas.gov/edims/pio/document.cfm?id=414814

Mercedes-Benz. (2021). *Drive Pilot first responder interaction plan*.

Mercedes-Benz. (2023). *Automated driving revolution: Mercedes-Benz announces U.S. availability of Drive Pilot—The world's first certified SAE level 3 system for the U.S. market*. https://media.mbusa.com/releases/automated-driving-revolution-mercedes-benz-announces-us-availability-of-drive-pilot-the-worlds-first-certified-sae-level-3-system-for-the-us-market

Mercedes-Benz. (n.d.). *Drive Pilot owner's manual*. https://www.mbusa.com/en/owners/manuals/drive-pilot

Michigan Firefighter Training Council. (2001). *State of Michigan basic vehicle extrication student guide*. https://www.michigan.gov/-/media/Project/Websites/lara/bfs/Folder2/Extrication_-_Student_Guide_1_Mar_01.pdf?rev=8fbe2bcaf0624f818a33a9a729748651

Miller, V., and Hayward, K. J. (2018). 'I did my bit': Terrorism, trade, and the vehicle ramming attack as an imitative event. *The British Journal of Criminology, 569*(1), 1–23.

Moody's. (2024). *Risky business? The seven indicators of shell company risk*. https://www.moodys.com/web/en/us/about/insights/data-stories/kyc-innovation-shell-company-indicator.html

Mrozik, W., Rajaeifar, M. A., Heidrich, O., and Christensen, P. (2021). Environmental impacts, pollution sources and pathways of spent lithium-ion batteries. *Energy & Environmental Science, 14*(12), 6099–6121.

National Highway Traffic Safety Administration. (2014). *Interim guidance for electric and hybrid-electric vehicles equipped with high-voltage batteries: Law enforcement/emergency medical services/fire department*. United States Department of Transportation.

National Highway Traffic Safety Administration. (2020). *Cybersecurity best practices for the safety of modern vehicles* [Draft 2020 update]. United States Department of Transportation. https://www.nhtsa.gov/sites/nhtsa.gov/files/documents/vehicle_cybersecurity_best_practices_01072021.pdf

National Highway Traffic Safety Administration. (2023). *Part 573 safety recall report 23V-838*. United States Department of Transportation. https://static.nhtsa.gov/odi/rcl/2023/RCLRPT-23V838-8276.PDF

National Highway Traffic Safety Administration. (2024a, January 6). *2021 Tesla Model Y 5-seat Complaints* [NHTSA ID No. 11564396]. United States Department of Transportation.https://www.nhtsa.gov/vehicle/2021/TESLA/MODEL%252520Y%252520%2525205-SEAT/SUV/RWD#complaints413

National Highway Traffic Safety Administration. (2024b). *Standing general order on crash reporting for incidents involving ADS and level 2 ADAS*. United States Department of Transportation. https://www.nhtsa.gov/laws-regulations/standing-general-order-crash-reporting

National Highway Traffic Safety Administration. (n.d.). *Automated vehicles for safety.* United States Department of Transportation. https://www.nhtsa.gov/vehicle-safety/automated-vehicles-safety

New York State Police. (2019). *Autonomous vehicle technology demonstration/testing addendum*. https://dmv.ny.gov/forms/av2.pdf

Norton, P. D. (2011). *Fighting traffic: The dawn of the motor age in the American city*. The MIT Press.

Nuro. (2024). *Law enforcement interaction plan*.

Obedience Required to Police Officers, School Crossing Guards, and Escort Flaggers, 7 Tex. Transp. Code § 542.501 (2019).

Operation of driverless-capable vehicle: Conditions, Kan. Stat. § 8-2902(b) (2023). https://law.justia.com/codes/kansas/chapter-8/article-29/section-8-2902/

Operation of fully autonomous vehicles without a human driver, W. Va. Code § 17H-1-5 (2023). https://law.justia.com/codes/west-virginia/chapter-17h/article-1/section-17h-1-5/

Operator of Automated Vehicle, 7 Tex. Transp. Code. § 545.453 (2017).

Pańcikiewicz, K., Maślak, M., Pazdanowski, M., Stankiewicz, M., and Zajdel, P. (2023). Changes in the microstructure of selected structural alloy steel grades identified after their simulated exposure to fire temperature. *Case Studies in Construction Materials, 18*.

Paul, K. (2023, July 16). The rebel group stopping self-driving cars in their tracks—One cone at a time. *The Guardian*. https://www.theguardian.com/us-news/2023/jul/26/san-francisco-stop-self-driving-cars-traffic-cone-safe-street-rebel

Pipeline and Hazardous Materials Safety Administration. (2024). *Emergency Response Guidebook*. United States Department of Transportation. https://www.phmsa.dot.gov/training/hazmat/erg/emergency-response-guidebook-erg

Police Executive Research Forum. (2023). *Vehicular pursuits: A guide for law enforcement executives on managing the associated risks*. Department of Justice, Office of Community Oriented Policing Services.

Powers of Local Authorities. 7 Tex. Transp. Code § 542.202 (2003).

Raguso, E. (2021, May 25). *Plans firm up to remove police from traffic stops, but it's a long road ahead.* Berkeleyside. https://www.berkeleyside.org/2021/05/25/berkeley-department-of-transportation-civilian-traffic-enforcement

Requirement to Take Action. 37 Texas Admin. Code § 3.21 (1976).

Rielage, R. (2024, June 17). *Developing SOPs for electric vehicle incidents*. FireRescue1. https://www.firerescue1.com/electric-vehicles/articles/developing-sops-for-electric-vehicles-incidents-CbHhgn5759QnLDv3/

Rogers, B. (2023, August 31). Venti aims to bring autonomous vehicles to ports, factories, and airports. *Forbes*. https://www.forbes.com/sites/brucerogers/2023/08/31/venti-aims-to-bring-autonomous-vehicles-to-ports-factories-and-airports/?sh=63be43d0466e

SAE International. (2021). *Taxonomy and definitions for terms related to driving automation systems for on-road motor vehicles* (SAE International Standard No. J3016_202104). https://www.sae.org/standards/content/j3016_202104/

Sawers, P. (2018, November 20). *Volvo's first commercial self-driving trucks will be used in mining*. VentureBeat. https://venturebeat.com/business/volvos-first-commercial-self-driving-trucks-will-be-used-in-mining/

Schickler, J. (2024, February 15). *Run by toddlers, based in ancient Egypt: welcome to the bizarre world of shell companies*. Euro News. https://www.euronews.com/business/2024/02/15/run-by-toddlers-based-in-ancient-egypt-welcome-to-the-bizarre-world-of-shell-companies

Securing the information and communications technology and services supply chain: Connected vehicles, 49 FR 79088 (to be codified as 15 CFR 791) (proposed 2024, September 26). https://www.federalregister.gov/documents/2024/09/26/2024-21903/securing-the-information-and-communications-technology-and-services-supply-chain-connected-vehicles

Seo, S. A. (2019). *Policing the open road: How cars transformed American freedom*. Harvard University Press.

Shirley, T. (2024, February 21). *White House works to protect nation's ports*. KXAN Austin. https://www.kxan.com/news/washington-dc/white-house-works-to-protect-nations-ports/amp/

Slovick, M. (2023, December 5). *BMW to offer level 3 "hands-off, eyes-off" technology in 2024*. Electronic Design. https://www.electronicdesign.com/markets/automotive/article/21277683/electronic-design-bmw-to-offer-level-3-hands-off-eyes-off-technology-in-2024

Son, P., Long, C. S., Karanth, A., Matkowski, L., Szymkowski, T., Brydia, R., Fowler, M., Storey, B., and Noyes, P. (2024). Integrating Traffic Incident Management and Connected, Automated Technology Communities: A Guide for Communicating and Connecting (NCHRP Research Report 1104). National Cooperative Highway Research Program. https://nap.nationalacademies.org/read/27654/chapter/1

State of New York Senate-Assembly, S. 2005-C, A. 3005-C (2017, January 23). https://nyassembly.gov/2017budget/budget_bills/A3005C.pdf

Stoeltje, G., Antonio, A. J., and Goodin, G. (2017). *How does Texas law change the legal landscape for automated vehicles?* [Policy brief]. https://static.tti.tamu.edu/tti.tamu.edu/documents/PRC-2017-5.pdf

Stopping, Standing, or Parking Prohibited in Certain Places, 7 Tex. Transp. Code § 545.302 (1999).

Submission of law enforcement interaction plan to Department of Public Safety prior to operation required; contents, MS Code § 63-35-7 (2023). https://law.justia.com/codes/mississippi/title-63/chapter-35/section-63-35-7/

Swiatecki, C. (2023, October 30). *Mobility committee laments state law curtailing city's power over driverless car companies.* Austin Monitor. https://www.austinmonitor.com/stories/2023/10/mobility-committee-laments-state-law-curtailing-citys-power-over-driverless-car-companies/

Tabeta, S. (2021, March 19). *China bans use of Tesla by military, citing security concerns*. Nikkie Asia. https://asia.nikkei.com/Politics/International-relations/US-China-tensions/China-bans-use-of-Tesla-by-military-citing-security-concerns

Tesla. (2024). *Tesla model S owner's manual: Limitations and warnings.* https://www.tesla.com/ownersmanual/models/en_us/GUID-E5FF5E84-6AAC-43E6-B7ED-EC1E9AEB17B7.html

Tesla. (n.d.). *Autopilot and full self-driving capability*. https://www.tesla.com/support/autopilot

Texas A&M Engineering Extension Service. (2023). *Report from the TEEX Electric Vehicle/Energy Storage Systems Summit*.

Texas A&M Engineering Extension Service. (2024). *Current practices: Electric vehicle and energy storage systems*. https://teex.org/ev-ess-current-practices/

Texas Commission on Law Enforcement. (2023). Traffic code/crash investigation/TIM. In *Basic peace officer course licensing requirement*. https://www.tcole.texas.gov/course-curriculum-materials-and-updates

Texas Connected and Automated Vehicle Task Force. (2024). *Texas CAV task force*. https://www.txdot.gov/cavtaskforce/task-force.html

Texas Department of Information Resources. (2023). *Model security plan for prohibited technologies* [Version 1.0]. https://dir.texas.gov/sites/default/files/2023-02/Statewide_Plan_for_Preventing_Use_of_Prohibited_Technology_in_State_Agencies_%28Final_OOG%29.pdf

Texas Department of Public Safety, Safety Regulatory Services Division. (2022). *Vehicle inspections*. https://www.dps.texas.gov/internetforms/getForm.ashx?id=VI-82.pdf

Texas Department of Public Safety. (2023). Chapter 6: Commercial motor vehicle. In *Vehicle inspection operations and training manual for official vehicle inspection stations (vehicle safety inspection)*.

Texas Department of Transportation, Traffic Safety Division (2023), *Texas peace officer's crash report*. https://eforms-xapi-prod.us-e1.cloudhub.io/api/eforms?formName=/CR-3_2023.pdf&appID=/TRF&status=/reportError.jsp&configFile=WFServletConfig.xml

Texas Department of Transportation, Traffic Safety Division (2023), *Texas peace officer's crash report code sheet*. https://ftp.txdot.gov/pub/txdot-info/trf/crash_notifications/2023/code-sheet.pdf

Texas Department of Transportation, Traffic Safety Division. (2024). *Instructions to police for reporting crashes* (Version 28.0). https://www.txdot.gov/content/dam/docs/trf/crash-records-forms/cr100-v28.0.pdf

Texas Department of Transportation. (2014). Part 7: Traffic control for school areas. In *Texas manual on uniform traffic control devices* (2nd revised ed.).

Texas Department of Transportation. (n.d.). *San Antonio highway emergency response operator (HERO) program*. https://www.txdot.gov/about/programs/highway-roadside-assistance/san-antonio-hero.html

The White House. (2024a). Biden-Harris administration announces initiative to bolster cybersecurity of U.S. ports [Fact sheet]. https://www.whitehouse.gov/briefing-room/statements-releases/2024/02/21/fact-sheet-biden-harris-administration-announces-initiative-to-bolster-cybersecurity-of-u-s-ports/

The White House. (2024b). President Biden issues executive order to protect Americans' sensitive personal data [Fact sheet]. https://www.whitehouse.gov/briefing-room/statements-releases/2024/02/28/fact-sheet-president-biden-issues-sweeping-executive-order-to-protect-americans-sensitive-personal-data/

Timsit, A. (2021, November 22). SUV crash into Wisconsin Christmas parade is latest among deadly car-ramming incidents. *The Washington Post*. https://www.washingtonpost.com/nation/2021/11/22/vehicle-ramming-attacks/

Torc Robotics. (2023). *First responder guide*.

Transportation Safety Advancement Group. (2020). *CV/AV needs specific to emergency response* [White paper]. https://www.ite.org/pub/?id=2401AD63-9D58-2A4F-AB3E-3D4FA7F9223B

Trefz, B., Bierling, D., and Williams, F. A. (2019). *Local emergency planning committee (LEPC) combined guidebook*. Texas Division of Emergency Management.

Tsur, A. M., Nadler, R., Sorkin, A., Lipkin, I., Gelikas, S., Chen, J., and Benov, A. (2022). Patterns in vehicle-ramming attacks. *Israel Medical Association Journal*, *24*(9), 579–583.

TuSimple. (2021). *TuSimple opens new autonomous trucking facility in Texas to meet rising demand*. https://ir.tusimple.com/press-releases/news-details/2021/TuSimple-Opens-New-Autonomous-Trucking-Facility-in-Texas-to-Meet-Rising-Demand-06-16-2021/default.aspx

Use of fully autonomous vehicle permissible—Conditions— Law enforcement interaction plan, Ky. Rev. Stat. § 186.763(3) (2024). https://apps.legislature.ky.gov/law/statutes//statute.aspx?id=55488

Viswanatha, A., Lubold, G., and O'Keeffe, K. (2023, March 5). Pentagon sees giant cargo cranes as possible Chinese spying tools. *The Wall Street Journal*. https://www.wsj.com/articles/pentagon-sees-giant-cargo-cranes-as-possible-chinese-spying-tools-887c4ade

Volenik, A. (2024, September 17). *Tesla switches to "full self-driving supervised" for new cars – and the conspiracy theories are already flying*. Yahoo Finance. https://finance.yahoo.com/news/tesla-switches-full-self-driving-133154276.html

Volkswagen Autonomous Driving Mobility and Transport, LLC. (2024). *Emergency response and law enforcement interaction guide*. Volkswagen Group of America, Inc.

Waymo, LLC. (2024). *Waymo autonomously driven Jaguar I-Pace: Emergency response guide and law enforcement interaction protocol*.

Wessling, B. (2023, September 22). *Waabi partners with Uber Freight to deploy autonomous trucks at scale*. The Robot Report. https://www.therobotreport.com/waabi-partners-with-uber-freight-to-deploy-autonomous-trucks-at-scale/

White, W. 2023. Traffic enforcement and management [Presentation]. Austin Police Department, Highway Enforcement Command. https://services.austintexas.gov/edims/document.cfm?id=405874

Wilson, C. (2023, May 22). *Who's testing the latest autonomous vehicle tech? The Port Authority. Here's how.* North Jersey. https://www.northjersey.com/story/news/transportation/2023/05/22/port-authority-ny-nj-testing-autonomous-street-sweepers/70170495007/

Wolverton, T. (2024, June 20). CPUC judge approves $112,500 settlement with Cruise over SF accident. *The San Francisco Examiner*. https://www.sfexaminer.com/news/technology/cpuc-judge-approves-112500-settlement-with-cruise/article_5c41f020-2f68-11ef-9077-b74a63491d31.html

Zhou, T., Sun, J., Li, J., Wei, S., Chen, J., Dang, S., Tang, N., Zhu, Y., Lian, Y., Guo, J., Zhang, F., Xie, H., Li, H., Qiu, X., and Chen, L. (2023). Toxicity, emissions, and structural damage from lithium-ion battery thermal runaway. *Batteries*, *9*(6), 308.

Zimmerman, S. (2021, October 7). *Union Pacific to test robotic cranes at Chicago intermodal hub*. Supply Chain Dive. https://www.supplychaindive.com/news/union-pacific-autonomous-cranes-pilot-joliet-chicago/607811/

Zoox. (2024a). *Emergency response guide information for first and second responders for autonomous Zoox vehicles*.

Zoox. (2024b). *Law enforcement interaction plan: California*.

APPENDIX A. STATE AND FOREIGN REGULATORY STANDARDS FOR FRIPS/LEIPS

ARIZONA

Department of Public Safety; Law Enforcement Protocols; Law Enforcement Interaction Plan, Ariz. Rev. Stat. § 28-9703(III) (2021)

> The department of public safety, in coordination with other relevant law enforcement agencies, shall maintain a law enforcement protocol for fully autonomous vehicles. The protocol shall include guidelines for persons who operate fully autonomous vehicles to provide information to law enforcement agencies and other first responders on how to interact with fully autonomous vehicles in emergency and traffic enforcement situations, including how to provide contact information for insurance and citation purposes and any other information needed to ensure the safe operation of fully autonomous vehicles in this state. The department of public safety may issue a revised law enforcement protocol after providing advance notice to and an opportunity for comment from persons that have submitted statements pursuant to section 28-9702, subsection C, paragraph 2.

Law Enforcement Protocol-Requirements of Fully Autonomous Vehicle Companies, Ariz. Rev. Stat. § 28-9703(III) (2021)

> A. The person operating a fully autonomous vehicle shall provide the Arizona Department of Public Safety and the Arizona Department of Transportation a copy of a law enforcement interaction protocol that will instruct first responders in the vicinity of the operational design domain how to interact with the fully autonomous vehicle in emergency and traffic enforcement situations. This interaction policy shall be on file with Operational Communications and available through the Arizona Department of Transportation Motor Vehicle Division (MVD).
> B. The law enforcement interaction protocol shall include:
> 1. How to communicate with a fleet support specialist who is available during the times the vehicle is in operation;
> 2. How to safely remove the vehicle from the roadway;
> 3. How to recognize whether the vehicle is in autonomous mode and steps to safely tow the vehicle;
> 4. A description of the cities where the vehicle will be in operation;
> 5. Any additional information the manufacturer deems necessary regarding hazardous conditions or public safety risks associated with the operation of the autonomous vehicle.

CALIFORNIA

Manufacturer's Permit to Test Autonomous Vehicles that Do Not Require a Driver, 13 Cal. Code Regs. § 227.38(e) (2024)

> (e) The manufacturer provides a copy of a law enforcement interaction plan, which includes information that the manufacturer will make available to the law enforcement agencies and other first responders in the vicinity of the operational design domains of the autonomous vehicles that will instruct those agencies on how to interact with the vehicle in emergency and traffic enforcement situations. For the purposes of this section "first responder" means law enforcement, fire department, and emergency medical personnel.

(1) The law enforcement interaction plan shall include, but not be limited to the following:
(A) How to communicate with a remote operator of the vehicle who is available at all times that the vehicle is in operation, including providing a contact telephone number for the manufacturer;
(B) Where, in the vehicle, to obtain owner information, vehicle registration, and proof of insurance in the event of a collision or traffic violation involving the vehicle;
(C) How to safely remove the vehicle from the roadway;
(D) How to recognize whether the vehicle is in autonomous mode, and if possible, how to safely disengage the autonomous mode;
(E) How to detect and ensure that the autonomous mode has actually been deactivated,
(F) How to safely interact with electric and hybrid vehicles, when applicable.
(G) A description of the operational design domain of the vehicle.
(H) Any additional information the manufacturer deems necessary regarding hazardous conditions or public safety risks associated with the operation of the autonomous vehicle.
(2) The law enforcement interaction plan shall be reviewed on a regular basis by the manufacturer and updated as changes are needed, but no less than an annual basis.
(3) Within 10 days of approval of the testing application, the manufacturer shall submit the law enforcement interaction plan to the California Highway Patrol by E-mail to, AVUnit@chp.ca.gov.
(4) Manufacturers shall provide other law enforcement agencies and first responders in the vicinity of the operational design domain where testing of driverless autonomous vehicles is being conducted and the department with the internet web site address where the law enforcement interaction plan may be accessed.

EU

Commission Implementing Regulation (EU) 2022/1426 of 5 August 2022 Laying Down Rules for the Application of Regulation (EU) 2019/2144 of the European Parliament and of the Council as Regards Uniform Procedures and Technical Specifications for the Type-Approval of the Automated Driving System (ADS) of Fully Automated Vehicles (2022)

11.1. The manufacturer shall draw up an operating manual. The purpose of the operating manual is to ensure the safe operation of the fully automated vehicle by means of detailed instructions to the owner, vehicle occupants, transport service operator, on-board operator, remote intervention operator and any relevant national authorities. When the fully automated vehicle includes the possibility of manual driving for the purpose of maintenance or to take over after a minimal risk manoeuvre, it shall also be covered by the operating manual.
11.2. The operating manual shall include the functional description of the ADS.
11.3. The operating manual shall include the technical measures (e.g. checks and maintenance works of vehicle and off-board infrastructure, transport and physical infrastructure requirements such as localization marker and perception sensors), operational restrictions (e.g. speed limit, dedicated lane, physical separation with oncoming traffic), environmental conditions (e.g. no snow) and operational measures (e.g. on-board operator or remote intervention operator needed) necessary to ensure safety during the fully automated vehicle operation.

> 11.4. The operating manual shall describe the instructions for vehicle occupants, transport service operator, on board operator (where applicable) and remote intervention operator (where applicable) and public authorities in case of failures and ADS request.
> 11.5. The operating manual shall set out rules to ensure proper performance of maintenance, overall tests and further examinations.
> 11.6. The Operating Manual shall be submitted to the type-approval authority together with the application for a type-approval and shall be annexed to the type-approval certificate.
> 11.7. The Operating Manual shall be made available to the owner and, where applicable, to the transport service operator, on-board operator (where applicable), remote intervention operator (where applicable) and any relevant national authorities.

KANSAS

Operation of Driverless-Capable Vehicle; Conditions, Kan. Stat. § 8-2902(b) (2023)

> (b) Prior to operating a driverless-capable vehicle on the public roads of this state without a conventional human driver, the owner of such driverless-capable vehicle shall submit a law enforcement interaction plan to the Kansas highway patrol that describes:
> (1) How to communicate with a fleet support specialist who is available during the times the vehicle is in operation, and on which side of the vehicle contact information of the fleet support specialist is readily visible;
> (2) information regarding safety considerations for first responders in dealing with a driverless-capable vehicle as the result of collision or fire;
> (3) how to recognize whether the driverless-capable vehicle is in autonomous mode; and
> (4) any additional information the manufacturer or owner deems necessary regarding hazardous conditions or public safety risks associated with the operation of the driverless-capable vehicle.

KENTUCKY

Use of Fully Autonomous Vehicle Permissible; Conditions; Law Enforcement Interaction Plan, Ky. Rev. Stat. § 186.763(3) (2024)

> (3) Prior to operating a fully autonomous vehicle on the highways of this state without a human driver, a person shall submit a law enforcement interaction plan to the Transportation Cabinet and the Department of Kentucky State Police that describes:
> (a) How to communicate with a fleet support specialist who is available during the times the vehicle is in operation;
> (b) How to safely remove the fully autonomous vehicle from the roadway and steps to safely tow the vehicle;
> (c) How to recognize whether the automated driving system is engaged on the fully autonomous vehicle; and
> (d) Any additional information the manufacturer or owner deems necessary regarding hazardous conditions or public safety risks associated with the operation of the fully autonomous vehicle.

MAINE

Autonomous Vehicle Pilot Program Rules-Application Process, 17 Me. Code Rules § 229-800-3(5) (2018)

(5). Safety and Risk Mitigation:
a. A detailed account of the safety record, including any crash history and subsequent fixes, of the ADS-Equipped Vehicle intended to be used in Pilot Project and associated ADS prior to commencement of the Pilot Project in Maine.
b. A description of public safety precautions that will be taken during the Pilot Project to ensure the safety of the public.
c. A description of any previous Pilot Projects or live implementation of the Pilot Project vehicle and associated ADS, noting any difficulties identified or encountered in any prior activities.
d. A detailed description of a first responder interaction plan addressing how state, county or municipal law enforcement officials and emergency response personnel will be informed and educated about the Pilot Project, including instructions about how to proceed if unsafe or obstructive conditions occur. A description on how first responders can disable the vehicle in an emergency must be included.
e. In lieu of the requirement of sections 5(a) through 5(d), above, a Tester may submit with the application a copy of its Voluntary Safety Self-Assessment as submitted to the National Highway Traffic Safety Administration.

MASSACHUSETTS

Application to Test Automated Driving Systems on Public Ways in Massachusetts-Detail #4: First Responders Interaction Plan (2019)

A First Responders Interaction Plan will be made available to the law enforcement agencies and other first responders (including fire departments and emergency medical personnel) which operate in the permitted testing areas in the Testing Locations Menu. The First Responder Interaction Plan should instruct those agencies on how to interact with the vehicle in emergency and traffic enforcement situations, including but not limited to:
1) Applicant’s primary emergency contact information (including phone numbers) and secondary contact information if applicable
2) Identifying the vehicle (make, model, color(s), and appearance, identifying decals or indicators)
3) How to:
a) Recognize whether the ADS is engaged, safely disengage the ADS, and detect and ensure that the ADS has actually been deactivated
b) Immobilize or otherwise disable the vehicle to prevent movement or subsequent ignition of the vehicle
c) Safely interact with electric, hybrid, or alternative fuel vehicles, when applicable
d) Safely remove the vehicle from the roadway
4) Any additional information as deemed necessary regarding hazardous conditions or public safety risks associated with the operation of the test vehicle
The First Responder Interaction Plan shall be reviewed on a regular basis by the Applicant and revised and resubmitted at least annually, or as changes are needed.

The First Responder Interaction Plan will be made available by MassDOT to law enforcement agencies and other first responders, including fire department and emergency medical personnel.
A copy of the First Responder Interaction Plan must be carried in the approved test vehicle(s) at all times in the glove box or another conspicuous location.

MISSISSIPPI

Submission of Law Enforcement Interaction Plan to Department of Public Safety Prior to Operation Required-Contents, MS Code § 63-35-7 (2023)

(1) Prior to operating a fully autonomous vehicle on the public roads of this state without a human driver, a person shall submit a law enforcement interaction plan to the Department of Public Safety that describes:
(a) How to communicate with a fleet support specialist who is available during the times the vehicle is in operation;
(b) How to safely remove the fully autonomous vehicle from the roadway and steps to safely tow the vehicle;
(c) How to recognize whether the fully autonomous vehicle is in autonomous mode;
(d) Any additional information the manufacturer or owner deems necessary regarding hazardous conditions or public safety risks associated with the operation of the fully autonomous vehicle; and
(e) Other elements determined to be necessary by the Department of Public Safety and made publicly available on the Department of Public Safety's website by July 1, 2023.
(2) If a person fails to submit a law enforcement interaction plan prescribed by subsection (1) of this section, the Department of Public Safety may immediately issue a cease-and-desist letter prohibiting the operation of the person's fully autonomous vehicle on public roads of this state until the person submits the law enforcement interaction plan.
(3) This section shall stand repealed on July 1, 2026.

NEW HAMPSHIRE

Automated Vehicle Testing Pilot Program and Deployment Requirements, NH Rev. Stat. § 242:1 (2022)

(2) A copy of the testing entity's emergency response guide, including information on how to instruct law enforcement, fire, and emergency medical personnel on safe interaction with the vehicle in emergency and traffic enforcement situations.
(b) The department shall distribute any emergency response guide received pursuant to subparagraph (a)(2) to all law enforcement, fire, and emergency response personnel with jurisdiction over the geographic area in the vicinity of the test entity's stated testing area.

NEW MEXICO

Law Enforcement Interaction Protocol, N.M. Admin. Code § 18.24.1.10 (2022)

A. Prior to testing or operating a fully autonomous motor vehicle on New Mexico public roadways without a driver, the autonomous motor vehicle owner shall provide the New Mexico department of public safety and the New Mexico department of transportation a copy of a law enforcement interaction protocol that will instruct first responders in the vicinity of the operational design domain how to interact with the fully autonomous motor vehicle in emergency and traffic enforcement situations. This interaction protocol shall be on file with and available through the New Mexico state police.

B. The law enforcement interaction protocol shall include:

(1) How to communicate with a fleet support specialist who is available during the times the vehicle is in operation;

(2) How to safely remove the vehicle for the roadway;

(3) How to recognize whether the vehicle is in autonomous mode and steps to safely ow the vehicle;

(4) A description of the cities where the vehicle will be in operation;

(5) Any additional information the manufacturer or owner deems necessary regarding hazardous conditions or public safety risks associated with the operation of the autonomous motor vehicle.

C. For the purpose of this section, vehicle owner, registration, insurance, and contact information for the fully autonomous motor vehicle can be accessed through the New Mexico motor vehicle division system. Exchange of information, issuance of citations and repair orders with the fully autonomous motor vehicle owner shall be done through the electronic mail or physical mailing address provide, which can be accessed through the MVD system.

D. The law enforcement interaction protocol submitted by the vehicle owner will detail how compliance with the relevant sections of Part 3, Article 7 of Chapter 66, Motor Vehicles, will be ensured in the event of a collision.

(1) The fully autonomous motor vehicle's owner contact information, registration, and insurance information shall be noted on the New Mexico crash report.

(2) If injury to a person, damage to any vehicle, or damage to any other property occurred in the collision, the officer shall provide the fully autonomous motor vehicle owner's name, address, and insurance information to the drivers of all other vehicles, any injured parties involved in the collision, and owners of damaged property.

(3) If the fully autonomous motor vehicle violates a traffic law resulting in the collision, the officer may issue a citation to the registered owner of the vehicle.

NEW YORK

State of New York Senate-Assembly, S. 2005-C, A. 3005-C (2017)

Notwithstanding the provisions of section 1226 of the vehicle and traffic law, the New York state commissioner of motor vehicles may approve demonstrations and tests consisting of the operation of a motor vehicle equipped with autonomous vehicle technology while such motor vehicle is engaged in the use of such technology on public highways within this state for the purposes of demonstrating and assessing the current development of autonomous vehicle technology and to begin identifying potential impacts of such technology on safety, traffic control, traffic enforcement, emergency services, and such other areas as may be identified by such commissioner. Provided, however, that such demonstrations and tests shall only take place under the direct supervision of the New York state police, in a form and manner prescribed by the S. 7508--C 5 A. 9508—C superintendent of the New York state police. Additionally, a law enforcement interaction plan shall be included as part of the demonstration and test application that includes information for law enforcement and first responders regarding how to interact with such a vehicle in emergency and traffic enforcement situations.

Autonomous Vehicle Technology Demonstration/Testing Addendum (New York State Police, 2019)

(I) The applicant demonstration/test entity shall submit with this application a law enforcement interaction plan to inform law enforcement officers and first responders how to safely interact with the demonstration/test vehicle(s) in emergency and traffic enforcement situations. The plan shall include the intended operational design domains in which the entity intends to operate, as defined in the Federal Automated Vehicles Policy. The law enforcement interaction plan shall also include, but not be limited to, the following:
(1) Contact phone number for the representative responsible for demonstration/testing;
(2) How the vehicle will be identified/distinguished from other conventional vehicles;
(3) How to safely immobilize, disable and tow the vehicle if it is involved in a crash;
(4) How to recognize if the vehicle is being operated in an autonomous mode;
(5) How to disengage an autonomous mode in the event the operator is incapacitated; and
(6) Any other public safety concerns during operation or in the event of a collision, including any that may impact law enforcement, fire, EMS, or towing professions.
The Law Enforcement Interaction Plan shall be reviewed regularly by the demonstration/test entity and updated as needed to ensure safety, but at least annually.

OKLAHOMA

Conditions Required to Operate Fully Autonomous Vehicles Without a Human Driver, 47 OK Stat. § 1703 (2023)

(B) Prior to operating a fully autonomous vehicle on the public roads of this state without a human driver, a person shall submit to the Department of Public Safety a law enforcement interaction plan that contains, but shall not be limited to, information that describes:
1. How to communicate with a fleet support specialist who is available during the times the vehicle is in operation;
2. How to safely remove the fully autonomous vehicle from the roadway;
3. How to recognize whether the fully autonomous vehicle is in autonomous mode and steps to safely tow the vehicle; and
4. Any additional information the manufacturer or owner deems necessary regarding the hazardous conditions or public safety risks associated with the operation of the fully autonomous vehicle.
(C) The Department is authorized to promulgate rules regarding the contents of the law enforcement interaction plan described in subsection B of this section.

PENNSYLVANIA

Highly Automated Vehicles-Powers of Department, 75 Pa. Cons. Stat. § 8505(4) (2023)

(4) By order of the secretary, to collect the following information on a periodic basis:
(i) The process an emergency service responder should follow when a highly automated vehicle without a highly automated vehicle driver on board is disabled or involved in an accident.
(ii) If applicable, the highly automated vehicle driver information, including name, driver's license number, state or country issued, and a summary of any training received to operate the highly automated vehicle.
(iii) A description of whether the highly automated vehicle will transport passengers or goods. If the highly automated vehicle will not be transporting passengers or goods, a description of the service or function being provided by the highly automated vehicle.
(iv) Location information, including a list of municipalities where the highly automated vehicle is expected to operate.
Pennsylvania Automated Vehicle Testing Guidance, (9) Emergency Service Responder Plan [Required as Part of "Notice of Testing Application]
The Emergency Service Responder Plan should provide the necessary information for emergency service responders to safely address an incident involving the HAV. The Emergency Service Responder Plan shall include, at a minimum:
(a) How to identify the vehicle (e.g., branding);
(b) How to secure the vehicle (e.g., disengaging the ADS);
(c) Location of vehicle registration and proof of insurance;
(d) Extrication considerations;
(e) Towing considerations;
(f) Firefighting considerations
(g) Post-crash considerations; and
(h) Any additional considerations, if applicable.

WEST VIRGINIA

Operation of Fully Autonomous Vehicles Without a Human Driver, W. Va. Code § 17H-1-5 (2023)

(b) Prior to operating a fully autonomous vehicle on the public roads of this state without a human driver, a person as defined in this article shall submit a law enforcement interaction plan to the department that describes:
(1) How to communicate with a fleet support specialist who is available during the times the vehicle is in operation;
(2) How to safely remove the fully autonomous vehicle from the roadway and steps to safely tow the vehicle;
(3) How to recognize whether the fully autonomous vehicle is in autonomous mode; and
(4) Any additional information the manufacturer or owner deems necessary regarding hazardous conditions or public safety risks associated with the operation of the fully autonomous vehicle.

APPENDIX B. AV SUMMIT EXIT SURVEY RESULTS

Among the 50 AV Summit attendees, 17 attendees submitted feedback using the survey link provided at the conclusion of Day 2 and in subsequent messages thanking participants for their attendance. Appendix B summarizes the results of this feedback.

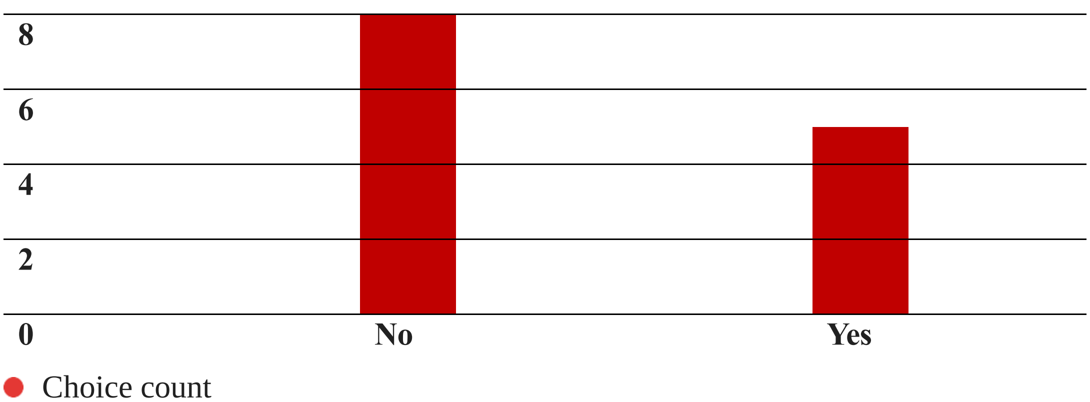
Q1 - Please rate the AV Summit overall.

	Min	Max	Mean	Responses
	4.00	5.00	4.82	17

Q2 - Please rate the summit in the following areas:

	Min	Max	Mean	Responses
Keynote speakers	4.00	5.00	4.87	15
Breakout sessions	4.00	5.00	4.67	15
Group discussion	4.00	5.00	4.80	15
Day 1 happy hour	2.00	5.00	3.92	13
Breakfasts/beverages	2.00	5.00	3.93	15
Lunches	3.00	5.00	4.33	15

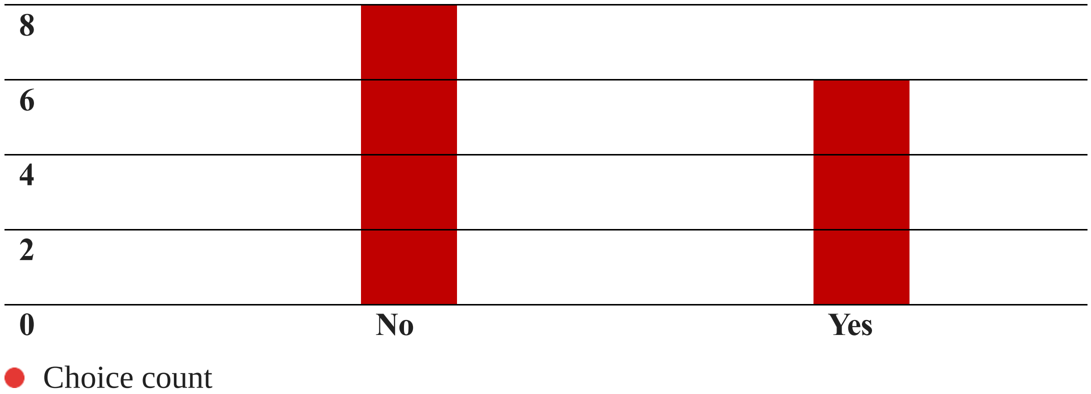
Q3 - Did you stay at the hotels with the dedicated room blocks?



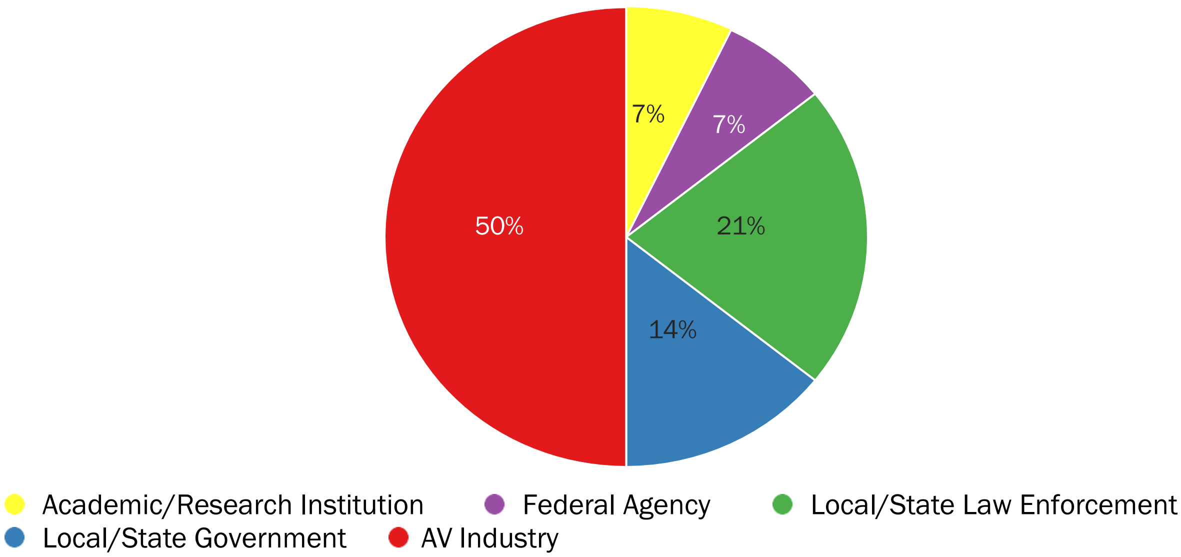
Q4 - Please rate your hotel (1=Disappointing and 5=Exceptional).

Field	Min	Max	Mean	Responses
Dedicated Hotel	1.00	5.00	4.33	9
Stayed Elsewhere	1.00	5.00	3.67	9

Q5 - Did you sign up to participate in the RELLIS Tour?



Q6 - What type of organization did you represent at the summit?



Q7 - Did the summit meet its goal of identifying first responder interaction scenarios and best practices for inclusion in the first responder guide? Why or Why not?

- Yes, this was very beneficial but needs to be held again next year.
- Yes, but I think it's important to keep in mind that it's almost impossible to capture all of the possible scenarios of AVs and need to ensure we are training toward the spirit safety that the AV industry is designing toward.
- The summit met its objectives by laying out specific levels and scenarios, assigning responsibilities, and discussing how state legislation can complement federal efforts. Aside from that, interactions with TIM/work zones, policy considerations, and standardization presented critical discussions for all stakeholders. Really took away groundwork for specifications and further development at the federal level, stressed the need for minimum standards at local/state level to steer federal change.
- This showed me the need to collaborate with other state regulators.
- Yes! Very informative and respectful discussion.
- In some instances, industry overtook conversations, and response scenarios became second priority.
- Yes.
- Yes.
- Yes.
- 👍.

Q8 - What are your organization's key takeaways from the summit?

- Six amazing pages of notes and new relationships made with industry partners, emergency responders, and researchers.
- Be more inclusive to other first responders, not just law enforcement.
- How I can best build Arizona's first responder group that is currently in its infancy.
- Awareness improved, informed on work needed.
- Many topics and inputs relevant to best practices.
- Texas leadership.
- We need a collaborative effort to ensure a consistent plan and a location for keeping the plans for accessibility.

Q9 - What parts of the summit could we improve on/change? Why?

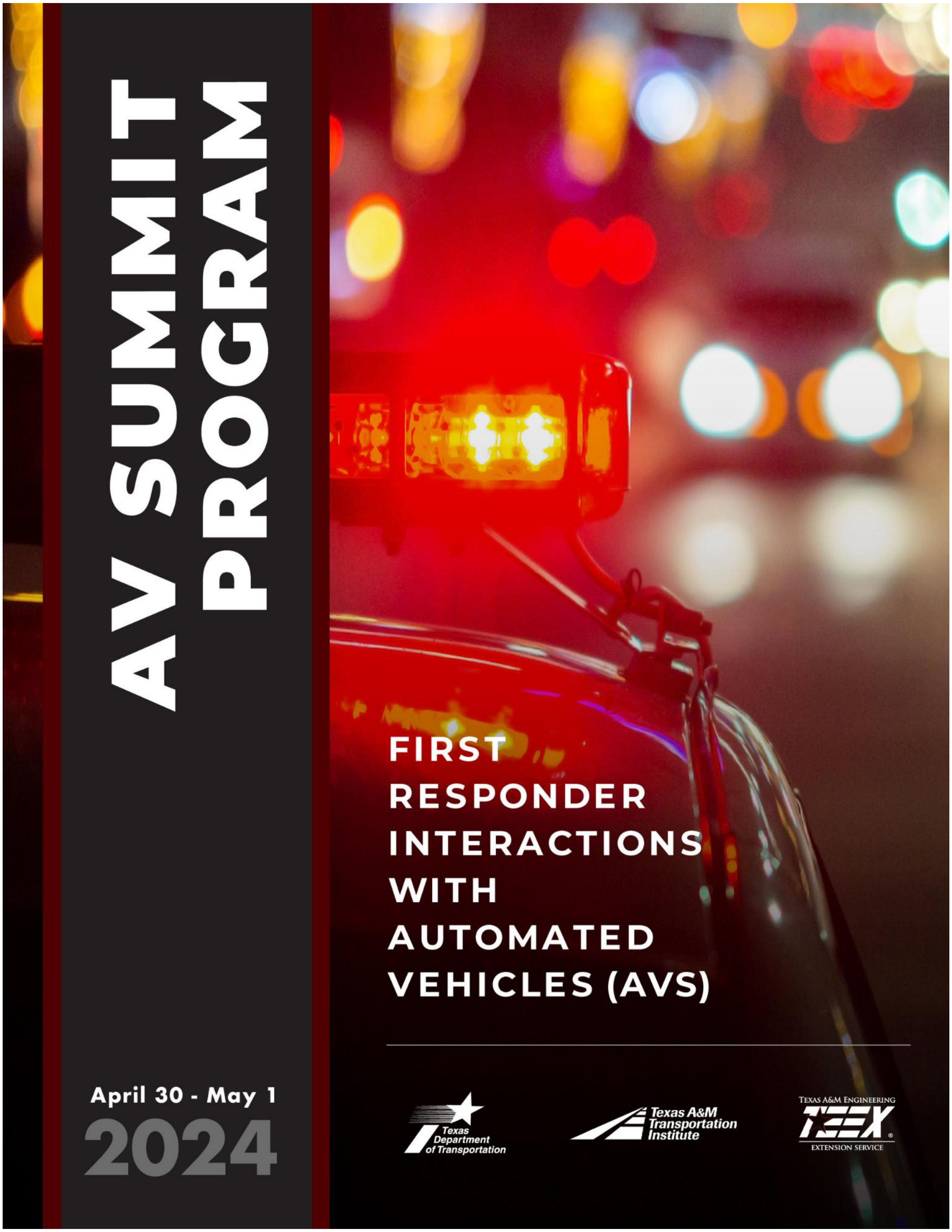
- A location closer to a major airport.
- N/A.
- Keep it going.

Q10 - Do you wish to commend any of the staff from TTI or TEEX? Who? Why?

Q11 - Any other comments/concerns?

- N/A.
- Please send a roster with just names and affiliations.
- Looking forward to continuing engaging on this effort with TEEX and TTI.
- Gig' em.

APPENDIX C. AV SUMMIT PROGRAM BOOKLET



About the Project

Texas Department of Transportation Research and Technology Implementation Division Project 0-7199: Identification of Needs and Strategies for First Responder Interactions with Automated Vehicles (AVs)

This project will identify needs and strategies for first responder interactions with automated vehicles (AVs) and provide guidance to them on how to safely interact with AVs in the course of their duties. This joint Texas A&M Transportation Institute (TTI) and Texas A&M Engineering Extension Service (TEEX) project includes a literature review, policy and regulatory evaluation, a first responder and AV industry summit, and the creation of a catalog of scenarios, best practices, and AV interaction plans based on first responder and industry input, leading to the development of a first responder AV interaction guide.

Bradley Trefz, TTI Principal Investigator
Raymond Ivie, TEEX Principal Investigator

A special thanks to the

TEXAS DEPARTMENT OF TRANSPORTATION PROJECT MONITORING COMMITTEE (PMC)

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TxDOT Project Manager

EZEKIAL Reyna
TxDOT PMC Chair

CRAIG BURGAN
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Dallas District

MIKE ARELLANO
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NICOLE TYLER
Transport Funding Specialist,
Traffic Safety Division

VANESSA LOPEZ
Utility Coordinator,
San Antonio District

SEAN MANNIX
Statewide Traffic Incident
Management Coordinator

AV SUMMIT

Tuesday April 30, 2024 Wednesday – May 1, 2024

Texas A&M Transportation Institute

Texas A&M Engineering Extension Service

DAY 1

8:00 A.M. – 8:20 A.M.

Arrival and Check-in

Continental Breakfast

8:20 A.M. – 9:15 A.M.

Introductory Remarks

9:15 A.M. – 11:45 A.M.

Keynote Speakers

11:45 A.M. – 12:00 P.M.

Group Assignments

LUNCH

Baked Potato Bar

1:00 P.M. – 4:00 P.M.

Arrival and Check-in

Continental Breakfast

4:00 P.M – 5:00 P.M.

Concluding Remarks

5:00 P.M. – 7:00 P.M.

Social Event at the Center for

Infrastructure Renewal

AV SUMMIT

Texas Department of Transportation | Texas A&M Transportation Institute | Texas A&M Engineering TEEX Extension Service

Tuesday April 30, 2024 Wednesday – May 1, 2024

Texas A&M Transportation Institute

Texas A&M Engineering Extension Service

DAY 2

8:00 A.M. – 8:10 A.M.

Arrival and Check-in

Continental Breakfast

8:10 A.M. – 8:30 A.M.

Day 1 Summation

8:30 A.M. – 9:00 A.M.

Keynote Speakers

9:00 A.M. – 12:00 P.M.

Group Breakout Assignments

LUNCH

Taco Bar

1:00 P.M. – 3:00 P.M.

Large Group Meeting/Discussion

3:00 P.M – 4:00 P.M.

Summit Review and Next Steps

Concluding Remarks

4:00 P.M. – 5:00 P.M.

RELLIS Campus Tour for Interested Parties

AV SUMMIT

Tuesday April 30, 2024 Wednesday – May 1, 2024
Texas A&M Transportation Institute
Texas A&M Engineering Extension Service

BREAKOUT TOPICS

TOPIC 1
Law Enforcement Interactions

TOPIC 2
Traffic Incident Management
Construction Zones

TOPIC 3
Commercial Vehicle and CMV Enforcement

TOPIC 4
Policy

Regulation

Liability

Crash Investigation

Data Sharing

AV SUMMIT

BREAKOUT SESSION SCHEDULE

DAY 1

1:00 P.M. – 2:15 P.M.

TOPIC	GROUP	ROOM
1	A	1109
2	B	1108
3	C	1107
4	D	1105

2:30 P.M. – 3:45 P.M.

TOPIC	GROUP	ROOM
1	B	1109
2	A	1108
3	D	1107
4	C	1105

DAY 2

9:00 A.M. – 10:15 A.M.

TOPIC	GROUP	ROOM
1	C	1109
2	D	1108
3	A	1107
4	B	1105

10:30 A.M. – 11:45 P.M.

TOPIC	GROUP	ROOM
1	D	1109
2	C	1108
3	B	1107
4	A	1105

SPEAKERS

Greg Winfree

Gregory Winfree was appointed Agency Director of the Texas A&M Transportation Institute (TTI) in December 2016. TTI is a state agency and the largest and most comprehensive higher education-affiliated transportation research institute in the United States, with $119 million in research expenditures and about 700 employees. He is also an Adjunct Professor at the Texas A&M School of Law. Greg served for almost seven years at the U.S. Department of Transportation (USDOT), most recently as Assistant Secretary of Transportation overseeing the department's research and technology agency. He is a member of the Presidential National Space-Based Positioning, Navigation, and Timing Advisory Board sponsored by NASA, the Texas Connected and Automated Vehicle Task Force, the Intelligent Transportation Society (ITS) of America Board, the Transportation Research Board (TRB) AV Forum, and USDOT's Advisory Committee on Transportation Equity. A lifelong attorney, Greg previously served in the Civil Rights Division of the U.S. Department of Justice. He received a Juris Doctor degree from Georgetown University and a Bachelor of Science degree from St. John's University.

Darcyne Foldeneaur

Darcyne Foldenauer is Director of the Automated Vehicle Safety Consortium (AVSC) under SAE-Industry Technologies Consortia (SAE-ITC). She joined the company in 2022 as a 35-year manufacturing veteran in the automotive, aerospace, and defense sectors. In her current role, she is responsible for oversight and leadership of working groups to develop autonomous vehicle safety best practices, and strategic planning through the identification of new product lines and/or services, with an emphasis on new technologies. She also oversees all communication and outreach to members and stakeholders, along with government entities, to promote program, department, and related products and services related to safety of autonomous vehicles.

Prior to joining SAE-ITC, Foldenauer spent 11 years at Dakkota Integrated Systems, where she held roles as Director of Quality and Business Systems and Director of Program Management.

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SPEAKERS

Mike
Lukuc

Mike Lukuc is manager of the Federal Motor Carrier Safety Administration's (FMCSA) Automated Commercial Motor Vehicle (CMV) Evaluation Program. Mike is an accomplished leader, manager, collaborator, and systems engineer with 30 years of research, development, and implementation experience working on cutting-edge transportation technologies. He joined FMCSA's Advanced Technology Division 2.5 years ago as a senior engineer and manages the Agency's Automated Commercial Motor Vehicle research program.

Mike spent the first part of his career in the automotive industry, developing new chassis control technologies for future Cadillacs at the General Motors (GM) proving grounds. He moved to Delphi Automotive when the company was spun off from GM in 1998. Mike then moved to Mercedes-Benz Research and Development, focusing on advanced driver assistance systems and automated vehicle technologies, before joining the National Highway Traffic Safety Administration's (NHTSA) Office of Crash Avoidance Research in 2009.

Mike developed a passion for commercial motor vehicle safety while living in Texas, beginning at the Texas A&M Transportation Institute (TTI) in 2015. He then worked as the Texas Operations and Test Manager for Peloton Technology, a former automated commercial motor vehicle start-up company, and later joined FMCSA.

Gwyn
Kash

Gwyn Kash is a policy analyst at the Volpe National Transportation Systems Center Division of Technology, Innovation, and Policy. They received their Ph.D. in City and Regional Planning from the University of North Carolina at Chapel Hill. They are a mixed-methods researcher with expertise in engaging stakeholders in complex transportation issues including freight planning, public and nonmotorized transit, disaster resilience, and international planning. They have been awarded the Lee Schipper Memorial Scholarship for Sustainable Transport and Efficiency and are a two-time recipient of the Dwight David Eisenhower Graduate Transportation Fellowship. They are currently leading stakeholder engagement on a project titled Developing an Emergency Response Framework for ADS-Equipped Commercial Motor Vehicles commissioned by the Federal Motor Carrier Safety Administration.

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SPEAKERS

Brett Fabbri

Brett Fabbri is the Head of Law Enforcement Policy for Kodiak Robotics, a self-driving trucking technology company. In this role, Brett oversees Kodiak's relationships with law enforcement agencies across the 50 states, to develop policies for and train officers in how to interact with self-driving trucks.

Prior to joining Kodiak, Brett spent 30 years in law enforcement, and the last 23 years with the California Highway Patrol (CHP), retiring as Assistant Chief in the Enforcement and Planning Division. In this role, he provided managerial oversight of California's Commercial Vehicle Program and led CHP's work on autonomous vehicle technology. Brett also served as Chair of the Commercial Vehicle Safety Alliance's Enforcement and Industry Modernization Committee, which is responsible for evaluating how new technologies may impact commercial vehicle enforcement.

Lt. William White

Lt. William White is currently the police representative for the City of Austin Autonomous Vehicle Task Force. He is also a member of the Impaired Driving Action Team for the City of Austin and the Austin-area Incident Management for Highways.

Lt. White graduated with a bachelor's degree from the University of Texas at Austin in 1997. He worked for the federal government in the areas of intelligence, field management, and polygraph before joining the Austin Police Department in 2002.

During his time with the police department, he worked as a patrol officer before being promoted to detective in 2006. As a detective, he worked in domestic violence, property crime, and homicide before being advanced to sergeant in 2013. During his tenure as a sergeant, he worked in patrol, robbery, and child abuse before being promoted to lieutenant in 2019. He was then assigned to the Real Time Crime Center before transferring to the Highway Enforcement Command. In this role, he supervises the Vehicular Homicide Unit, Highway Enforcement Investigations Unit, Wrecker Unit, Impaired Driving Investigations Unit, Vehicle Abatement Unit, and Motors Auxiliary Unit.

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AGGIE MAP

Scan the code below to receive the link for Aggie Map. This mapping system has all Texas A&M University and RELLIS buildings. Just search the building name, address or building number, and the app will find the location and offer you a link for directions.

SCAN ME

APPENDIX D. SUMMIT SUMMARY SENT TO ALL PARTICIPANTS

SCAN FOR SURVEY

April 10, 2025

Greetings:

Thank you so much for attending the First Responder Interactions with Automated Vehicles Summit. Your participation, input, and dedication to protecting road users and first responders were invaluable to the success of this effort. We hope you enjoyed your visit to Aggieland!

If you have not done so already, please take a moment to scan the QR code above or click the link (https://teex.co1.qualtrics.com/jfe/form/SV_0BQsVKGVrSGIDoW?Q_CHL=qr), and fill out an exit survey on our summit.

Attached to this letter is a summary of highlights from summit discussions. As we continue with further steps in our project, we look forward to working with you to refine some of these issues and identify solutions to move toward the preparation of a Guide to Automated Vehicle Interactions for First Responders.

Please contact b-trefz@tti.tamu.edu or call 202-494-8027 if you have questions or would like to discuss our follow-on tasks in this project.

Thank you again for your participation in this critical effort. It was an honor meeting you and we look forward to working with you in the future as this project moves forward.

Sincerely,

Bradley Trefz
Project Principal Investigator
Texas A&M Transportation Institute

Ray Ivie
Director, Test & Innovation Center
Texas A&M Engineering Extension Service

SUMMARY OF SUMMIT DISCUSSIONS

COMMON THEMES

- Information sharing portals (between industry, first responders, and traffic management centers)
- Hand and Arm Signals for human directed traffic (37 TAC 3.41)
- Identifying AVs, getting contact #, wait times for remote operators
- Standardization of training and procedures
- Autonomy indication and manual override
- Desire for follow-on summits/meetings/working groups

TOPIC 1: LAW ENFORCEMENT INTERACTIONS

- Standardized hand and arm signals used by responders and construction workers that all industry can train their AVs to understand and responders can use to communicate effectively with AVs
    - Texas Administrative Code (Traffic Direction) – 37 Texas Administrative Code (TAC) 3.41 is the standard for directing traffic in Texas (though it may lack some signals for certain situations)
- Responders want a way to identify a vehicle as an AV
    - Visible/clear signage on all four sides of the vehicle
        - Industry fears that this kind of signage leads to aberrant driving behavior around the vehicle
    - A link between the license plate that includes information about emergency contact/operations center and links to response information when entering the vehicle's registration or license plate information into existing systems
- Continued education credits, mandatory training, and new curriculum in first responder academies and training programs focused on AVs
    - AV/identification/awareness, understanding different SAE levels of autonomy, how to interact with AVs, and how to manually disable when necessary
- Responders want to be sure that there will not be a long wait time for a call center or remote operator in the event of an emergency
- An information sharing portal with exclusive access between responders, industry, and governmental agencies
    - Shares information on planned work zone areas, large events, or road closures
    - Quick and secure communication between industry partners and responders
    - Stores interaction plans, extrication guides, and best practice information for each company/vehicle model

TOPIC 2: TRAFFIC INCIDENT MANAGEMENT & CONSTRUCTION ZONES

- Ways to identify autonomy status of a vehicle
- Responders wanted to ensure AVs have manual over-ride capabilities in case the AV is not understanding a situation or needs to be moved quickly to avoid creating traffic flow issues
- There needs to be continuous, open communication between first responders and industry
  - Facilitate the notification of significant events affecting traffic flow and temporary work zones so AV companies can adjust their operations accordingly, ahead of time
  - A trusted and easy communication between AV operators and first responders for quicker response times and identification of the problem by both parties
- Scenario – unexpected object on freeway/limited visibility
  - Discussion of technology limitations of LIDAR/RADAR and video
    - Lowers level of confidence, reduces range of AV response
    - May affect minimal risk maneuvers and conditions
- Adding AV awareness/identification/interaction training to TxDOT HERO/Tow-and-Go/Courtesy Patrol/etc. responders

TOPIC 3: COMMERCIAL MOTOR VEHICLES & CMV ENFORCEMENT

- Human Intervention:
  - Ensure that autonomous commercial vehicles possess traditional driving systems that allow for easy human intervention when necessary in emergency situations
  - Develop clear protocols and procedures for human intervention, including how and when human drivers can/should take control of the vehicle
- Security Measures:
  - Use advanced authentication methods, beyond just onboard cameras, to verify the identity of officers during inspections/interactions
  - Implement secure remote disabling and locking features that can be activated in case of unauthorized access or hijacking attempts
- Inspections:
  - Develop and implement specialized verification methods for customs and cross-border agricultural screenings compatible with the CVSA enhanced self-inspection processes
  - Conduct regular audits and reviews of the inspection process to identify and address any vulnerabilities or opportunities for malicious activity (e.g., narcotics/human trafficking) or issues with self-inspection

TOPIC 4: POLICY, REGULATION, LIABILITY, CRASH INVESTIGATION, & DATA SHARING

- Participants from industry and responder communities agreed that AVs should be regulated in regard to first responder interactions and safety. A regulatory framework in Texas, as well as at the federal level, would level the playing field and remove some of the guess work involved in first responder interactions. Regulations at the federal level would facilitate vehicle standardization for efficient first responder access into AVs and a standardized safety testing and rating system. At the state level, voluntary compliance is working for now, but mandatory state requirements may become necessary at some point as the AV market matures.
- Session participants identified policy priorities for the state, including requiring submission of law enforcement interaction plans before deploying or testing, devising a training scheme for first responders to become familiar with and aware of mitigating safety risks from AVs, geofencing to prevent AVs from entering certain areas (e.g., work zones, fire stations, special events, emergency events), creating and maintaining a portal/repository of first responder resources (e.g., LEIPs and other information from industry), and creating and maintaining a "data lake" that local and state agencies could drop information related to incidents and emergencies into so that industry could avoid operating in affected areas.
- Industry's model legislation could be a resource for Texas to consider for the next legislative session since it includes a requirement that AV companies submit a LEIP prior to testing or deploying on public roads. It also designates an agency or pair of agencies to implement and enforce the AV law and serve as a single point of contact for industry.

GROUP DISCUSSION

- The summit was the beginning of a discovery, and stakeholders recognize the need for additional sessions, dialogues, and working groups
    - Desire for a "Texas Jam" where all AV companies and several first responders from around the state come together to spread awareness of the AVs operating in/near their jurisdictions, receive instruction on how to interact with AVs, and form a relationship with trust and open communication between all parties
    - Stakeholders eagerly seek ongoing discussions on emerging issues
- The industry actively works to standardize functions and processes in the autonomous vehicle sector, although challenges remain
    - First responders expressed willingness to collaborate and standardize their operations in tandem with AV industry
- Manufacturers and developers actively resolve operational challenges and engage with stakeholders, including law enforcement
    - Desire for continued collaboration and best practice development among organizations such as TTI, TEEX, TxDOT, and industry bodies.

Collaboration and information sharing seen as crucial for ensuring road safety with the increased adoption of autonomous vehicles in the near term.

APPENDIX E. VALUE OF RESEARCH ASSESSMENT

As part of this project, the research team completed a value of research (VoR) assessment based on the benefit areas selected at the beginning of the project (see Table E4).

PROJECT STATEMENT

The number of vehicles with automated functions continues to increase on Texas roadways. Several companies are testing or will soon deploy demonstrations of SAE Level 4 AVs or CAVs within the state, with no notification requirements. Additionally, several automated CMV projects are testing SAE Level 4 automation. While safety goals are aimed at minimizing the number of adverse incidents that occur, crashes or other adverse operations involving these AVs are inevitable.

TxDOT's HERO program and other first responders are part of the front line that must be prepared to encounter a AV/CAV or automated CMV during a routine interaction or adverse event/accident. This project identified needs and strategies for first responders to understand how AVs operate, how to safely approach and disable AVs as needed during routine and adverse incident interactions, and how to interact with AVs during an accident or emergency.

Table E4. Selected Benefit Areas for VoR Assessment.

Selected	Benefit Area	Qualitative	Economic	Both	TxDOT	State	Both	Definition in Context to the Project Statement
X	Level of knowledge	X					X	• Identified needs and strategies for first responder-AV interactions. • Created a new communication forum and provided information to stakeholders to reduce or eliminate gaps and needs. • Developed the first frontline user guide for first responder-AV interactions .
X	Management and policy	X					X	• Identified areas and concerns where TxDOT and other governmental agencies may establish or improve policies and procedures to mitigate safety risks. • Conducted first exploration of case law and statutes related to first responder-AV interactions. • -Identified issues, gaps, and silences in the law and associated legal and technical mitigation strategies.

QUALITATIVE ASSESSMENT

Project outcomes determined the VOR assessment. Specifically, the project provided foundational research that expanded the level of knowledge of TxDOT and first responders regarding interactions with AVs. This project increased knowledge by identifying needs and strategies for first responders to understand how AVs operate, how to safely approach and disable AVs as needed during routine and adverse incident interactions, and how to interact with AVs during an accident or emergency, drawing on input from researchers; first responders; local, state and federal agencies; and the AV industry. This project established and improved communication between stakeholders through the AV Summit, and provided a common operating picture for industry, responders, and TxDOT that can reduce or eliminate current gaps and needs. In addition to providing critical information to inform this project, the AV Summit informed ongoing regulatory and research efforts by NHTSA, FMCSA, and the Volpe Center. The AV Summit and project outcomes directly informed efforts by the Texas CAV Task Force. The summit also led to increased attention to first responder issues by the AV industry and the formation of first responder advisory councils in industry organizations. In addition to identifying specific scenarios and best practices to address those scenarios, this project created the first end-user/frontline first responder guide for AV interactions that provided significant information to TxDOT, first responders, and the AV industry. This guide and the information developed over the course of the project provide the basis for follow on efforts including additional research and development of a training program for first responders.

This project also provided management and policy improvements to address areas of concern where TxDOT and other governmental entities may establish policies or procedures to mitigate safety risks to first responders when interacting with AVs. This project included the first exploration of case law and statutes related to first responder interactions with AV technology undertaken by TxDOT. The research identified issues, gaps, and silences in the law and associated legal and technical mitigation strategies. Potential changes to TxDOT management and policy include working with legislative staff to change laws and policies that may reduce liability and improve safety. New laws at all levels of government have the potential to impact AVs, and the value of this foundational research provided essential guidance for future efforts in management and policy development by providing a snapshot of current gaps and needs.