



Connected and Automated Vehicle Licensing and Registration

Texas CAV Task Force White Paper Subcommittee on Licensing and Registration

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Disclaimer

The contents of this white paper reflect the views of the Texas CAV Task Force members, who are responsible for the information presented herein. The contents do not necessarily reflect the official views or policies of the State of Texas or any Texas state agencies. The white paper does not constitute a standard, specification, or regulation, nor does it endorse standards, specifications, or regulations. This white paper does not endorse practices, products, or procedures from any private-sector entity and is presented as a consensus broad opinion document for supporting and enhancing the CAV ecosystem within Texas.

Texas CAV Task Force Charter

The Texas CAV Task Force was created at the request of Texas Governor Greg Abbott in January 2019. The Texas CAV Task Force is responsible for preparing Texas for the safe and efficient rollout of CAVs on all forms of transportation infrastructure.

The primary functions are:

1. Coordinating and providing information on CAV technology use and testing in Texas.
2. Informing the public and leaders on current and future CAV advancements and what they mean in Texas. This process includes reporting on the current status, future concerns, and how these technologies are changing future quality of life and well-being.
3. Making Texas a leader in understanding how to best prepare and wisely integrate CAV technologies in a positive, safe way, as well as promoting positive development and experiences for the state.

The Texas CAV Task Force is composed of a voting group of no more than 25 members and represents the full spectrum of CAV stakeholders.

Terminology Note

The Texas CAV Task Force addresses the full spectrum of connected, automated, and autonomous vehicles. An *automated vehicle* refers to a vehicle that may perform a subset of driving tasks and

require a driver to perform the remainder of the driving tasks and supervise each feature's performance while engaged. A *fully autonomous vehicle* refers to a vehicle that can perform all driving tasks on a sustained basis. These definitions are still blurred in common discussions and language. Currently, the industry is developing automated vehicle capability while pursuing fully autonomous vehicles. The white papers generally use the term *autonomous* to refer to the vehicles with fully autonomous capabilities and the term *CAV* to refer to the grouping of connected, automated, and autonomous vehicles. Please see the "CAV Terminology" white paper for a full listing of terms and definitions used in this developing technology ecosystem.

List of Terms and Acronyms

ADS	automated driving system
ADS 2.0	<i>Automated Driving Systems: A Vision for Safety 2.0</i>
AV	automated vehicle
AV 3.0	<i>Preparing for the Future of Transportation: Automated Vehicles 3.0</i>
CAV	connected and autonomous vehicle; also, connected and automated vehicle
CDL	commercial driver license
CMV	commercial motor vehicle
CV	connected vehicle
FMCSA	Federal Motor Carrier Safety Administration
FMCSR	Federal Motor Carrier Safety Regulation
FMVSS	Federal Motor Vehicle Safety Standard
GVWR	gross vehicle weight rating
NHTSA	National Highway Traffic Safety Administration
OEM	original equipment manufacturer
PDD	personal delivery device
TDI	Texas Department of Insurance
TNC	transportation network company
TxDMV	Texas Department of Motor Vehicles
TxDOT	Texas Department of Transportation
TxDPS	Texas Department of Public Safety
USDOT	U.S. Department of Transportation
VSSA	Voluntary Safety Self-Assessment

Executive Summary

In 2017 and 2019, the 85th and 86th Texas Legislatures enacted legislation to create a regulatory framework to allow for connected and automated vehicles to be tested and deployed in Texas. In 2017, the Texas Legislature passed laws changing vehicle following distances to allow for truck platooning and adding rules for automated vehicles (AVs) to operate within Texas. In 2019, the Texas Legislature passed a bill to allow personal delivery devices (PDDs) to operate on sidewalks and crosswalks. This paper examines how these laws have led to a recent wave of innovation and experimentation—on roads, streets, and sidewalks; in cities; and on rural highways—operating within a range of public- and private-sector agencies and operators with state regulations that focus on regulating drivers and operators and on regulating vehicles.

A range of automated vehicles have been deployed and tested in Texas:

- Large and small freight vehicles (some with safety drivers, some in automated operation).
- Zero-occupant delivery vehicles on roadways.
- Shuttles and robotaxis carrying passengers on roadways.
- Personal delivery devices (PDDs) operating on sidewalks and crosswalks.

The Texas Department of Public Safety (TxDPS) has responsibility for licensing drivers for automobiles and light trucks and for commercial vehicles. TxDPS also regulates vehicle inspection stations that offer annual safety inspections (that enforce state laws establishing vehicle safety standards) as well as emissions testing in 17 counties in nonattainment areas. TxDMV is responsible for the registration (vehicle operation) and titling (vehicle ownership) of vehicles and commercial fleet services in Texas. Proof of insurance is required before vehicles can be registered. TxDMV is also responsible for regulating the sale of motor vehicles by licensed dealers. In Texas, manufacturers may not sell vehicles directly to customers, and all vehicles must be purchased from a licensed dealer. The Texas Department of Insurance (TDI) regulates insurers providing mandatory auto insurance policies for all drivers, personal and commercial. State, county, and local law enforcement agencies are authorized to enforce state laws on motor vehicle operations on roadways in their respective jurisdictions. At the Federal level, the National Highway Traffic Safety Administration sets the Federal Motor Vehicle Safety Standards (FMVSS) aimed at increasing safety on roadways and reducing vehicular accidents. The FMVSS stipulate specific design, construction, performance, and durability standards for all motor vehicles, personal and commercial. The Federal Motor Carrier Safety Administration (FMCSA) sets national commercial drivers licensing standards and sets hours-of-service regulations for interstate truck drivers. The FMCSA also issues certificates of operating authority for commercial motor vehicle (CMV) fleet owners; and the Texas Department of Motor Vehicles (TxDMV) also registers CMV fleets transporting passengers or cargo on CMVs with over 26,000 pounds or more gross vehicle weight.

Texas law authorizes operation of automated motor vehicles without human operators. This 2017 law establishes that an automated driving system is considered to be licensed to operate a motor vehicle when the automated driving system is engaged. This section also makes the owner of the automated driving system responsible for compliance with traffic or motor vehicle laws, with or without a test driver present. State laws requiring state inspections to enforce vehicle equipment

standards do not make any allowances for specially equipped and manufactured AVs. The FMCSA is working to adapt current CMV regulations to accommodate automated driving systems, but those regulations are not being adjusted for incremental adoption of advanced driver assistance systems that might enhance operational safety without eliminating driver control of the vehicle. Texas laws do not currently exempt AVs from TxDMV registration requirements if the vehicles are operated on public highways, nor do they exempt AVs from compliance with motor vehicle dealer sales and lease regulations administered by TxDMV. Transportation of passengers for hire requires operating authority certification from TxDMV regardless of vehicle size. AVs operated by transportation network companies are subject to insurance requirements set by law for those firms. State law has authorized operation of PDDs on city sidewalks, but the state establishes no registration or inspection requirements of the vehicles.

By enacting AV legislation in 2017, the Texas Legislature created an environment that has allowed the AV industry to expand its testing and development in Texas. By clarifying the legal obligations of AV developers and vehicle owners, Governor Greg Abbott and the Texas Legislature have increased the regulatory certainty for these firms to consider deployment and development opportunities in Texas. This white paper identifies opportunities for adding regulatory clarity for more AV innovation:

- AV developers and the TxDPS could collaboratively discuss compliance with state motor vehicle equipment standards and current AV configurations, particularly for PDDs and zero-occupant vehicles.
- AV developers and manufacturers, TxDMV and the Texas Automobile Dealers Association could discuss how current dealer licensing/sales laws and registration rules affect the range of commercial relationships between original equipment manufacturers and AV developers.
- If some AV developers are considering alternatives that include AV operation entirely by remote operators (rather than by onboard software that controls vehicle driving tasks), the AV industry may want to interact with applicable state agencies to determine how the current regulatory structure addresses such operations.
- The AV industry and national associations of state transportation and motor vehicle agencies can develop guidelines for best practices for identifying AV vehicles and responsible parties for meeting licensing and operating requirements of state law

Introduction

Connected vehicles (CVs) are vehicles capable of communicating with other objects through wireless data platforms. Automated vehicles (AVs) are vehicles that use sensors, computers, and other tools to take over driving tasks from a human driver. Since 2017, regulatory and legislative guidance and activity have largely pertained to AVs, which are the focus of this paper. SAE International outlines a [taxonomy](#) with five levels of automation for vehicles that range from no automation, where a human operator must perform all driving tasks, to full automation, where all driving tasks are performed by the vehicle itself with no need for a human driver. Testing of AVs is being actively pursued in Texas across many platforms, such as personal delivery devices (PDDs), motor vehicles, shuttles, and commercial motor vehicles (CMVs). The purpose of this paper is to highlight the licensing and registration implications related to AVs operating within Texas.

Public Agency Roles and Responsibilities

Many public agencies can impact AV policy. This section highlights the public agencies that will play an important role in developing and implementing AV policy in the years to come.

U.S. Department of Transportation

The U.S. Department of Transportation (USDOT) is tasked with making sure that America's transportation system operates in a safe and efficient manner. USDOT houses many agencies that also play significant roles in their own rights. In these early stages of AV development, USDOT has not enacted regulations so that the emerging technology can be developed in a way that encourages innovation. However, USDOT has urged state and local governments, original equipment manufacturers (OEMs), research and safety institutions, and other stakeholders to be actively engaged in the development of the guidance that it produces (1).

USDOT has produced three documents that provide guidance related to AV activities:

- ***Automated Driving Systems: A Vision for Safety 2.0*** (ADS 2.0) was published in September 2017 by the National Highway Traffic Safety Administration (NHTSA) and provides voluntary guidance for stakeholders to develop AV technology (1).
- ***Preparing for the Future of Transportation: Automated Vehicles 3.0*** (AV 3.0) was published in October 2018 by USDOT and expands the guidance developed in ADS 2.0 to reduce the uncertainty surrounding AVs and outline a process for stakeholders to engage with USDOT on AV policy (1).
- ***Ensuring American Leadership in Automated Vehicle Technologies: Automated Vehicles 4.0*** was published in January 2020 by USDOT and further expands AV guidance and seeks to develop a consistent high-level policy approach to AV development and deployment (1).

In March 2018, President Trump signed the Consolidated Appropriations Act 2018 into law. This act provided \$100 million in funding for the research and development of AVs (2).

USDOT has taken a cautious approach in terms of actual policy development for AVs but has remained active in engaging with stakeholder groups and providing high-level guidance and oversight.

Among USDOT's first steps in creating a framework around AVs was to develop the concept of Voluntary Safety Self-Assessments (VSSAs). VSSAs entail 12 sections—ranging from system safety and validation methods to consumer education and government engagement—where companies document and explain how they approach and ensure safety. The level of detail in these reports continues to advance as companies' technologies and safety management evolve.

In AV 3.0, USDOT expanded its guidance to incorporate CMVs. Notably, USDOT and the Federal Motor Carrier Safety Administration (FMCSA) concluded that SAE Level 4 operation for commercial vehicles was allowable under existing trucking regulations, noting that "FMCSA regulations will no longer assume that the CMV driver is always a human or that a human is necessarily present onboard a commercial vehicle during its operation." Furthermore, FMCSA asserted preemption authority over state or local legal requirements that interfere with the application of federal motor carrier safety regulations, including as they pertain to automated driving system (ADS) development, testing, and deployment in interstate commerce.

National Highway Traffic Safety Administration

NHTSA is the USDOT agency charged with developing and issuing Federal Motor Vehicle Safety Standards (FMVSSs) aimed at increasing safety on roadways and reducing vehicular accidents. The FMVSSs stipulate specific design, construction, performance, and durability standards for motor vehicles and are codified in Title 49 §571 of the U.S. Code of Federal Regulations (3).

NHTSA's authority has two main implications for AVs. First, because FMVSSs have not yet been updated for vehicles that are designed to operate without a human driver, any AV would either have to be compliant with all relevant existing FMVSSs required of any other vehicle or receive an exemption if some aspect of the AV were not compliant. Depending on the intended use case of an AV, some existing FMVSSs that are important for human-driven vehicles end up being largely irrelevant for AVs. One example is Title 49 §571.103 of the U.S. Code of Federal Regulations, which requires windshield defrosting and defogging systems. In the case of a fully autonomous passenger vehicle where there is no driver, for example Waymo's One, a passenger would not need to be able to see the roadway, and the need would be negated. However, this equipment would still be mandatory unless the AV developer successfully petitioned for an exemption to §571.103. Similarly, fully autonomous delivery vehicles, such as Nuro's R2, where only cargo is in the vehicle, would not require traditional safety standards; Nuro was able to receive an exemption that did not require the vehicle to have windows. However, many AV developers, especially those developing automated commercial vehicles, are building on top of FMVSS-compliant vehicles and therefore would not need FMVSS exemptions.

The second potential NHTSA impact on FMVSSs is that given NHTSA's authority to regulate vehicle equipment, NHTSA would be the lead agency to define any ADS equipment or performance requirements. To date, NHTSA has not yet provided any regulations exclusively pertaining to AVs. NHTSA will continue to play a vital role in the development of safety standard policy for AVs for the foreseeable future. A 2016 enforcement guidance bulletin reiterated NHTSA's broad enforcement authority under existing statutes and regulations to address existing and emerging automated safety technologies to protect the safety of the driving public against unreasonable risks of harm.

NHTSA recently also implemented the AV TEST program to help educate the public on where and how ADS testing and development take place. In response to many state and local jurisdictions asking for more information on nearby testing, NHTSA created an interactive Test Tracking Tool where the public can view up-to-date information on each company's testing activity. This tool launched in September 2020 of this year with a limited set of test participants, but NHTSA will allow all ADS developers to publish data in the tool in late 2020.

Federal Motor Carrier Safety Administration

FMCSA regulates interstate commercial vehicle operations, including setting licensing standards, hours-of-service limits, and safe operation practices through Federal Motor Carrier Safety Regulations (FMCSRs). FMCSA also provides guidance to state enforcement agencies on CMV inspection and enforcement activities. Unlike passenger vehicles, federal regulation of interstate commercial vehicle operations, such as large trucks and buses, is much more extensive given their role in interstate commerce. A wide range of FMCSRs relate to driver requirements, behaviors, or activities, making them highly relevant to connected and automated CMVs. In AV 3.0, FMCSA asserts its authority to take enforcement action if an automated system inhibits the safe operation of a CMV, while concluding that automated CMV operation is allowable under existing FMCSRs, assuming it can be compliant with the same operational requirements as a human-driven CMV. Furthermore, AV 3.0 notes FMCSA policy would no longer assume that the driver of a CMV is always human or that a human is necessarily on board, and that human-specific FMCSRs, such as drug testing and hours of service, would not apply to SAE Level 4 or 5 CMVs operating without a human driver.

Addressing the impact of differing state AV testing and deployment policies on automated CMVs engaged in interstate commerce, AV 3.0 notes that "if FMCSA determines that State or local legal requirements may interfere with the application of FMCSRs, the Department has preemptive authority."

Texas Department of Public Safety

In Texas, the Texas Department of Public Safety (TxDPS) is responsible for issuing commercial and motor vehicle driving licenses. TxDPS officers also enforce the motor vehicle regulations and FMCSRs to maintain safe roadways. While TxDPS does not issue vehicle registrations, TxDPS officers are charged with enforcing the requirements (4). TxDPS also regulates vehicle inspection stations that offer annual safety inspections and emissions testing in 17 counties in nonattainment areas.

Texas Department of Motor Vehicles

The Texas Department of Motor Vehicles (TxDMV) is responsible for titling and registering vehicles in Texas. The revenue from motor vehicle registrations is used to build and maintain Texas roadways. TxDMV is also responsible for issuing oversize/overweight permits for CMVs and issues operating authority credentials for motor carrier firms (not just vehicles). Prior to a vehicle being registered in Texas, it must pass an inspection and have proof of insurance (5).

Texas Department of Transportation

The Texas Department of Transportation (TxDOT) is responsible for building and maintaining Texas roadways and for providing state and federal funding for transportation infrastructure, operation, and

safety needs (6). TxDOT is responsible for a range of federal planning requirements and reporting, including performance measurement, asset management, infrastructure condition, strategic highway safety planning, and long-range planning. At the direction of Governor Greg Abbott, TxDOT also created the Texas Connected and Autonomous Vehicles (CAV) Task Force in 2019 comprised of industry representatives, government officials, and other key stakeholders. The Texas CAV Task Force was designed to be an information portal for all things CAV in Texas and promote opportunities for CAV growth and understanding (7).

Texas Department of Insurance

The Texas Department of Insurance (TDI) is responsible for the oversight of the insurance industry within Texas. To register a vehicle in Texas, the vehicle owner must provide proof that the vehicle is insured. In Texas, drivers are responsible for paying for accidents in which they are found liable. Insurance can pay for automobile repairs and medical bills if there is an accident (8). The Texas Legislature sets insurance requirements, and TDI regulates the insurers that offer the policies.

Municipalities and Other Local Authorities

According to Title 2 §51.001 of the Texas Local Government Code, municipalities have the power to adopt and enforce regulations that are “(1) for the good government, peace, or order of the municipality or for the trade and commerce of the municipality; and (2) necessary or proper for carrying out a power granted by law to the municipality or to an office or department of the municipality” (9). Cities and counties have responsibilities for roads, streets, and the complete right of way in their jurisdictions and for partnering with TxDOT on state highway projects, but only cities have the authority to adopt ordinances regulating land use and commercial activities. Cities also regulate taxis and limousines (passenger transportation for hire). Municipalities have the authority to enforce statutes applicable to motor vehicles operating on roads within the city’s jurisdiction. Local authorities may also regulate the operation of PDDs under Title 7 §552A.009 of the Texas Transportation Code, provided their regulation is in a manner that is consistent with §552A for highways and pedestrian areas.

Other Roles and Responsibilities

Other individuals and organizations can also impact AV policy. This section highlights the other entities whose roles and responsibilities will affect AV policy in the years to come.

Original Equipment Manufacturers and Automated Vehicle Developers

Most cars and trucks are designed and manufactured by companies that FMVSSs refer to as OEMs. Many OEMs are testing and deploying driver assistance technologies that incrementally increase the driving functions that are being automated. Some OEMs are also testing AV systems to consider how to incorporate increasing levels of driver assistance and replacement in vehicles sold to customers.

In addition to OEM AV development, a range of technology firms referred to here as *automated vehicle developers* are testing systems of sensors, cameras, software, and artificial intelligence that offer levels of vehicle automation, usually as an aftermarket adaptation of existing vehicles and often with the cooperation of an OEM. Some of these AV developers are also offering commercial services (freight or passenger carriage) to consumers.

Vehicle Owners and Operators

As vehicles become increasingly automated, many Texans purchase cars and trucks with driver assistance technologies for personal use and will be responsible for operating those vehicles in compliance with all applicable state and local laws and regulations. When vehicles are operated for hire to transport freight or passengers, companies that own these vehicles and employ drivers are likewise responsible for complying with applicable laws and regulations. Current AV deployments also involve vehicle manufacturers and developers that provide services to customers.

Property Owners and Developers Supporting Experimentation

Some AV deployments have involved property owners and venues seeking to expand their brand through innovation. Automated shuttles have been tested at entertainment venues (Arlington, TX), universities (Texas A&M University and Texas Southern University), and mixed-use developments (Hillwood/Frisco Station). PDDs have been tested on the University of Houston campus. Some of these demonstrations have included transportation management associations or interlocal agreements with transit agencies.

Customers and Passengers

For those AV developers offering freight services (e.g., Kodiak, TuSimple, and Embark) as part of their testing operations, shippers and receivers are involved in the transaction and may participate in the interest of supporting innovation. Passengers choosing to board an automated shuttle are directly involved in AV testing and demonstrations. As more such services are offered, shippers and passengers will indicate their acceptance of the new technologies by their patronage. The market acceptance of such services may be critical in the continued commercial viability of AV developers and the public considering these services.

Types of Automated and Connected Vehicles Active in Texas

In 2017, Texas became one of 10 regions USDOT selected to test AV technologies. This opportunity became known as the Texas AV Proving Grounds Partnership (10). While USDOT has withdrawn all Proving Grounds designations, AV research is a continuing strength in Texas.

Large and Small Freight Vehicles Operating on Roadways with Safety Drivers

In August 2019, Kodiak Robotics announced that it was testing a commercial route of an autonomous truck with a safety driver between Dallas and Houston as an example of AV truck testing in Texas (11). Kodiak has collaborated with Texas law enforcement to provide training to officers on the trucks and how they operate. The trucks have safety drivers but computer brains that use cameras, lidar, and sensors to navigate the way. Kodiak has ensured that safety drivers meet impeccable safety and regulatory requirements, such as:

- Possessing a commercial driver license (CDL).
- Completing three years of commercial driving experience.
- Maintaining a high safety record.
- Passing a drug and background check.
- Passing an interview and road test for the autonomous vehicle (12).

Other firms testing AV trucks in Texas include TuSimple, Aurora, and Embark (testing in Texas until early 2020). These firms were attracted to Texas by the state's AV law enacted in 2017. While AV trucks are currently being tested with safety drivers, they are not required to do so under Texas law.

Autonomous Freight Vehicles on Roadways

In August 2020, Waymo announced that it had begun testing autonomous trucks along I-10, I-20, and I-45 in Texas. The current testing will use Peterbilt trucks with and without cargo, but they will not be used for commercial purposes just yet (13). Because the testing is just getting under way, it may be some time before any information is available about licensing and registration. Under AV 3.0, FMCSA has indicated that it would not apply human-oriented regulations to driverless trucks but could potentially provide rulemaking action that could be carried out by local law enforcement, for such things as motor vehicle inspections. FMCSA has taken no final action at this time.

Zero-Occupant Delivery Vehicles on Roadways

In December 2019, Nuro announced that it had begun testing a zero-occupant delivery vehicle in Houston, TX (14). Nuro has partnered with Kroger, Domino's, Walmart, and CVS in the Houston area. The vehicles are smaller and lighter than conventional vehicles, operate at lower speeds, and do not require an in-vehicle operator. Remote drivers continually monitor operation of the vehicles (15).

Shuttles and Robotaxis Carrying People on Roadways

Autonomous shuttle pilot projects have been popping up across Texas, with notable deployments under way in Arlington, Bryan/College Station, Frisco, and Houston.

Arlington

EasyMile operated an autonomous shuttle project on city sidewalks briefly in 2017. Drive.ai completed an autonomous shuttle pilot project in Arlington's Entertainment District in 2019. During the pilot project, the shuttle service completed 760 trips for 1,419 passengers, driving more than 440 miles (16). On March 16, 2020, the City of Arlington was awarded just under \$1.7 million to incorporate autonomous vehicles into its on-demand carsharing program. The funding will provide wheelchair-accessible service and service for students at the University of Texas at Arlington (at no cost) (17).

Bryan/College Station

In 2019, Navya partnered with Texas A&M University to deploy an 11-passenger autonomous shuttle on campus. The shuttle operated on weekdays on a designated route on the main campus, with two designated stops. The shuttle was available to students, faculty, staff, and the local community (18).

Frisco

In 2018, Drive.ai partnered with the City of Frisco and other parties to complete an on-demand autonomous shuttle project, available in a geofenced area. During the pilot project, the shuttle service completed more than 3,000 trips for almost 5,000 passengers (19).

Houston

In 2019, EasyMile partnered with First Transit and the Metropolitan Transit Authority of Harris County to operate an autonomous shuttle on the Texas Southern University campus. The 12-passenger, fully autonomous shuttle operates on a pre-programmed, 1-mile pedestrian trail on the campus. The shuttle is available to students, staff, and visitors on weekdays, and a consent form is required for transport (20).

Personal Delivery Devices and Mobile Carrying Devices

The Arlington City Council approved a resolution that would allow the testing and deployment of PDDs. In 2018, Marble was the first company to begin mapping sidewalks in order to deploy the delivery devices (21). Not much information is publicly available on the current status of the project.

PDD tests in the City of Frisco included both the Starship Technologies PDD robot in May 2020 and the FedEx PDD branded Roxo in October 2019 (FedEx and Frisco entered into a memorandum of understanding for the tests, but no formal agreement was made with Starship). The Starship PDD offered food and grocery deliveries in certain neighborhoods for 10 weeks, and the FedEx PDD operated on predetermined routes on one city street for two weeks. The University of Houston also sponsored PDD tests in fall 2019 on its campus using the Starship PDD.

During the Starship deployment, two incidents were reported. Title 7 §552A.007 of the Texas Transportation Code requires PDDs to have a marker with the owner's name and contact information. After one of the incidents, a public citizen was concerned about not being able to locate a phone number to contact the owner of the device. In another incident, the device left the scene before law enforcement arrived. This brings to light issues of how to determine compliance with Title 7 §552A.005 of the Texas Transportation Code, which requires PDDs to obey applicable motor vehicle laws; if law enforcement officers are unable to determine ownership, they may not be able to properly apply the law. The visibility of the PDDs, due to their small size, was another concern raised during the deployment, especially when the devices were crossing a roadway. Some devices were stuck at crosswalks or in other roadway crossings.

Regulation of Drivers and Operators

TxDPS is responsible for licensing drivers and (along with other local law enforcement agencies) enforcing the rules of the road.

Current Licensing Requirements

To become a licensed driver in Texas, a driver must complete the following steps to obtain a driver license:

- Submit an application form and provide all necessary forms of identification and residency.
- Pass a vision test.
- Pass a knowledge and driving skills test.

A CDL is required for large commercial vehicles and buses. The three types of CDLs are:

- **Class A:** any combination of vehicles with a gross combination weight rating of 26,001 pounds or more, provided the gross vehicle weight rating (GVWR) of the vehicle or vehicles towed exceeds 10,000 pounds.
- **Class B:** any single vehicle with a GVWR of 26,001 pounds or more, any single vehicle with a GVWR of 26,001 pounds or more that is towing a vehicle with a GVWR that does not exceed 10,000 pounds, and any vehicle designed to transport 24 passengers or more, including the driver.
- **Class C:** any single vehicle or combination of vehicles that is not a Class A or B if the vehicle is designed to transport 16 to 23 passengers including the driver, or is used in the transportation of hazardous materials that require the vehicle to be placarded under Title 49, Part 172, Subpart F of the U.S. Code of Federal Regulations (22).

To obtain a CDL, a driver must submit an application, prove identity and residency, and pass a vision test. The knowledge and driving skills tests are more advanced than for a standard driver license. Driver requirements include passing a safety inspection, knowledge of skills related to the specific commercial vehicle type, and any necessary endorsements. Endorsements are required for certain types of transportation needs. For example, a passenger endorsement is required if the driver will be transporting more than 16 people. CDL drivers are also required to indicate if they will be driving within the state only (intrastate) or if they will be driving across state lines (interstate). CDL holders must maintain a valid medical certification that is validated every two years. Licensed commercial vehicle operators are also subject to hours-of-service regulations established by FMCSA.

Current Certification/Registration Requirements of Vehicle Fleet Operators

Motor carriers are defined in Title 7 §643.001 of the Texas Transportation Code as “an individual, association, corporation, or other legal entity that controls, operates, or directs the operation of one or more vehicles that transport persons or cargo over a road or highway in this state” (23). Yet much of the regulation of motor carriers in terms of operating authority is linked to larger vehicles. Motor carriers operating vehicles over 10,000 pounds in gross vehicle weight in interstate commerce are required to obtain certificates of operating authority from FMCSA. Motor carriers operating within Texas are required by Title 7 §643.051 of the Texas Transportation Code to register with TxDMV if they operate CMVs—defined by Title 7 §548.001 of the Texas Transportation Code as motor vehicles used on a public highway to transport passengers or cargo if the vehicle has a GVWR of 26,000 pounds or more.

Expectations of Automated and Connected Vehicles in Texas

Chapter 545, Subchapter J of the Texas Transportation Code sets out authorization for operation of automated motor vehicles without human operators. Title 7 §545.453 states that an ADS is considered to be licensed to operate a motor vehicle when the ADS is engaged. This section also makes the owner of the ADS responsible for compliance with traffic or motor vehicle laws, with or without a test driver present. This overall authorization seems limited to the operation of the motor vehicle and does not affect other state laws that are related to the size of the vehicle or the nature of the services provided by the AV. AVs used in commercial motor carrier operations (carrying freight for

hire, not just for testing) are subject to regulations requiring operating authority certification at the federal or state level (depending on intrastate or interstate operations). Many of those motor carrier regulations regarding operating authority for freight carriers are limited to larger trucks (over 26,001 pounds GVWR). FMCSA is already taking steps to adapt current CMV regulations to ADSs. In AV 3.0, the agency concluded that SAE Level 4 operation for commercial vehicles was allowable under existing trucking regulations and that human-centric regulations like drug testing and hours of service will not apply to driverless trucks. FMCSA will continue to adapt trucking regulations to AVs as issues arise, and is already working with law enforcement and developers to address evolving issues like vehicle inspections. State or local agencies are not allowed to impose a franchise or other regulation related to AV operation.

Current state laws in Chapter 547 of the Texas Transportation Code, which specifies motor vehicle equipment standards, and Chapter 548, which governs mandatory vehicle safety inspection requirements, do not make any particular exemptions for AVs.

Transportation of passengers for hire requires operating authority certification from TxDMV regardless of vehicle size. AVs used in passenger transportation affiliated with a public transit operator may be subject to the safety regulations of the Federal Transit Administration that apply to the transit operator. AVs operated by transportation network companies (TNCs) are subject to insurance requirements set out in Title 10 §1954.053 of the Texas Insurance Code.

Gaps in Driver/Operator Regulation Requirements for Automated Vehicles

The current definition of automated motor vehicles requires that the ADS be capable of performing all aspects of the entire dynamic driving task without a human operator—that is, a person in the vehicle who controls the entire dynamic driving task. The current law allows for a vehicle to operate on Texas roads. AV stakeholders are continuing to work with government agencies to develop and deploy the technology within the confines of current law and to ensure a robust working relationship to discuss any changes to operator requirements that could be necessary as AV technology continues to develop.

As more trucks are operated with advanced driver assistance systems that assume more control over certain elements of the dynamic driving tasks, FMCSA may consider flexibility or waivers of hours-of-service regulations for truck operations with these advanced technologies.

Regulation of Vehicles

TxDMV is responsible for the registration and titling of vehicles and commercial fleet services.

Current Registration and Titling Requirements for Vehicles

To register and title a vehicle in Texas, the vehicle owner must show proof of insurance and a passing safety inspection for the vehicle. The registration sticker includes the registered vehicle license plate number and the county in which it is registered. These two pieces of information assist in theft and fraud prevention. Registrations are not transferable. To apply for a title, the applicant must show proof of ownership (24).

Title 7, Chapter 643 of the Texas Transportation Code requires that CMVs operating on Texas roadways be registered. The registration application is \$100 plus \$10 for each registered vehicle and must include the following information:

- “the name of the owner and the principal business address of the motor carrier;
- “the name and address of the legal agent for service of process on the carrier in this state, if different;
- “a description of each vehicle requiring registration the carrier proposes to operate, including the motor vehicle identification number, make, and unit number;
- “a statement as to whether the carrier proposes to transport household goods or a hazardous material;
- “a declaration that the applicant has knowledge of all laws and rules relating to motor carrier safety, including this chapter, Chapter 644, and Subtitle C;
- “a certification that the carrier is in compliance with the drug testing requirements of 49 C.F.R. Part 382, and if the carrier belongs to a consortium, as defined by 49 C.F.R. Part 382, the names of the persons operating the consortium;
- “a valid identification number issued to the motor carrier by or under the authority of the Federal Motor Carrier Safety Administration or its successor; and
- “any other information the department by rule determines is necessary for the safe operation of a motor carrier under this chapter” (25).

CMVs, like conventional vehicles, must also provide proof of insurance. TxDMV sets this liability insurance coverage based on the size and class of the CMV and the persons or cargo that is being transported. Title 43 §217.46 of the Texas Administrative Code states that any motor vehicle used for the primary purpose of delivering goods, including a passenger vehicle, must be registered as a CMV. Title 43 §217.54 of the Texas Administrative Code states that in cases where one entity owns 25 or more motor vehicles, the entity’s vehicles may be registered as a fleet, instead of individually.

Current Regulations for Vehicle Sales and Operations

In Texas, any person that buys, sells, or completes any business of exchanging motor vehicles must have a general distinguishing number, or a dealer license, that TxDMV issues under the provisions of Chapter 2301 of the Texas Occupations Code. In Texas, manufacturers may not sell vehicles directly to customers, and all vehicles must be purchased from a licensed dealer. A 6.25 percent sales tax is levied on vehicles sold in Texas, based on the sale price of the vehicle and not including trade-in allowance (24), or vehicles relocated and subsequently registered in Texas based on their net present value. This is true for cars, trucks, and buses—all are sold by licensed dealers. Chapter 2301 currently has no provisions for special considerations for CVs or AVs.

Expectations of Automated and Connected Vehicles in Texas

While Chapter 545, Subchapter J of the Texas Transportation Code authorizes AV operations, those statutes do not exempt AVs from registration requirements if the vehicles are operated on public highways, nor do they exempt AVs from compliance with sales and lease regulations in Chapter 2301 of the Texas Occupations Code. This is also the case for trucks operating in platoons with connected braking systems with shorter following distances under Title 7 §545.062(d) of the

Texas Transportation Code. AVs requiring registration to operate on state highways may find the completion of mandatory safety inspections set out in Chapter 548 of the Texas Transportation Code (related to equipment standards in Chapter 547) a challenge, given the unique design features of some zero-occupant delivery vehicles, which are not necessarily exempted. There are currently no requirements that a PDD be registered or inspected, but the name and contact information for the owner must be visible as required in Chapter 552A of the Texas Transportation Code.

Gaps in Vehicle Regulation Requirements for Automated Vehicles

The most prominent gaps in vehicle regulation are related to how sales and lease regulations and the interaction with registering vehicles may limit AV manufacturers (individually or in partnership with OEMs), and how state inspection requirements linked to vehicle equipment specifications affect certain kinds of AVs.

The regulations for AVs and PDDs are different. AVs and PDDs alike, when built to operate without a human driver or a human occupant, may also face challenges with inspection compliance because they are specifically built and not standard for vehicle inspections. TxDOT/TxDMV can look at what reasonable accommodations/amendments should be made to inspection requirements, as authorized to do so, to ensure these vehicles can still be successfully registered in the state.

Additionally, Chapter 552A of the Texas Transportation Code requires the owner's name and contact information to be visible on the device, but not all municipalities may be familiar with the requirements. During one incident involving the Starship deployment in Frisco, TX, a citizen was concerned that there was no phone number on the device, only a website address. The industry could work with the Texas Municipal League to develop best practices for product identification. Public and private cooperation could also develop best practices for incident response for the public, PDD operators, law enforcement, and municipalities.

Other Regulations and Issues

Current federal regulations and local policy need to be reviewed for applicability to AVs. This section highlights some of these regulations or other concerns that may become problematic with AVs.

Current Federal Safety Standards

Title 49 §571 of the Code of Federal Regulations (26) establishes the safety standards required for motor vehicles. These standards can require equipment to be on or in the motor vehicle or certain testing to be completed. The code includes the exact specifications for equipment and placement. While the current federal safety standards should not be repealed, they may not be relevant to the safe operation of AVs, especially when there is no human driver. Some AV developers choose to build their technology on FMVSS-compliant vehicles and retain all equipment that maintains FMVSS compliance. For these types of AVs, there is no conflict with existing FMVSSs. Other AV developers choose to develop novel vehicle designs or make modifications that are not compliant with current FMVSSs, such as removing the steering wheel for a vehicle never intended to be driven by a human. For those AVs, FMVSS exemptions would need to be granted for such vehicles to be deployed. Table 1 highlights but a few of the federal safety standards that may not apply to AVs, requiring AVs

to have either extraneous equipment installed simply for compliance purposes, or an FMVSS exemption in order to take such equipment out.

Table 1. Federal Motor Vehicle Safety Standards and Associated Concerns with AVs.

FMVSS	Requirement
Standard No. 101: Controls and displays	Driver warning and indicator system
Standard No. 102: Transmission shift position sequence, starter interlock, and transmission braking effect	Location and operability of the transmission shift lever
Standard No. 103: Windshield defrosting and defogging systems	Windshield defrost and defogging system
Standard No. 104: Windshield wiping and washing systems	Windshield wiping system
Standard No. 111: Rear visibility	Inside and outside rearview mirrors
Standard No. 204: Steering control rearward displacement	Location specification for the steering control system
Standard No. 207: Seating systems	Driver’s seat

NHTSA has recently published an Advanced Notice of Proposed Rulemaking (Docket No. NHTSA-2020-0106) to apply to ADSs, which are defined by SAE International as driving automation Levels 3 to 5. This rulemaking would develop a framework for ADS safety that “would objectively define, assess, and manage the safety of ADS performance while ensuring the needed flexibility to enable further innovation.” This framework might lead to development of new FMVSSs for ADS components if provided in a vehicle, not necessarily requiring ADS elements in all new vehicles. The applicability of FMVSSs to CVs and AVs is thus still in development.

Law Enforcement Issues with Automated Vehicle Licensing and Registration Regulations

Many AVs are distinctively designed or manufactured so that a law enforcement officer would be able to discern that some measure of vehicle automation was being deployed. Title 7 §545.456 of the Texas Transportation Code, which allows AV owners to identify their vehicles as such to TxDMV for registration purposes, does not necessarily specify how AVs are identified for law enforcement purposes. Title 7 §545.453 of the Texas Transportation Code makes the owner of the ADS responsible for complying with vehicle operation laws but also does not specify how such ownership is to be displayed or made accessible to law enforcement personnel. Defining the kind of visible marking to distinguish CV or AV vehicle operation may be best accomplished as best practices to be shared among state agencies participating in their national associations or as required by federal guidelines or regulations.

Case Studies Involving Licensing and Registration Requirements

As AV technologies grow and states continue to partner with the private sector to deploy them, lessons can be learned from the successes and failures of others. Case studies from Arizona,

California, and Florida offer specific examples of experiences with licensing and registration. By 2017, 18 states had introduced AV legislation, with 11 states enacting legislation (27).

Arizona

In 2015, Governor Ducey of Arizona signed an executive order that allowed the elimination of regulations that hindered the deployment of self-driving vehicles, while still requiring them to comply with all state and federal safety standards and regulations. The executive order instructed law enforcement agencies to develop first responder action plans (28). This executive order opened the door for testing of fully autonomous vehicles without an operator within the state. In 2018, Governor Ducey updated the executive order to allow fully automated vehicles to operate on Arizona roadways without a human driver.

California

In 2014, California began the Autonomous Vehicle Tester Program, which allows OEMs to test autonomous vehicles with a human in the driver seat. The OEMs must apply to the program, which is administered by the California Department of Motor Vehicles. As of September 1, 2020, the program had 60 permit holders. The following steps are a summary of the extensive permit application required to apply to the program:

- Obtain an Employer Pull Notice Program number, which allows commercial and government organizations to monitor their employees' driving records and enroll test operators in the program.
- Submit an application for a Manufacturer's Testing Permit.
- Obtain an Autonomous Vehicle Manufacturer Surety Bond or an application for self-insurance.
- Submit an operator training program description.
- Submit a copy of the articles of incorporation, corporate minutes, or other document filed with the Secretary of State, which identifies the officers, shareholders, and managers (if filing as a corporation, limited liability company, or limited liability partnership owned business) (29).

In 2018, this program expanded to the Autonomous Vehicle Tester Program, which allows OEMs to test vehicles without a human in the driver seat. As of October 2020, the program had five permit holders. The following documents, among others, are required to apply to the program:

- Autonomous Vehicle Tester Program Application for Manufacturer's Testing Permit.
- Autonomous Vehicle Manufacturer Surety Bond or Autonomous Vehicle Tester Program Application for Certificate of Self-Insurance.
- A copy of the articles of incorporation, corporate minutes, or other document filed with the Secretary of State, which identifies the officers, shareholders, and managers (if filing as a corporation, limited liability company, or limited liability partnership owned business) (30).

Both programs require a \$3,600 fee to participate in the program. This fee includes 10 vehicle permits and 20 operator permits. Additional fees are required to add vehicles and drivers. In the

testing program, the vehicles must be registered in California or operate under manufacturer or distributor plates and have a California Certificate of Title. Operators must certify that they will only operate the vehicles for testing purposes (30).

California has not yet integrated CMVs over 10,000 pounds GVW into its Autonomous Vehicle Tester Program. This has created a high degree of regulatory uncertainty for CMV ADS developers. Long-haul shipping is now seen as one of the first likely deployments of automated driving, but with this regulatory uncertainty, the likelihood of its early deployment in California may be diminishing. Texas could avoid this fate by addressing AVs in a comprehensive manner that is vehicle agnostic when appropriate.

Florida

In July 2019, Governor DeSantis of Florida signed a law allowing fully autonomous vehicles at SAE Level 4 or 5 to operate within the state without a safety driver. The law also required shared service companies, such as Uber and Lyft, to provide \$1 million in liability coverage for these fully autonomous vehicles. Passengers of these fully autonomous vehicles also became able to use wireless devices as a part of the law (31, 27).

Balancing Regulatory Posture and Economic Development

The successful deployment of AV policy will require a balance between regulatory posture and economic development. AVs will need to be regulated in a way that the policies of OEMs and local stakeholders are not hindered, and economic development can thrive.

Texas has been making great strides in becoming a leader in AV deployments. Austin has received some of the largest amounts in funding opportunities across the United States, and AV stakeholders continue to set their sights on Texas as one of the major playing fields to test their products. Both Aurora and Tesla have recently shared that they will be expanding their activities in Texas.

Texas Transportation Code Encouraging Deployment and Innovation

By enacting AV legislation in 2017, Governor Greg Abbott and the Texas Legislature created an environment that has allowed the AV industry to expand its testing and development in Texas. By clarifying the legal obligations of AV developers and vehicle owners, Governor Greg Abbott and the Texas Legislature have also increased the regulatory certainty for these firms to consider deployment and development opportunities in Texas. This has increased the number of AV-related jobs in Texas and has allowed Texas businesses and vehicle owners a wider range of choices for vehicle purchases and transportation services that may increase traffic safety and expand infrastructure capacity.

Texas public agencies can document the results of AVs and new driver assistance technologies, which decision makers and regulators can use to inform decisions about how to respond to specific regulatory issues or gaps. In the absence of clear guidance and regulations at the federal level, Texas and other states have the chance to tailor their regulatory responses to AVs to increase safety for all motorists, and to increase opportunities for Texas businesses and consumers to use new technologies to expand economic opportunity. Any regulations would need to be made at the state

level in a way that provides regulatory consistency and maximizes opportunities for economic development.

Scenarios for Public Expectations for Regulation and Risk Management of Automated Vehicles on Roads

Sometimes public regulation seeks to respond to and prevent adverse outcomes of the past in a way that constrains future development of new technologies. As AVs are involved in crashes, many parties in the transportation policy environment—drivers, insurers, crash litigation firms, organized labor, and advocacy groups—will react in ways that can affect the operating environment for AVs. An AV-pedestrian fatal crash in 2018 in Arizona had significant implications for TNCs adopting AVs. As larger AVs are involved in crashes in Texas, elected officials and public agencies will need a broad range of information at their disposal to respond to the crashes in a way that balances the safety risks of AVs with the safety risks of other vehicles. Some of the education messaging discussed previously could help motorists, motor carriers, and law enforcement make informed decisions about how to modify the regulatory framework for AVs in Texas.

Opportunities in Texas

This document identifies a series of regulatory opportunities to clarify AV development in Texas and outlines a series of information/education opportunities to expand understanding of AVs in the state.

Regulatory Opportunities

This document identifies some opportunities for additional clarity in the interaction of current statutes and regulations and AV deployment:

- **Regulatory flexibility:** AV developers and TxDPS could collaboratively discuss compliance with state motor vehicle equipment standards and current AV configurations, particularly for PDDs and zero-occupant vehicles. TxDPS can determine how much regulatory flexibility it has to accommodate these unique AV designs.
- **Stakeholder collaboration:** AV developers and manufacturers, TxDMV, and the Texas Automobile Dealers Association could discuss how current dealer licensing/sales laws and registration rules affect the range of commercial relationships between OEMs and AV developers.
- **Alternative opportunities:** If some AV developers are considering alternatives that include AV operation entirely by remote operators (rather than by onboard software that controls vehicle driving tasks), the AV industry may want to interact with applicable state agencies to determine how the current regulatory structure addresses such operations.

Further Opportunities for Discussion among Stakeholders

This document also identifies a series of opportunities for the public and private sectors to cooperate in advancing AV development in Texas. As AV developments continue in the future, there is an opportunity for all stakeholders to continue the conversation to produce continued benefits for all. The following questions can guide this discussion:

- **Law enforcement engagement:** How can the AV industry engage with TxDPS and local law enforcement organizations to develop voluntary standards to provide law enforcement with readily available information on which entity meets the operating and licensing requirements of Chapter 545, Subchapter J of the Texas Transportation Code? Can this be developed nationally through associations of state transportation and regulatory agencies working with the AV industry?
- **Public transportation engagement:** How can the AV industry collaborate with public transportation agencies represented on the Texas CAV Task Force in addressing some of the education and messaging opportunities identified in other Texas CAV Task Force white papers for different segments involved in transportation?
- **Future regulations and planning requirements:** How can the Texas CAV Task Force share information on possible AV regulations or planning requirements that may be included in congressional action on surface transportation reauthorization?

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